Measuring Our Path to the Future

Using Indicators of Sustainable Development in Transportation Planning

Interim Report

April 2000

Project Team

State and Local Policy Program

Lee Munnich Jr., Senior Fellow and Director
Cynthia Pansing, Transportation Research Manager and Research Fellow
Barbara Rohde, Research Fellow
Michelle West, Research Assistant
Craig Lamothe, Research Assistant
Andrew Mielke, Research Assistant

Claremont Graduate University

Tom Horan, Executive Director
Grant McMurrin, Research Assistant
Jason Venetoulis Research Assistant

Project Sponsor

Minnesota Department of Transportation

The Humphrey Institute of the University of Minnesota is hospitable to diversity of opinions and aspirations. The Institute itself does not take positions on issues of public policy.
TABLE OF CONTENTS

ACKNOWLEDGEMENTS........................................................................................................... i

EXECUTIVE SUMMARY AND RECOMMENDATIONS......................................................... ii

INTRODUCTION..................................................................................................................... 1

CHAPTER ONE..................................................................................................................... 7
Sustainability Indicators and Selection

CHAPTER TWO................................................................................................................... 13
The Urban Context
Section 1: Lake Street Case Study..................................................................................... 21
Section 2: Sustainability Indexes and the Lake Street Corridor......................................... 27

CHAPTER THREE............................................................................................................. 47
The Rural Context
Two Harbors Case Study.................................................................................................. 48
Microcase Studies............................................................................................................. 56

APPENDIX A: Tables

APPENDIX B: Maps

APPENDIX C: Documents

APPENDIX D: Sustainable Transportation Technology

APPENDIX E: Outreach Materials
Acknowledgements

The project team wishes to thank Congressman Martin Olav Sabo for his great interest in finding ways to implement sustainability and the Minnesota Department of Transportation, whose financial support made this study possible. We wish to acknowledge the work of each of our advisory committee members. Their contributions to the project team proved invaluable.

Finally, we wish to thank all of the individuals who participated in the project and to Minnesota officials, planners, and community organizers for their continued efforts to create a more sustainable Minnesota.

The State and Local Policy Program Project Team
EXECUTIVE SUMMARY

As a region, state, and nation, we are attempting to become more intelligent and more ecological in our land use practices. Transportation planning and design are fundamental pieces of the land use puzzle. As we move into the 21st century, our transportation systems will be increasingly called upon to enhance community livability and protect green space, in addition to providing access. Novel transportation planning and design frameworks are necessary to meet these and future demands.

This report discusses the use of indicators in transportation planning to achieve sustainable communities. Indicators were applied in both rural and urban settings, then mapped using geographic information systems (GIS) — a visual modeling tool, which can be used to help communities make informed decisions. While many cities and towns around the country are using GIS to inventory key characteristics, few are harnessing the power of this tool to measure progress toward sustainable communities and smart growth. After an extensive literature review of the field, the research team undertook case studies in both urban and rural contexts, conducted interviews with transportation planners, and assessed indicator data for an urban corridor in Minnesota.

Sustainability and smart growth are conceptual frameworks that aid in the development of community friendly and environmentally sensitive approaches to transportation design, land use, and economic development. While “sustainability” is a term that preceded smart growth, both adhere to these principles.

The Ventura Administration’s Smart Growth Initiative is one way Minnesota is moving toward an integrated transportation system. This initiative, focuses on making wise use of land and natural resources, linking public investments, creating choices and incentives for local communities, and engaging citizens in planning and decision-making will go a long way in moving Minnesota toward this goal.

Significant findings of the research include:

- The state of the art in measuring progress toward sustainable transportation systems involves tracking indicators and applying them through the use of visualization techniques and mapping.
- The capacity for assessing indicators of sustainability or smart growth varies widely by region; in particular rural areas seem to lack the capability to do so.
- There are community planning techniques, such as the TAM Process, that can integrate the overall concept of environmentally-responsive transportation systems into local transportation planning efforts, though these have yet to utilize innovative planning methodologies.
- In the urban context, there is considerable data for assessing transportation impacts, yet the relationship between transportation, the built environment, and the surrounding community is quite complex and requires an integrated policy approach and understanding.
Central Research Findings:

1) **Indicators are necessary to measure progress toward smart growth initiatives.**

The first and most general observation of this study is that good indicators are needed to measure progress toward environmentally efficient growth. As government agencies are becoming more outcome-based in their efforts to demonstrate performance and efficiency, so must our transportation systems. The better we become at measuring our progress toward a balanced transportation system, the more likely we will be to know when we reach it.

2) **Enhanced data collection capacity is needed in order to measure smart growth objectives, particularly in non-urban areas.**

There are two parts to this observation. First, because existing Minnesota transportation data was collected for traditional transportation planning rather than for sustainable or smart growth, it does not include all of the information that would be needed to benchmark these objectives. For example, because smart growth emphasizes mixed use, pedestrian-oriented development as a means to decrease automobile dependence, it would be useful to have information on pedestrian trips as well as automobile trips. However, this data was not available for any of the case study areas examined in this project. Second, there seems to be a disparity between the urban and rural areas in Minnesota in GIS capacity. While most Minnesota communities seem to have access to GIS, GIS-ready data was found to be far more prevalent in the Twin Cities than the rest of Minnesota. In order to fully implement a smart growth indicator program in Minnesota, a new system of collecting and storing GIS-ready information is necessary.

3) **Minnesota is in a position to be ahead of the curve nationally as an innovator in planning for smart growth.**

Minnesota has a long history of progressive land use policies aimed at efficient planning and resource use. The Minnesota Community-based Planning Act of 1997 and the Livable Communities Grant Program, as well as the leadership of the Metropolitan Council, have helped put Minnesota on the smart growth map. However, as new technologies for mapping and visualization have emerged, Minnesota has not kept pace with initiatives by other states. For example, Envision Utah, a project to help citizens understand the trade-offs associated with sprawl, is a good example of a visualization technique that Minnesota should consider. At the same time, Maryland has implemented an incentive scheme to encourage growth in appropriate places and San Francisco has begun implementing an initial sustainable transportation indicator program. Minnesota is in a unique position to join leading states on the national stage as an innovator in planning for smart growth by harnessing the power of new technologies and techniques in land use and transportation planning.
INTRODUCTION

Traditional transportation policy solutions to population and economic growth, which emphasized highway capacity, are increasingly becoming a thing of the past. The Intermodal Surface Transportation Efficiency Act (ISTEA), along with its successor legislation, TEA-21, have set the stage for the smart growth movement by encouraging development of transit and bike lanes, as well as land uses that minimize the need to travel long distances. While capacity building continues to be one goal in the transportation arena, multiple aims of the transportation system, including livability, mobility, accessibility and environmental sustainability are gaining importance.

Past research by the State and Local Policy Program and Claremont Graduate University identified a need to refine ways of measuring progress toward non-traditional, integrated transportation systems. Predecessor projects included Wired to Go\textsuperscript{1} and Transportation and Information Technologies for Sustainable Communities.\textsuperscript{2} Both of these projects provided useful background for this study on how transportation technologies can help create more livable places, as well as the connections between transportation and sustainable community development. In addition, the Midtown Greenway Project\textsuperscript{3} identified the need to integrate transportation design, financing and planning, and provided valuable background information on the Lake Street Corridor. This study provides measurement tools and implementation processes necessary to foster integrated transportation planning in urban and rural communities.

Why measure our progress toward more integrated transportation systems?

The transportation system has a major impact on our built environment, and in turn, our quality of life. For example, delays in traffic decrease the amount of time spent with family. Also, when farmland and forests are lost, there is less green space available to be enjoyed. Finally, if population increases continue without new land use policies, congestion and loss of green space will only increase.

Numbers published by Minnesota Planning indicate the extent to which Minnesota is feeling the impact of sprawl.\textsuperscript{4} First, Minnesotans are driving 42% more, while the number of roads has remained constant, resulting in delays due to congestion. At the same time, Minnesota is steadily losing farmland, forests and wetlands. Farmland has decreased by more than 200,000 acres since 1982. Forest land has shrunk by 2.2 million acres in the last 20 + years. As of 1992, about half of Minnesota’s 20 million acres of wetlands had been drained. At the same time, the population continues to increase steadily at 1%.

\textsuperscript{1} SLPP, Claremont Graduate University, and the Surface Transportation Policy Project, “Wired to Go,” August 31, 1998.
On the national level, people are paying for automobile dependence through increased congestion and health impacts. In a report by President Clinton's Transportation and Sustainable Communities Initiative, these trends were identified as serious cause for concern. They found that transportation accounts for as much as one-third of U.S. emissions of greenhouse gases. In addition, after bottoming out in 2010 at levels about 30% lower than in 1990, nitrogen oxide emissions in the Northeast Ozone Transport Region will reverse course and begin climbing through 2015 and beyond. At the same time, 120 million U.S. residents live in areas with unhealthy air, violating National Ambient Air Quality Standards and annual congestion costs are $6.6 b. in NY and $7.7 b. in LA, where it would require 665 new lane miles of highway annually to maintain current mobility.

**The Smart Growth Movement**

Closely related to Sustainable Development, smart growth focuses on reducing congestion, making efficient use of land, preserving open space and advancing integrated transportation policies. In addition, it encourages the use of transportation options such as transit, biking and walking through mixed-use, urban infill and compact development that are found to result in decreased dependence on automobiles.

Increasingly popular with constituents and policy makers, smart growth has become a policy tool for encouraging livable communities. In the November 1998 elections, voters overwhelmingly said “yes” to smart growth and open space initiatives. Of the 240 measures on the ballot at all levels of government, voters approved 72 percent and agreed to more than $7.5 billion in financing for these measures.

Smart growth has become one policy tool which decision-makers can draw upon to weigh the alternatives related to land use and transportation. While Smart Growth is still evolving, it has become a useful tool help increase awareness of the impacts arising from unchecked growth.

**Policy Context**

In 1992, the United States met with nearly 180 other countries at the “Earth Summit.” A commitment was made by these countries to pursue sustainable development as the operating principle for their respective nations. In the United States, this commitment has led to an increased emphasis on smart growth practices and federal funding for state and local governments to use new visual modeling technologies, as well as the establishment of the President’s Council on Sustainable Development.

---

5 President Clinton's Transportation and Sustainable Communities Team, “Transportation and Sustainable Communities Initiative: Overview of Federal Sustainable Transportation Activities,” June 1998.


7 President Clinton’s Transportation and Sustainable Communities Team, 1998.
In addition to the Council, the Clinton Administration has established a Livability Agenda. This initiative, announced on January 11, 1999, seeks to protect green space, alleviate traffic congestion, promote sense of place, encourage cooperation at the regional level, and promote economic competitiveness. According to the Administration, these five elements taken together encourage livable community development. Also, in President Clinton's fiscal year 2000 budget, smart growth was highlighted as a means for communities to increase planning flexibility. The budget includes $7 million to fund a grant program to promote geospatial applications for better community land use.  

Minnesota Governor Ventura is also an advocate for smart growth. The administration has introduced a Smart Growth Initiative focused on making wise use of land and natural resources, linking public investments, creating choices and incentives for local communities, and engaging citizens in planning and decision-making.\(^9\) One component of this initiative is a set of smart growth criteria that is currently being developed by the Minnesota Finance Department. These criteria will be used by the Administration to evaluate capital bonding proposals. Key components of these components may include using existing urban lands and infrastructure instead of greenfields, having consistency with comprehensive plans, broad citizen buy-in and promoting housing and transportation options for the community.\(^10\)

The Minnesota Department of Transportation (MnDOT) has made sustainability a key aspect of its mission. By stressing the need to integrate all forms of travel and make connections between them, the Department’s mission highlights the need to encourage sustainable transportation practices.\(^11\)

*We will lead and act to:*

- Preserve, manage and improve the state's highway system;
- Promote and support the transit, air, rail, waterways, bicycle and pedestrian system;
- Promote non-travel alternatives; and
- Promote and support connections among transportation systems.

The Department also recognized in its 1997 Strategic Plan the fact that "Minnesota citizens are concerned with having transportation choices that balance personal, social, economic and environmental values."\(^12\) In its vision, the Department acknowledges the need to respond to the values of Minnesota's citizens.\(^13\)

\(^9\) [www.metrocouncil.org/planning/smartgrowth.htm](http://www.metrocouncil.org/planning/smartgrowth.htm)
\(^10\) "Ventura Administration Creates ‘Smart Growth Criteria’ For Bonding," 1000 Friends Newsletter, November 2, 1999.
\(^11\) Minnesota Department of Transportation, "Charting our Course, Strategic Plan," June 1997.
\(^12\) Ibid.
\(^13\) Ibid.
More recently, MnDOT has demonstrated its emphasis on these aspects of its mission in two ways. First, the Department has implemented the use of performance measures to measure its progress toward its mission. Second, the Department has designated the Sustainable Transportation Initiatives Group to help manage traffic growth by integrating bicycling, walking, and telework with all other modes so that they become safe, realistic, alternatives to driving.

The Sustainable Transportation Initiatives Group (STI) is a group within the Office of Advanced Transportation at MnDOT that has been developing ways to leverage public support for transportation projects that promote sustainable transportation objectives and incorporate community values into the transportation planning process. One of the ways STI is achieving this end is by providing a means through which members of the community can participate in the transportation planning process from the outset, rather than after all of the technical decisions have already been made. By tapping into the knowledge and interests of the community from the beginning, MnDOT is finding that it can better address its mission of integrating all forms of transportation and better respond to the values of Minnesota citizens.14

One way STI has begun to do this is through the use of the Transportation Action Model (TAM). The TAM was initiated and designed by a national consortium led by staff at the U.S. Department of Agriculture (USDA) who sought to develop a planning framework that would respond to the emphasis placed on public input embedded in ISTEA. The Model was designed specifically for use in rural and small urban areas to help local leaders take a more active role in transportation planning. USDA found the need for developing such a tool to be particularly important as a means of stabilizing economies in rural communities that are often specialized in a limited number of industries including agriculture, making them particularly vulnerable to economic downturns and inclement weather. With enhanced public input, it was thought that responses to such conditions specific to rural and small urban areas would be more likely to be considered and reflected in transportation planning activities.15

Indicator Applications

One of the best tools available to help communities make informed decisions that can lead to more integrated transportation systems is visual modeling.16 But to do so, a state agency or local unit of government needs the data resources necessary to accurately assess its land use and transportation systems. While several large metropolitan areas have begun to store digitized data down to a parcel level for purposes of balanced, efficient community planning focused on livability and sustainability, many more metropolitan areas have foregone such data collection. Also, in non-urban areas, such analysis is sometimes overlooked as an inefficient use of time and resources, especially

15 North Central Regional Center for Rural Development, Iowa State University, "Transportation Action: A Local Input Model to Engage Community Transportation Planning," April 1996.
16 For more information on visual modeling see Appendix D: Sustainable Transportation Technology, or http://www.wenet.net/~shprice/home.html
since such communities have not yet experienced the magnitude of growing pains facing their urban counterparts. However, there are the rare exceptions that are quickly becoming the norm in certain communities.

For example, in rural Oregon, the Mid-Willamette County Council of Governments facilitated the development and implementation of 15 advanced visual modeling systems for each of their member local units of government. Through an innovative combination of grants from the Oregon Economic Development Agency and the Environmental Systems Research Institute (ESRI), these governments obtained the resources necessary to apply digitized data analysis and create a common database containing data down to the parcel level.

Another example of local communities coming together to apply new analytical frameworks to enhance local planning initiatives is the North Metro I-35W Coalition project. This coalition of local governments has come together to address their concerns about the shortfalls of conventional transportation planning processes that focus too much on target Levels of Service (LOS) on the major road networks rather than serving broad-based, local community social, economic and environmental needs. Through innovative application of visual modeling and sustainability indicators, the Coalition hopes to refocus the objectives of transportation planning on communities' needs and values.

**Research Methodology**

The study methodology included several case study applications in both urban and rural contexts, interviews with transportation planners, extensive review of the sustainable indicators literature, and quantitative assessment of indicator data for an urban corridor in Minnesota.

The case studies involved four communities of various sizes, at different stages of transportation planning and with different geographic characteristics were chosen in which to apply the indicators. The Transportation Action Model (TAM) was used to explore ways to incorporating indicators into transportation planning processes. The cities of Two Harbors, St. Peter and Nisswa each had experience with this Model. While the Lake Street Corridor did not have experience with the TAM, it was chosen as a study area because of the community character and the depth and richness of data available.

There were two levels of analysis undertaken in the case studies, “major” case studies and “micro” case studies. GIS analysis was applied to the major case studies, and a quantitative assessment of the indicators was performed in the Lake Street case study. Initially, the project team planned to apply the indicators in Two Harbors and the Lake

---

17 Personal correspondence with Rob McDougald at the Mid-Willamette County Council of Governments on August 19, 1999.
Street Corridor only. However, it soon became apparent that applying the indicators to a broader range of communities could enhance the case study analysis. This scan of a range of communities was intended to help ascertain how the applicability of the indicators would differ based on the particular characteristics of a community.

The micro case studies served as a medium through which the project team explored via interviews with community transportation planners their interest and inclination in using sustainable transportation indicators in their day-to-day work. The micro case studies also provided a forum through which the project team could introduce the concept of sustainable transportation into the community transportation planning process, and begin to apply relevant sustainability objectives and indicators within the community context, albeit through a surface scan. Because St. Peter was in the process of completing a TAM, this city was the perfect location to apply this portion of the research.

In addition to the case studies and micro case studies, literature searches were also performed for this research project. From these literature searches were gleaned best practices in the development and application of sustainability indicators to be used in each of the study areas and the best visual modeling techniques available for communities in planning sustainable transportation systems.

**Strengths and Weaknesses of the Research**

There are some specific strengths and weaknesses that should be noted. One strength in particular was the mixture of urban and rural communities. Because most studies on smart growth have focused on urban areas only, this fact sets this research apart.

However, due to the lack of GIS-ready data for the rural case study comparisons between the studies was difficult. Another weakness of the study is the low sample size. While the research involved four communities: Lake Street, Two Harbors, St. Peter and Nisswa, quantitative assessment of indicator data was only conducted for Lake Street. While this was partly due to lack of data, it is important to note that a larger sample size would have yielded more statistically significant findings. Therefore, generalizations about the impacts of certain community design characteristics on travel behavior were not possible. In addition, because all of the communities studied were located in Minnesota, generalizations about impacts on travel behavior in other states can not be made. Finally, while one survey was conducted, the process for obtaining community input was not consistent across applications.
CHAPTER 1: Sustainable Transportation Indicators

Tools to Measure Our Way

Indicators provide the kaleidoscope through which to view the big picture of sustainability. Individually as small bits of information, indicators reflect the status and progress of larger community systems. Taken together, indicators can help decision-makers make better choices through a more integrated, and when mapped, colorful, understanding of the whole.

Unlike traditional measures, such as Gross Domestic Product, unemployment rates, or in the transportation arena, traffic counts, which treat economy, society and the environment as often disconnected, unrelated realms, sustainability indicators attempt to measure progress in all of these areas at once.19 As Dr. Lamont Hempel, a sustainability advocate and theorist, describes indicators, they are “essentially integrative measures of ecological, social, and economic health that are designed to gauge a community’s systemic balance and integrity over long periods of time.”20

Though they are non-traditional measurement tools, like GDP indicators are often very powerful. Not only can they help communities make better informed decisions about their future, they can improve accountability by providing a benchmark by which communities can gauge their progress toward goals in a city plan or community agenda. Indicators can be leverage points within systems to make change happen because it is being measured, without the initiation of any new regulations, programs or policies.21 They are also leverage points to inspire actions at many levels of communities.

Information provided by an indicator or set of indicators can alert communities to patterns of development, transportation, or energy use that are out of sync with sustainability objectives and help provide direction for corresponding changes. For example, an integrated set of sustainability indicators could reveal that over a given period of time, air quality has been diminishing as the number and length of trips by mobile source, gasoline-powered vehicles has increased while stationary source, commercial and industrial air emissions have remained steady. Such an indicator could help determine the probable sources and levels of the unhealthful air pollution, as well as the segments of a community most vulnerable to it. This type of information can help clarify where effective change needs to be made to anticipate and turn around environmental decline.22

20 Lamont Hempel, Sustainable Communities, Claremont: CGU 1998
21 Tyler Norris Associates, 3.
22 Information on software packages available to track such indicators is discussed in Chapter 5 of this report.
**Indicator Selection**

The first step taken in the process of indicator selection was a detailed literature search of international, national, state, and local sources serving as examples of best practices in indicator research and projects. This search procured information on several hundred indicators that were considered for use by the research team. This list included several types of indicators, from those that were just theoretical and never field-tested, to indicators that not only have been field-tested but also systematically put into practice in many communities. In addition, there were two categories of indicators identified, among which there were two subcategories. These categories consisted of performance measures and community measures. Both quantitative and qualitative performance and community measures were found.

In narrowing the list of indicators chosen, the research team decided to focus on indicators that could be explored using extant data for two reasons. First, the team wanted to delve into the types of indicator analysis that could be completed without extensive, original data collection. This exercise would allow the team to identify what data sets were readily available for objective application and analysis of the indicators that communities themselves could collect and use. The primary sources used in the compilation of the final list included materials from Hart Environmental Data, the City of Minneapolis, and the Victoria Transport Policy Institute. In the second phase of indicator selection, several dozen indicators were identified relating to transportation and community sustainability. This list included indicators that were directly or indirectly related to transportation plus indicators critical to the discussion of community sustainability in general.

The initial set of indicators was narrowed in the first phase of the research project was guided a sense of community interests and feasibility of data collection. The guiding principles for indicator selection used by the team are listed below:

- Had a transportation element or connection;
- Data to calculate the indicator existed;
- Were measurable at the community scale;
- Helped to relate data gathered to individuals (through %, ratios or per-capita calculations);
- Were understandable to community members;
- Contributed to a balance between indicators that can be monitored yearly and indicators that are better suited to measure long-term progress;
- Were able to measure direction toward or away from sustainability;
- Contributed to a balance of indicators that measure all aspects of sustainability; and
- Allowed ready testing of the relationships between indicators.

---

23 The indicators used by Hart Environmental Data can be found at http://www.subjectmatters.com/indicators/HTMLSrc/Indicators.html.
Next, a worksheet was designed as a tool to help reduce the list of indicators to a reasonable number that could be objectively field-tested in the case studies. The worksheet used selection and evaluation of sustainable community indicators and helped the research team narrow the indicators based on the principles listed above.

The Initial Indicator Set

The following indicator set was established as the base list examined in each of the case studies:

- Ratio of E85 FFV to Non-E85 FFV
- Percentage of Household Expenses Spent on Transportation
- Time Devoted to Non-Recreational Travel Per Capita
- Percent of Traffic Injuries to Pedestrians and Cyclists
- Ability of Non-Drivers to Reach Employment Centers
- Ability of Non-Drivers to Reach Basic Services and Recreation
- Ratio of Street Intersections to Intersections and Cul-de-Sacs
- Percent of Street Miles Designated for Bike Route Miles
- Ratio of Trails to Streets and Roads
- Percent of Street Frontage with Sidewalks
- Land Per Capita Used for Transportation
- Ratio of Low-Emission Vehicles to High-Emission Vehicles
- Population Density
- Mode Split
- Vehicle Miles Traveled Per Capita
- Vehicle Hours Traveled Per Capita

Sustainability Indexes

After the core indicators had been applied to the case study sites, as well as additional indicators that were particularly applicable in an urban setting, the project team evaluated the preliminary findings. While the information gained by the core set of indicators provided useful insights, there were aspects of community sustainability that did not seem to be adequately reflected through this core set. In addition, there appeared to be ways that indicators could be applied in combination that might fill some

---

26 To view a list of the core indicators accompanied by a description of why they were chosen see Appendix.
of the holes that could be better addressed by a combination of indicators. These areas included economic viability, air quality and transit access.

The team recombined indicators and added some new indicators to construct "indexes." These new "indexes" were then viewed alongside one another to grapple with the ways they could be used to augment the core set of indicators. Because the Lake Street Corridor was the study area with the highest degree of data availability it was chosen as the test bed for these indexes.

In order to measure the attributes associated with more livable neighborhoods, including steady housing stock, low crime, ample employment opportunity, improved air quality, and transit options for individuals without access to single occupancy vehicles, the following combinations of indicators were used:

- **Economic viability** - First, median income, median home values, housing availability and crime were combined. Next, the population density and percent impervious surfaces were combined. These two composite measures were then combined further and used as the basis of this group of measures.

- **Air quality** - Through mobile source emissions. In order to assess the areas in the Twin Cities that contribute the most to automobile emissions derived from trips to or from the Lake Street study area, the team used vehicle trips by destination transportation analysis zone (TAZ), modal split and annual vehicle miles traveled to find an aggregate emissions-generated figure.

- **Equitable transit access** - Finally, age, location of major community destinations and number of automobiles owned per household were used in combination with a plotting of transit routes to measure how well transit is serving the study area.

The indexes will be discussed in further detail in Chapter 4.

**Mapping Indicators**

Mapping has always played an important role in transportation planning by providing visual information and visual referents to aid decision-making. But two-dimensional maps as representations of select, natural and man-made physical features present incomplete graphic information. While physical features are shown in proximity to one another, the underlying relationships and interactions between these layers of information are not adequately illustrated through two-dimensional surfaces.

New technologies have facilitated the creation of three-dimensional maps which yield information about components of a system (or community), their interactions and impacts. With the aid of geographic information systems (GIS), many geographic and other physical features and relationships can be presented in a single image. Transportation, economic, and environmental data, for example, can be integrated to show a more complete, systemic picture of communities.
This integration of multiple features and maps is necessary to fully represent how social, economic and environmental systems interact. For example, a new road can and will influence the economic and social structure of a community. Roads can enhance the mobility of an area's residents as well as provide more direct throughways for goods movement and thus help spur economic development. Physically, roads can create barriers and boundaries between communities or parts of the same community where none existed before. Roads influence the shape of communities - from population density to the type and direction of residential and commercial development. Better representations and measurements of the multiple influences that transportation systems have on our built and natural environments will provide communities and decision-makers with three-dimensional "road-maps" and the tools necessary for making and implementing more informed, sustainable policies.

Chapter Summary

As has been demonstrated by the use of traditional indicators, such as GDP, indicators are powerful. They frame debates, steer planning, affect budgets, and motivate action. Indicators, as new measures of progress, are being discussed and applied, globally and locally. In an increasingly complex world, the search for better indicators must be a continuous one.

Like bits of colored glass in a kaleidoscope, indicators can be combined to help us see the patterns and systems embedded in our communities and neighborhoods. Our findings lend support to the contention that the lens that is our perception of the world can be made more complete through the use of indicators, measuring all of the spheres within which communities hope to succeed.

As points of leverage, indicators can help community members push for new policies, urban developers implement innovative proposals and planners measure performance. Indeed, indicators and the concept of sustainability can provide the channel through which to communicate and achieve multiple aims at once.

More and more, the process of choosing our measures of progress must be a collaborative process, drawing on the creativity of the whole community. Many communities, inspired by the goal of achieving long-term health and sustainability, are finding more integrated measures of progress. But they understand that measuring progress is not the same as making it, and they are now turning to action. With their indicators as their guide, they are working to reverse the negative trends and strengthen the positive ones - and to create the communities that they envision handing down to the next generation.
Chapter 2: The Urban Context

This portion of the research applied sustainable transportation indicators that showed substantial merit in defining key development characteristics that lead to sustainable transportation behavior in the urban environment. The Lake Street Corridor in Minneapolis was the area of focus, though all of the communities in the Hennepin County jurisdiction were considered as a point of contrast.

The Lake Street Corridor is a section of Minneapolis reaching from the Mississippi River on the east to Calhoun-Isles on the west and from approximately Highways I-94 on the north and 36th Street on the south. Several different neighborhoods are included in this study area, ranging from more affluent neighborhoods located around major recreational areas including Lake Calhoun and Lake of the Isles in the west, to a stable, working-class neighborhood in the east along the Mississippi River. Throughout the central portion of the study area are more distressed or transitional neighborhoods, though they too have pockets of vitality. The poverty rate in these central neighborhoods sometimes exceeds 50% of the total population.27

The Lake Street Corridor was chosen as a case study site for several reasons. First, the research team was familiar with this site through past research on sustainability in this corridor. In the Midtown Greenway project, an assets and liabilities survey was conducted and the data obtained was mapped. This data was useful background for this project. In addition, the variability of the Lake Street Corridor, from different neighborhoods with different types of development, provides an interesting test bed for pursuing sustainability indicators. Finally, because the corridor is located in the urban core of Minneapolis, this study area satisfied the project team’s desire to study an urban area in the second case study.

Research Questions

One of the indicators presented in Chapter 1 that the project team assumed to be a critical factor in creating the foundation for a sustainable transportation system in an urban area is population density. Relatively high population density accompanied by mixed-use retail that is easily reachable via means other than the car seems to stimulate alternative modes of transportation such as walking and bicycling. Generally, however, in urban and suburban areas, the trend away from compact living questions its desirability. Also, high population density implies urban space consisting mostly of concrete and rooftops, which is not typically associated with environmental sustainability. The research team found that this problematic feature of population density warrants additional and innovative research on this topic. Subsequently, the part population density plays in sustainable transportation constituted the research team’s second research question for this case study.

**Methodology**

ZIP code was the unit of analysis in this project. While this relatively large-scale level of analysis reduced our ability to make detailed description of the corridor, it did allow us to compare the Lake Street corridor with the rest of Hennepin County. Four ZIP were identified as constituting the Lake Street corridor, (55404, 55407, 55408, 55409 - see Map 1). Once we identified the Lake Street corridor ZIP codes, we were then able to compare indicators from ZIP codes in Hennepin County outside of the corridor. Using ZIP codes as the unit of analysis also allows relative simply comparisons with other areas of the United States.

This project uses a variety of data sources to compile the sustainable transportation indicators. The United States 1990 census was the primary source for most of the basic demographic data such as population totals and travel times to work. Data purchased from National Decision Systems contributed household spending data and travel diaries obtained through the Metropolitan Council provided trip behavior data. The Metropolitan Council also provided land use data that was critical in calculating the impervious surface indicators.\(^{28}\)

Innovative methodologies in compiling some indicators were used. A community assessment survey conducted by Lyn Kathlene and Tom Horan had respondents place their community appraisal on a hand drawn map. These maps then were converted digitally by the aid of GIS that then created maps that represented composite community assessments. GIS was also used to create the impervious surface indicator.

GIS aided in the analytical portions of this report. Once the indicators were placed on a map, spatial patterns appeared. Often a "bull's eye" effect appeared on the map as the ZIP code indicators consistently changed color the further they were from downtown Minneapolis. Map after map these patterns were the rule rather then the exception supporting our belief that the Lake Street corridor was significantly different from the rest of the county.

T-tests were conducted to statically test the differences between the Lake Street corridor and the rest of Hennepin County. Multi-variant regression was used with a number of the indicators with the ZIP being the unit of analysis. The regressions were conducted to determine the influences of certain indicators on others. Because the research team hypothesized that population density and impervious surface strongly influenced transportation choices, regression analysis is the logical method.

Finally, the three indexes, economic viability, air quality and equitable transit access were applied to the Lake Street Corridor.

---

\(^{28}\) The authors wish to thank Craig Lamothe for his diligent support in helping us obtain this data from National Decision Systems and the Metropolitan Council.
Sustainable Transportation Indicators

The point of departure for this study is the core indicator set from Chapter 1. While this list provides a good foundation for studying sustainable transportation, we needed to deviate from some of these indicators for a variety of reasons. The first was limited data availability. Second, some of the indicators were better suited to be used in an indicator analysis that focused on a more micro-level analysis with a lower density study area, such as Two Harbors. Finally, the case involved data standardization to the ZIP code level. Some of the indicators could not be easily analyzed on this level. Overall, we mostly kept the intent of the original indicator and discovered important insights along the way.

Our first insight was to divide the indicators into two categories: individual and urban indicators. This separation is important for it captures input and output indicators or supply and demand indicators. (See Table 1 below.) The individual (or household) indicators are intended to measure the result of people’s transportation choices. The amount of time devoted to travel, the number of vehicles available, and the amount of expenditures each household spends on transportation measures the cost of transportation to the end user.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Core Indicator Set</th>
<th>Individual (Household) Indicator</th>
<th>Urban Layout Indicator</th>
<th>Lake Street equivalent Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Time devoted to non-recreational travel</td>
<td>X</td>
<td>X</td>
<td>Travel Time to Work</td>
<td></td>
</tr>
<tr>
<td>2) Number of commuters living within 30 minutes of work</td>
<td>X</td>
<td>(x)</td>
<td>Percent of Workers within 30 minutes to work</td>
<td></td>
</tr>
<tr>
<td>3) Percent of street miles designated for bike routes</td>
<td>X</td>
<td>X</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>4) Ratio of trails to streets and roads</td>
<td>X</td>
<td>X</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>5) Percent traffic injuries to pedestrians &amp; Bicyclists</td>
<td>X</td>
<td>(x)</td>
<td>Street Layout</td>
<td></td>
</tr>
<tr>
<td>6) Ratio of street intersections vs. intersections &amp; cul-de-sacs</td>
<td>X</td>
<td>X</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>7) Percent of total street frontage with sidewalks</td>
<td>X</td>
<td>X</td>
<td>Land per capita for roads</td>
<td></td>
</tr>
<tr>
<td>8) Land per capita used for transportation</td>
<td>X</td>
<td>X</td>
<td>Per Capita Consumption of Oil, Tires, ....</td>
<td></td>
</tr>
<tr>
<td>9) Portion of household expenses spent on transportation</td>
<td>X</td>
<td>X</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>10) Percent of vehicles powered by renewable energy</td>
<td>X</td>
<td>X</td>
<td>% Workers within 30 min to work &amp; HH with Vehicles</td>
<td></td>
</tr>
<tr>
<td>11) Ability of non-drivers to reach employment centers</td>
<td>X</td>
<td>X</td>
<td>% Workers within 30 min to work &amp; HH with Vehicles</td>
<td></td>
</tr>
<tr>
<td>12) Ability of non-drivers to reach basic services &amp; recreation</td>
<td>X</td>
<td>X</td>
<td>Population Density</td>
<td></td>
</tr>
<tr>
<td>13) Population density</td>
<td>X</td>
<td>X</td>
<td>Percent workers who drive, % Workers who walk</td>
<td></td>
</tr>
<tr>
<td>14) Modal split in vehicle type</td>
<td>(x)</td>
<td>X</td>
<td>Average miles of Vehicle Trip</td>
<td></td>
</tr>
<tr>
<td>15) Vehicle miles traveled per capita</td>
<td>X</td>
<td>X</td>
<td>Average hours of Vehicle Trip</td>
<td></td>
</tr>
<tr>
<td>16) Vehicles hours traveled per capita</td>
<td>X</td>
<td>X</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

Development of Supplemental Set

1) Traffic counts
2) Percent impervious surface
2) Per capita impervious surface
3) Percent of households without a vehicle

X
X
X

None
Percent Impervious Surface
Per Capita Impervious Surface
Percent of Households without a vehicle
The indicators assessing the urban layout typically calculate the infrastructure allocated to and/or needed for transportation. The amount of roads and bike paths clearly are infrastructure that supports transportation, yet population density may also be considered an important infrastructure as precondition. High population density typically reduces the distance needed to travel, thus creating infrastructure for those who walk or bike. Just as cars do not function well without roads, people who walk or bike will have trouble getting around in a low-density community.

In economic terms, the individual indicators generally are part of the demand function for transportation, while urban layout indicators are part of the supply function. Advocates of sprawl, Gordon and Richardson, have stated many times that the high propensity of automobiles with single occupant drivers is simply an expression of the people's demand for transportation and ultimately low density single family tract homes. Yet, unlike a competitive free market, the supply of transportation is almost solely provided by the government. While car companies build automobiles, roads are typically designed, maintained, subsidized and/or built with government funds. The government's monopolistic role in zoning can determine the supply of transportation that in turn influences the demand of transportation. The supply of infrastructure for transportation is far from a free market system because of the primary role of local, state, and federal governments play in manipulating it intentionally or unintentionally.

The importance of individual indicators is that they can help measure the full cost of transportation. Because the transportation market is heavily subsidized by the government's investment in transportation supply, the individual indicators do not measure true demand for transportation. Clearly, this relationship is not an efficient one: the externalities created by this relationship between heavily subsidized supply and demand — where cost averaging and not marginal cost pricing are the rule — are not reflected in the cost or pricing of transportation infrastructure. A large percentage of Americans own multiple automobiles, but this large expenditure would be greatly curtailed if the government stopped subsidizing roads and automobile related goods, or else priced them according to full social costs.

Urban layout indicators are important as well since these indicators are relatively easy for policymakers to influence. Government officials typically set the amount of parking, the population density of a city, the design of the city, and the shape of the roads. Adding more bike paths in a community or establishing maximum parking can change some of these indicators. Urban planners can clearly influence the supply of transportation by providing transit and other means of public transportation. Yet, the greatest influence urban planners have on transportation is selecting the amount of density for a community.

Population density is strongly connected with transportation mode choice. The more compact an urban area, the more likely someone will be within walking distance of a desired activity. Numerous studies have shown this strong linkage between population density

density and transportation mode choice. A study in Oregon by the Land Use, Transportation, Air Quality Connection (LUTRAQ), have shown that densely populated areas will tend to use non-automobile modes of transportation while the opposite occurs in low-density areas. In their study of cities around the world, Peter Newman and Jeffrey Kenworthy found that as density increases, the transportation options for the community’s residents multiply. Gasoline usage is also related to population density. Low density American and Canadian cities consume far more gasoline per capita than the moderate density cities of Europe. And the high-density cities of Asia are the lowest per capita user of gasoline of any large urban area.

Land per capita devoted for the automobile is a powerful indicator especially since most urban space is devoted to the automobile and not for social or economic activities. Land set aside for cars often are the predominant feature of an urban area. The space used for roads and parking regularly exceeds the amount of land used by humans for houses, schools, stores, offices, parks, and warehouses combined. Within the city of Los Angeles, up to 65% of the urban area is set aside for automobiles.

The large amount of land devoted to the automobile contributes to growing land consumption. From 1970 to 1990 land consumption outpaced population growth in many metropolitan areas (See Table 2 below).

Table 2

<table>
<thead>
<tr>
<th>Metropolitan Area</th>
<th>Population Growth</th>
<th>Urban Land Area Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago</td>
<td>4%</td>
<td>46%</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>45%</td>
<td>300%</td>
</tr>
<tr>
<td>New York City</td>
<td>8%</td>
<td>65%</td>
</tr>
<tr>
<td>Cleveland</td>
<td>-6%</td>
<td>31%</td>
</tr>
<tr>
<td>St. Louis</td>
<td>35%</td>
<td>35%</td>
</tr>
<tr>
<td>Minneapolis</td>
<td>22%</td>
<td>35%</td>
</tr>
</tbody>
</table>

The paving of the United States appears to be growing faster than population growth. Assuming that US population growth will continue well into the next century, prolonged land consumption shall result in dire consequences for the environment.

30 Land Use, Transportation, Air Quality Connection, 'Making the Land Use, Transportation, Air Quality Connection' (the LUTRAQ project, 1997), p.7.
One study has found that the land consumption rate is not sustainable within the Los Angeles region. Population projections conducted by the Southern California Association of Governance prediction that by the year 2020, the Los Angeles Region will grow by 6.7 million people. A study conducted by the Claremont Graduate University Research Institute has shown that, given this population prediction, there is not enough privately owned open space to accommodate these new comers at the 1994 rate of land consumption.

Unfortunately we tend to only value land that has human development, yet we clearly receive value from nature. Wetlands filter water and help prevent floods. Plants and trees sequester carbon dioxide. Recently a natural inventory was conducted of the earth to determine the value of the entire natural environment. While the study was not able to calculate the entire value of the natural environment, it did show that the value of the environment is worth at least as much as the entire human, built environment.

Land consumption displaces and can ultimately destroy wetlands and species, yet it also degrades the environment by increasing the amount of impervious surface. Impervious surfaces, such as streets, parking lots and rooftops, are visible indicators of environmental degradation. These visual effects of impervious surface are the most obvious, yet, impervious surfaces harm the environment in a number of ways that are less obvious.

Water quality is harmed by relatively small amounts of impervious surfaces. While impervious surfaces do not directly cause pollution, it does facilitate water quality degradation. Natural ground cover disperses stormwater runoff through infiltration and evaporation with a small percent of water runoff. Storm water would be "cleaned" though deep filtration into the soil. Yet as the level of impervious surface increases, the amount of stormwater runoff also increases at the expense of filtration contributing to the following problems:

1) Eroding the natural waterways
2) Aiding land uses that do generate pollution
3) Preventing natural water filtration processing in the soil
4) Providing an efficient means of transporting pollutants into waterways.

---

It does not take much impervious surface to produce a negative effect on the natural environment. An article by Arnold and Gibbons discusses the impacts that impervious surfaces have on surface water runoff as an environmental indicator. They find that degradation to the natural environment can be noticed when impervious surface reaches 10% of the local land area. While the physical design of the urban area has a major impact on the effects of impervious surfaces, harm to the natural environment becomes almost assured at impervious levels of 30%. The local land area and the physical design of cities have a major impact on the effects of impervious surfaces on the natural environment. While there is much debate over the exact effects impervious surfaces, three broad categories can be drawn: protected-less than 10% impervious surface, impacted-between 10%-30% impervious surface, and degraded-over 30% impervious surface.

This information directly relates to the urbanization patterns of cities, which in turn can be applied to sustainable transportation initiatives. Impervious surfaces are a good indicator to use because it can be easily measured and is applicable whether measuring for transportation purposes or environmental concerns.

There are a number of researchers using impervious surface as an environmental indicator. The Pacific Northwest Salmon Habitat Indicators Report, the Southeast Michigan Council of Governments (SEMCOG), and the University of Connecticut Extension System’s Non-Point Education for Municipal Officials Project (NEMO) all use impervious surface as an indicator of environmental degradations.

While an increasing level of impervious surface is clearly a negative environmental indicator, it could also be a positive variable that measures more efficient urban land uses. Dense, urbanized areas with more impervious surface tend to use more efficient means of transportation, while sprawling, suburbanized areas with less impervious surface tend to be auto dependent. The percent of impervious surface not only helps measure population density, but it also measures urbanization, especially when used in tandem with more specific land use data such as floor area ratio and other aspects of zoning. Population density captures urbanized areas where people live, yet fails to capture the urbanization caused by land use. For example, a community with mixed land use might have a relatively low population density when other, residential or non-residential land uses are adjacent. Other urban features such as stores and factories do not in and of themselves increase the population density of an area, but these features do affect transportation patterns and affect the size of population that can be supported in a given area. In fact, many downtown areas have relatively low population density, due to the high proportion of non-residential features in most American downtowns. For these reasons both the percent of impervious surfaces and the per capita impervious

39 Ibid. In this article, local land area was defined as a drainage basin.
40 Ibid.
surface indicators can be a better indicator of urbanization than population density. For additional information regarding impervious surface and its relationship to other indicators, see Appendix.

This study was not able to compile all the core indicators that are listed in table 1. This is not to say these indicators were not important, as all the indicators can present valuable information. Likewise, the loss of some of these indicators should not invalidate the results of this study. This study is not, nor attempts to compile a complete list to measure the full social impacts, both costs and benefits, of transportation. Our goal is to investigate accessible measurements of sustainable transportation and extract some meaning out of these indicators for policy makers.
Section One: Initial Indicator Application in the Lake Street Corridor

While the Lake Street corridor is not considered part of downtown Minneapolis, it is also not part of the growing edge cities that are surrounding the downtown area. While Lake Street is lined with commercial buildings, the surrounding areas appear to have more businesses. (See Appendix B, Map B-11) Thus, the corridor has more bedrooms than jobs, contributing to substantive commuting out in the morning and back in during the evening. (See Appendix B, Map B-12)

This geographic gap between home and work is a serious transportation cost. The further this gap, the more need for roads, the miles driven and the greater the likelihood for congestion. While the Lake Street Corridor has more residential population than worker, it is close to jobs in downtown Minneapolis.

Before the automobile, communities needed to have homes, jobs and shops all within walking distance of each other. These turn-of-the-century communities tended to have a grid layout of streets that united different land uses together.42 Almost the entire Lake Street corridor has a grid street network that has a four-way intersection at every block. (See Appendix B, Map B-13) This is in sharp contrast to the communities that surround Minneapolis. In the suburban sprawl example in Map B-13 of Plymouth, a newer suburb, west of interstate 494 we find many cul-de-sacs, but few intersections. While the suburban design attempts to reduce vehicle traffic in residential areas, it may actually create more motorized traffic since other modes of transportation are not convenient.

The straight roads can cause traffic to speed down residential streets that can be hazardous to other modes of transportation. Speed bumps, narrow streets, and center dividers are typically measures to calm traffic in these instances. One suburban answer to "calming" traffic is to create curving roads and cul-de-sacs. Probably the most influential means for keeping speeding vehicles from racing down residential streets is to move homes to their own separate area that is distant from other land uses and activity clusters. This reduces traffic in each residential neighborhood, but greatly increases the miles between home to work and home to shopping. Residents of Plymouth do not need to worry about being hit by traffic while walking to the grocery store, since they do not live close enough to walk to a grocery store.

The households within the corridor tend to rely on the automobile less than the rest of Hennepin County. Within the corridor nearly 30% of the household do not have a vehicle compared to less than 10% outside the corridor (See Appendix B). Map B-14 and Map B-15 help exemplify this fact as ZIP codes with high percentages of two or more vehicles are outside the corridor and away from downtown Minneapolis. The reverse is true for ZIP codes with high percentages of households with no or vehicles, as these ZIP codes tend to be in the core of Minneapolis. Furthermore residents of the Lake Street Corridor purchased less motor oil and other supplies related to the automobile than

42 State Transportation Policy Initiative, Ch. 10, p2.
those who live outside the corridor. A clear majority of workers in the corridor drove alone to work (58.71%), but this was considerably less than workers outside the corridor (76.16%).

Workers in the corridor tended to use a variety of transportation modes compared to those outside the corridor. Nearly 20% of corridor workers rode the bus to work, stressing the reliance of transit for many. A small percent of workers in the corridor either walked or biked to work (7.31%), but this percentage was higher than those workers outside the corridor (4.23%). The automobile may still be the preferred means of transport in the corridor, but a sizable percent of the residents use alternative modes of transport.

Table 3

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Lake Street Corridor</th>
<th>Outside the Corridor</th>
</tr>
</thead>
<tbody>
<tr>
<td>% HH without a Vehicle</td>
<td>29.52%</td>
<td>9.59%</td>
</tr>
<tr>
<td>% HH with 2 or More Vehicles</td>
<td>29.43%</td>
<td>57.24%</td>
</tr>
<tr>
<td>Per Capita Quarts of Oil</td>
<td>3.80</td>
<td>5.53</td>
</tr>
<tr>
<td>Per Capita Oil Filters</td>
<td>0.69</td>
<td>0.94</td>
</tr>
<tr>
<td>Per Capita Tires</td>
<td>0.59</td>
<td>0.81</td>
</tr>
<tr>
<td>Per Capita Spark Plugs</td>
<td>0.66</td>
<td>0.87</td>
</tr>
<tr>
<td>% Workers Drove Alone to Work</td>
<td>58.71%</td>
<td>76.16%</td>
</tr>
<tr>
<td>% Workers rode the Bus to work</td>
<td>19.31%</td>
<td>6.34%</td>
</tr>
<tr>
<td>% Workers Bicycle to Work</td>
<td>1.63%</td>
<td>0.54%</td>
</tr>
<tr>
<td>% Workers Walked to Work</td>
<td>5.68%</td>
<td>3.69%</td>
</tr>
<tr>
<td>Percent Workers Living within 30 minutes to work</td>
<td>79.58%</td>
<td>77.62%</td>
</tr>
<tr>
<td>% Workers Work in Place of Residence</td>
<td>62.13%</td>
<td>30.86%</td>
</tr>
<tr>
<td>Per of HH drive less than 5K miles a year</td>
<td>27.26%</td>
<td>23.54%</td>
</tr>
</tbody>
</table>

The characteristics of trips that corridor residents took also differ from the trips by Hennepin residents outside the Lake Street Corridor. Using data from the Metropolitan Council travel diary survey, we found a significant difference in trip-making behavior of Lake Street residents compared to all other Hennepin County residents. Using a sample of over 43,000 trips we found that the average distance a corridor resident's trip was significantly less than the average non-corridor resident's trip. (See Appendix.) When we divided the trips into driving, work, and shopping trips we again found that residents of the corridor averaged significantly fewer miles than residents outside the corridor.

Table 4

<table>
<thead>
<tr>
<th>Type of Trip</th>
<th>Distance of Trip in Miles</th>
<th>Duration of Trip in Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lake Street Corridor</td>
<td>Outside the Corridor</td>
</tr>
<tr>
<td>All Trips</td>
<td>4.82</td>
<td>6.15</td>
</tr>
<tr>
<td>All Driving Trips</td>
<td>4.91</td>
<td>6.37</td>
</tr>
<tr>
<td>All Work Trips</td>
<td>6.24</td>
<td>8.22</td>
</tr>
<tr>
<td>All Driving Work Trips</td>
<td>6.67</td>
<td>8.37</td>
</tr>
<tr>
<td>All Shopping Trips</td>
<td>3.47</td>
<td>4.16</td>
</tr>
<tr>
<td>All Driving Shopping Trips</td>
<td>3.37</td>
<td>4.12</td>
</tr>
</tbody>
</table>

3 US 1990 Census and National Decision Systems data.
4 Metropolitan Council Travel Diary Survey.
We found similar, but not as significant results when we compared the duration of trips. Again the average duration of all trips from corridor residents was significantly less than non-corridor resident trips, yet this comparison was not always significant for all categories of trips. When comparing all shopping, work, and driving shopping trips, corridor residents on average took almost as long and sometimes on average longer trips than non-corridor residents. This should not be so unexpected since corridor residents tend to use non-automobile modes of transportation that often take more time even when covering shorter distances.

The results from the travel diary are consistent with the use of other indicators. Residents of the Lake Street corridor drive less than residents outside the corridor. When Lake Street residents use an automobile, typically they go shorter distances and in general take less time to get there.

The corridor is far more urbanized than the rest of the county. While the corridor is less than 2% of the entire area of Hennepin County, it has over 10% of the residents. The average population density of the corridor is over 9,081 people per square mile, while the rest of the county averages a little over 1,548 people per square mile. To highlight this difference, the average city in the US northeast has a density of 9,147 people per square mile while the average city in the western United States has 1,735 people per square mile.\(^{45}\)

The Lake Street corridor is not part of downtown Minneapolis, yet its population density is as high or higher. (See Map B-16.) One ZIP code in the corridor 55404 has the highest density of all Hennepin ZIP codes at 12,785 person per square mile. While ZIP code 55454 to the northeast of the corridor has a population density of 12,054 and ZIP code 55403 to the north has a density of 9,714 the rest of the downtown has far less residential density than the Lake Street corridor.

Past research within the Lake Street Corridor has provided evidence that areas of high population density do not necessarily lead to negative public perceptions. Focus groups conducted by Lyn Kathlene and Tom Horan found that respondents typically did not have unfavorable perceptions of high-density residential areas. (See Appendix.) The respondents did have negative perceptions of the low-density residential area east of I-35 W and north of Lake Street, which was associated with criminal activity. The most unfavorable areas identified by the respondents were along congested Lake Street and the abandoned rail corridor.

These findings are consistent with findings by other researchers who found that population density by itself did not create a negative public perception. Walter et al found that people disliked the auto traffic most, rather than the high population density, and viewed the rail formation...\(^{45}\)

---

density.\textsuperscript{46} Kathlene and Horan's focus group results also coincide with real estate prices in the areas. Map B-18 shows the location of selected asking home prices near the abandoned rail corridor. Homes within 1000 feet of the rail corridor appear to be selling for considerably less than homes a few blocks away. The major exceptions to this finding are the low price homes east of I-35W and north of Lake Street, the same area that the focus group perceived as a liability. While there are many factors influencing people's perceptions, these findings do provide some evidence that people do not necessarily dislike high-density areas.

The impervious surface indicator also identifies the Lake Street corridor as more urban than the rest of the county. Using the 1990 land use data from the Metropolitan Council, we were able to approximate the total amount of impervious surface of Hennepin County by ZIP code using assumptions from other research. (See Appendix.) Again, the Lake Street corridor stood out from the rest of the county with over 45\% of the area covered with impervious surface compared with over 20\% for the rest of the county. (See Appendix.)

<table>
<thead>
<tr>
<th>Land Use Classification</th>
<th>LAKE STREET CORRIDOR</th>
<th>THE REST OF HENNEPIN COUNTY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Land (Sq. Ft.)</td>
<td>Impervious Surface (Sq. Ft.)</td>
</tr>
<tr>
<td>Low-Density Residential</td>
<td>143667569</td>
<td>5459676</td>
</tr>
<tr>
<td>High-Density Residential</td>
<td>58824434</td>
<td>38235882</td>
</tr>
<tr>
<td>Commercial</td>
<td>24060830</td>
<td>20451706</td>
</tr>
<tr>
<td>Industrial</td>
<td>13178914</td>
<td>9884186</td>
</tr>
<tr>
<td>Public</td>
<td>30926938</td>
<td>1546469</td>
</tr>
<tr>
<td>Airport</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Parks</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Agricultural/Vacant</td>
<td>555942</td>
<td>0</td>
</tr>
<tr>
<td>Highways</td>
<td>10500893</td>
<td>9975797</td>
</tr>
<tr>
<td>Water Bodies</td>
<td>30617538</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>32912668</td>
<td>148605715</td>
</tr>
</tbody>
</table>

Two important facts are revealed in the above table. The first is that the Lake Street corridor has a relatively high percentage of impervious surfaces, with over 45\% of the land covered by streets, sidewalks, parking lots, driveways, and roof tops. Compared to the rest of Hennepin County that had over 20\% impervious surface, the Lake Street corridor appeared on the surface to be more environmentally degraded.

The Lake Street corridor may be less damaging to the environment overall if population is taken into account. The average person in the Lake Street Corridor has about 1386 square feet of impervious surface dedicated to their use, while the average person in

Hennepin County outside of the corridor has about 3270 square feet of concrete and asphalt. Supporting a large population may degrade the environment, but it may prevent vast amounts of land from being consumed by low-density housing and thereby make more efficient use of limited land.

Maps B-19 and B-20 show the disposal or impervious surface in the county. Map B-19 graphically show impervious surface by land use as the core appears denser than the rest of the county; yet note the black ring on the outskirts of the city showing the highways, airports, and commercial ring that compose the growing edge cites. Map B-20 shows this same result by ZIP code.

The results from this comparison clearly show a difference between the Lake Street corridor and the rest of Hennepin County. Generally, residents of the Lake Street Corridor consumed far fewer resources in order to get from point A to point B. Corridor residents, in general owned fewer vehicles, which meant they bought fewer tires and drove fewer miles then those in the rest of the county. Residents in the corridor occupied far less land per person than those outside the corridor. Not only did each corridor resident require less in terms of transportation needs, but they also used less residential, commercial, and industrial land. Yet, the environmental quality inside the corridor seems more degraded overall, as demonstrated by the high proportion of impervious surface. However, one should be cautious in reaching conclusions about environmental degradation based upon proportion of impervious surface absent analysis of other relevant, important information such as land use, air, water and soil quality.

**Policy Implications**

Based upon the preliminary findings from the Lake Street case study, the relationship between the impervious surface variable and sustainable transportation can provide valuable insight in setting policy. At first glance, the results of this case study may appear to be contradictory. Impervious surfaces clearly degrade the environment by destroying habitat and facilitating water pollution, yet residents of areas with a high proportion of impervious surfaces tend to drive less and live closer to work and shops. This seemingly contradictory finding underscores the complicated problem of how one measures much less goes about achieving sustainable transportation.

The first policy recommendation is to encourage the beneficial aspects of compact urbanized spaces while mitigating the cost of compact development. Compact urban development uses land far more efficiently than low-density development. Assuming that most American metropolitan areas will experience large population increases over the next few decades, we should be planning and implementing ways for reducing inefficient low-density development.

There are a number of ways to reduce impervious surfaces in urbanized areas. Reducing the amount of parking can significantly reduce the total amount of a city's hard space. Most cities oversupply parking to the point that most parking lots fail to
reach capacity on a typical peak period. Zoning and other land use requirements, such as minimum parking standards, that result in an oversupply of parking, are one set of regulations that should be targeted for rethinking.

Another method to reduce impervious surface is to use planning techniques to minimize the negative environmental effects. Parking lots and streets can be designed to direct storm water runoff to achieve maximum deep filtration. Urban green spaces also should be encouraged to aid runoff filtration as opposed to quickly spilling into primary waterways.

Further research is needed to provide policy makers with the most accurate assessment of public perception with regard to high-density areas. While suburban sprawl appears to provide a more popular living arrangement when compared to high-density downtowns, there is a trend due to traffic congestion and a demand for more stimulating activities toward a rise of infill development in downtown areas. In addition, some of the apparent preference for suburban living could be explained by the existence of government subsidies provided to low-density development. There is a need for further research to better understand the relationships between people's residential preferences and indicators such as impervious surface, building density, and other environmental features.

**Section Summary**

In this project we found that the Lake Street corridor clearly stood out from the rest of the County, for the corridor, among other features, has a far higher population density and higher percentages of impervious surface than elsewhere in Hennepin County. The household indicators also differ greatly by geographic location. Residents of the Lake Street corridor depend less on automobile transportation than residents outside the corridor. Much of this difference could be explained by the difference in urban layout. High population density is associated with less automobile usage. The same is also true for areas with high percentages of impervious surface. While impervious surface has detrimental affects on the natural environment, dense areas of pavement appear to be more efficient use of urban land. This seemingly contradictory finding underscores the difficulties of measuring sustainable transportation. Our results also highlight the strong connection between urban design indicators and individual mode choice indicators. This strong relationship should cast doubt on whether automobile usage is an individual choice. Since driving behavior can be predicted by urban design, it is important for urban planners to help work towards sustainable transportation objectives.
Section Two: Sustainability Indexes and the Lake Street Corridor

Some of the most powerful indicators are often indexes where pre-existing relationships and interactions between elements have been established. As combinations of indicators, indexes do more than provide a means for examining a cross section of individual indicators, but rather articulating a composite "score" or value. Indexes, however, are only as strong as the elements that comprise them. While Gross Domestic Product (GDP), as one notable example of an index, has been employed to compare economic well-being across nations, it has been criticized for its focus upon economic indicators to the exclusion of other interactive indicators of quality of life such as access to food, shelter, housing and education. Within the past decade, there have been several attempts to develop an alternative index that would enable meaningful comparisons of quality of life across nations but these alternatives have yet to be adopted freely as replacements to GDP.

After testing our core set of indicators in the micro case studies and the case study sites, the project team found that there were three general areas of concern that were not adequately measured by this set. For example, neighborhood stability and economic viability as measured by income, median home values, employment, and weighted by crime rates and population density, among other indicators, was one area that the research team wanted to examine further. In addition, an explicitly environmental indicator or set of indicators such as air quality attributable to mobile source or vehicular emissions had not been yet applied yet but could be mapped using an index. Finally, whether or not a community had adequate access to transit for those who need it seemed to be a useful proxy equity measure to add value to the mix of sustainable transportation indicators applied thus far. The project team hoped to find combinations of indicators that could be used to complement the initial set of indicators.

Economic Viability

Communities seek to satisfy many goals simultaneously, some of which may compete with one another. First, communities may seek to increase home values over time. They also desire viable employment centers to be situated in or adjacent to them. At the same time, communities try to reduce their crime rates. Clearly difficult to achieve simultaneously, these goals constitute the stability most neighborhoods and communities hope to achieve.
The six indicators below were selected as measurements of neighborhood stability and economic viability.

- Median Home Values
- Housing Affordability
- Median Household Income
- Crime
- Population Density
- Percent Impervious Surface

The project team approached the application of this index by first mapping each of these indicators alone. Next, the team produced two composite scores. The first score measured median household income, median home values, housing affordability and crime together, assuming direct relationships and interactions between them. Next, a composite of population density and percent impervious surface was considered. The need for two different composite scores is due to the problematic nature of the population density and impervious surface indicators. While the other variables appear to be either assets or liabilities, density and impervious surfaces appear to be both. To resolve this difference two composite variables were created.

Each Indicator Taken Individually

Each of the indicators provided valuable insights to understanding the spatial differences within Hennepin County. Spatial patterns emerged illuminating the differences between downtown Minneapolis, to the edge cities that ring the city, to the rural outskirts. While there were some recurring patterns with these indicators, notable differences did occur.

These component variables were selected not only for their importance to sustainability, but also the ease of accessing the data. Four of these indicators were taken directly from the 1990 census, while the crime data was accessed online at the realtor.com web page. The impervious surface data was acquired from the Metropolitan Council land use data as described in Chapter 3 in the Lake Street case study.

Parsimony was another consideration in selecting these indicators. Wading though endless statistics often fails to inform the reader on the state of sustainability in his or her community. While the information may be technically accurate, it often fails to convey the relevancy of the data within the context of the community concerns. Pollution counts of parts per million and acceptable levels of risk do not project the same information that a third stage smog alert does for a community, or a visual image which conveys that the more frequently one drives at greater distances, the greater resultant vehicle emissions and air pollution. While the technical indicator may be more accurate and detailed, an easier to understand indicator that can be meaningfully represented in visual terms is often a necessary abstraction to make the data useful.
Median Household Income

Median household income is a popular measuring stick for the well being of a community. Within the context of this project, median household income was used as a proxy for access to employment opportunities. While large disparities of income presents its own social problems, we assume that higher income for the median household is a positive indicator.

In Hennepin County, the areas with the highest median household income are to the south and west of downtown Minneapolis. ZIP codes with median household income of over $55,000 are not uncommon in the southwest corner of Hennepin, which includes Edina, Minnetonka, and Eden Prairie. Downtown Minneapolis has the lowest median household income of the county. Nearly all the ZIP codes in this region have incomes less than $35,000 a year and in some ZIP codes, the median household earns less than $20,000 a year.

Median Home Value

Median home values are often assumed to be an indicator of the quality of an area. Homeowners are willing to pay a premium to live in a neighborhood with more amenities. Home values can work as a proxy for the quality of schools. Kerchner and McMurray found that homes within the Pomona Unified School District suffered from a "Pomona discount" for similar homes outside the district sell for considerably higher sums. Given the high cost of private education and tax breaks for homeownership it is often economically beneficial to pay the high cost of housing with a "good" school district.

---

Home values can reflect people's perception towards a neighborhood, but they also indicate the transportation costs for a community. In short, people are going to pay more for homes closer to work. High income workers will demand homes within a short drive, typically under 30 minutes\(^\text{48}\), of their work. Homes further than 30 minutes from employment centers will have higher transportation costs and thus sell for less than homes closer to work.

**Housing Affordability**

The high cost of housing forces a number of residents to remain as renters. Typically, a household cannot afford to own a house over three times the cost of its annual income. For this indicator we took the median home value in 1990 and divided by the household annual income in 1990.

Under the housing affordability indicator, we find that the more rural ZIP codes of northern and far western Hennepin County have the most affordable homes given median household income. The median wage earner typically will need to spend less than 3 times her annual income to buy the median home in more rural communities. This is in contrast to the newer suburbs just south and west of the downtown areas, which appear to be more difficult for the median wage earner to qualify for the median home. Although these newer suburbs typically have households with considerably higher incomes, often the median home is 2.5 to over 4 times which the median household earns.

**Crime**

Crime can be a serious problem for any community, whether or not it strives to become sustainable. Criminal activity can degrade community character and shift vast community resources to prevent or decrease crime and repair the damage that it creates. Since the poor are also often disproportionately victims, crime can play a direct role in perpetuating the cycle of poverty. And, there is the added

\(^{48}\) http://www.census.gov/population/socdemo/journey/ustime90.txt
perceptual liability: communities struggling with crime are often burdened by a reputation of being a high crime neighborhood and are thus avoided.

Crime is often the reason stated for the flight of higher income households to the suburbs. The apparent high crime risk in downtown areas can drive residents and merchants to the outskirts of the city. In greater Seattle, for example, one third of residents in low density areas stated that they would prefer living in higher density neighborhoods if it were not for crime. This flight ultimately lowers the tax base of the central city and deteriorates the cities' infrastructure, which in turn may weaken the war on crime. For the downtown to draw suburbanites back to the city, it must win the war of crime in the public's eye. According to crime data that we compiled, Minneapolis appears to be losing this public relations battle.

The crime risk indicator in Hennepin appears to follow a similar pattern for other indicators. Using data from Realtor.com we found that the downtown areas consistently rank at the highest crime risk indicator (5). All four ZIP codes in the corridor score at the highest risk, along with most of the surrounding ZIP codes, with only the University area scoring a moderate crime risk.

In contrast, many of the surrounding edge cities scored either moderate or low crime risk and the rural areas were almost all low crime risk. This wide gap between downtown Minneapolis and the suburbs underscores the difficulties of achieving sustainable development in the region. Residents who can afford to do so will prefer spending resources driving to suburban residences in order to avoid living in high crime areas.

Population Density

As mentioned earlier in this report, population density is a strong indicator of urbanization. Like most downtown areas, downtown Minneapolis has the highest population density of the county. All the ZIP codes in the downtown area have densities of at least 5,000 people per square mile with some ZIP codes exceeding 10,000 people per square mile. Not surprisingly, this density drops in the nearby suburbs as the majority of ZIP codes have at least 2,500 people per mile. The rural areas of the county of course have the lowest density, with less than 1,000 residents living in the average square mile.

Percent Impervious Surface

The percent of impervious surface indicator is a good measurement of urbanization similar to population density. The amount of land devoted to roads, buildings, and parking lots can provide a sense of the scale, location and concentration of human settlement and activity in core urbanized areas.

In Hennepin County, highly impervious areas are mostly found in the downtown area with many the percentages of impervious surfaces exceeding 45% in many ZIP codes. The outer ring of the edge cities have lower percentages of land paved over, with most ZIP codes ranging between 15% to 45% impervious surfaces. Not surprisingly, the rural areas of Hennepin County have the lowest amount of impervious surfaces with most ZIP codes possessing less than 15% of the land converted to impervious surface.

Indicators Taken Together as a Composite

After the six indicators were compiled, a composite was created. The research team standardized the six indicators by assuming the values fall within a normal distribution, then finding each value’s distance with the mean by finding its z-score. Then the team aggregated the scores into a single index by summing them to create a composite value. The prime question with this method was whether to treat each indicator as a positive or a negative.

There should be little opposition to treating crime as a negative in the index. ZIP codes with higher crime are less desirable and less sustainable.

ZIP codes with higher median household income, however, should be considered positive indicators. While higher median household income typically represents fewer families in poverty, this may not necessarily be the case since a ZIP code could have a wide income distribution. Higher median household income also indicates less unemployment. Also, there is a positive correlation between median household income and our next indicator, median housing values.

Median home value also could be considered a positive indicator. First, housing prices reflect the market preference of a community. Quality of schools and environmental amenities influence housing pricing which, in turn are captured in this indicator. Housing values could also indicate housing affordability since expensive homes are not within the price range of most people. In further support of this argument, there is a
positive correlation between median home values and housing unaffordability. Similarly, there is a strong negative correlation with median household income and housing unaffordability.

Population density and percent impervious surface can be thought as both positive and negative indicators. Both population density and impervious surfaces are often associated with negative components of urbanization. But in contrast, population density and impervious surfaces are also associated with jobs, shopping, and cultural activities.

Because of the problematic nature of population density and impervious surface, two indexes were constructed. In both cases we treated crime and housing affordability as negatives and median household income and housing values as positive indicators. The two indexes were distinguished in this manner: one treated population density and percent of impervious surface as negatives, while the other index treated them as positives. As expected, there were wide-ranging results upon applying the two indexes.

**Density Negative Index**

The "density negative" index follows a clear pattern. Downtown Minneapolis area scored lowest on the scale overall, with the scores increasing outward into the suburbs. The highest values fall within the ZIP codes that are farthest away from the downtown areas. Nearly all the ZIP codes that fall outside of the I-94/I-494 corridors score very high on this index while the downtown area that includes the study boundary area scores low on the index.

**Density Positive Index**

When applying the "density positive" index, the downtown area does not fare as poorly as it did under the other index. Most of downtown Minneapolis ranks at the lower end of the index but most of the other ZIP codes are not on the lowest end. Downtown Minneapolis could thereby skew the results. The ZIP codes on the outlying ends of the county fare poorly in the "density positive" index. While most of these ZIP codes are not on poorest end of the scale, these ZIP codes did decline in their position compared to the other index.
The inner ring suburb ZIP codes score the highest on the "density positive" index. The southwest portion of Minneapolis along with the growing edge cities of Eden Prairie and Minnetonka score quite high. In fact, there appears to be a "Midas touch" effect as nearly all ZIP codes that are bisected by I-494 appeared well in this indicator.

**Comparing Density Positive and Density Negative**

Comparing both indexes with a correlation table provides insights on the strengths of each individual indicator component of the index. The density negative indicator has a strong negative correlation to the crime, population density, and percent impervious surface indicators, with a weak negative correlation (-.488) to the housing unaffordability indicator. Furthermore, the density negative index has a strong positive correlation with median household income and a weak positive with median housing value.

The density negative appears to capture much of what the typical resident desires in looking for a place to live: low crime, open spaces, and affluent neighbors. Yet, while this index may explain what the individual prefers, it may fail to measure what is best for the whole region. If most people decided to live in ZIP codes that scored high in the density negative index, then the ZIP code would no longer score as high. The density negative index may do a good job explaining contemporary individual preferences, but it may fail measuring what is best for a sustainable, livable community.

The density positive index is not as intuitive as the density positive index, yet it may better explain the difficulty in measuring what is best for the individual and what is best for the community. The density positive index does not have as strong a correlation with its components as does the other index. Crime is again negatively correlated with this index, but not as strong as the density negative index. Median household income and home values are strongly positively correlated for the density positive index, but the three indicators fail to provide significant results.

The lack of significant correlation of its components, however, does not necessitate the failure of this index. In fact it could mean that the index provides some non-intuitive insights. While the urbanized areas have strong negative indicators, there are powerful incentives that keep people living near or adjacent to cities. Services such as roads, sewer and other public services and infrastructure are often more expensive to provide in less dense areas.\(^{50}\) These costs are often hidden to the consumer due to government subsidies.

<table>
<thead>
<tr>
<th>Pearson Correlation</th>
<th>INDEX Density Negative</th>
<th>INDEX Density Positive</th>
<th>Crime</th>
<th>Housing Affordability</th>
<th>Household Median Income</th>
<th>Median Housing Value</th>
<th>Percent Impervious Surface</th>
<th>Population Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDEX-Density Negative</td>
<td>.527(**)</td>
<td>.527(**)</td>
<td>.855(**)</td>
<td>.488(**)</td>
<td>.910(**)</td>
<td>.347(**)</td>
<td>-.796(**)</td>
<td>-.861(**)</td>
</tr>
<tr>
<td>INDEX-Density Positive</td>
<td>.527(**)</td>
<td>.527(**)</td>
<td>.574(**)</td>
<td>-.196</td>
<td>.726(**)</td>
<td>.529(**)</td>
<td>-.04</td>
<td>-.169</td>
</tr>
<tr>
<td>Crime</td>
<td>-.855(**)</td>
<td>-.574(**)</td>
<td>1</td>
<td>.256</td>
<td>-.709(**)</td>
<td>-.390(**)</td>
<td>.512(**)</td>
<td>.680(**)</td>
</tr>
<tr>
<td>Housing Affordability</td>
<td>-.488(**)</td>
<td>-.196</td>
<td>0.256</td>
<td>1</td>
<td>-.495(**)</td>
<td>.558(**)</td>
<td>.452(**)</td>
<td>.397(**)</td>
</tr>
<tr>
<td>Median Household Income</td>
<td>.910(**)</td>
<td>.726(**)</td>
<td>-.709(**)</td>
<td>.495(**)</td>
<td>.400(**)</td>
<td>1</td>
<td>-.618(**)</td>
<td>-.645(**)</td>
</tr>
<tr>
<td>Median Housing Value</td>
<td>.347(**)</td>
<td>.529(**)</td>
<td>-.390(**)</td>
<td>.558(**)</td>
<td>.400(**)</td>
<td>1</td>
<td>-.0057</td>
<td>-.0225</td>
</tr>
<tr>
<td>Percent Impervious Surface</td>
<td>-.796(**)</td>
<td>-.04</td>
<td>.512(**)</td>
<td>.452(**)</td>
<td>-.618(**)</td>
<td>-.0057</td>
<td>1</td>
<td>.538(**)</td>
</tr>
<tr>
<td>Population Density</td>
<td>-.861(**)</td>
<td>-.169</td>
<td>.680(**)</td>
<td>.397(**)</td>
<td>-.645(**)</td>
<td>-0.225</td>
<td>.538(**)</td>
<td>1</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).**

While the density positive index assumes high-density living is more sustainable, it also takes negative attributes of compactness into account. As we can see from the above table, population density is positively correlated with crime and is negatively correlated with median household income. By creating this index that has some of the components in opposition, we can better decipher the contradiction between what is best for the individual and what is best for the community.

Use of density negative index creates a powerful bias against the downtown area and a strong bias in favor of distant rural areas. This indicator may reflect stated preferences for rural living, but this indicator does not represent people's actual choices regarding where they live. The reality is that people choose both low and high-density living and they typically demand both. People want to live out in the country with big yards, while they also want to be close to jobs and shopping.

The automobile has been marketed as the miracle cure for this contradiction. The automobile allows people to live in low density housing while driving on wide, modern roads to get to work. The automobile provided people with choice: with the automobile, people gained greater freedom to vote with their newly-found mobility, for if living conditions in the central city became unacceptable, residents could pack up and move to the suburbs. The higher crime rates in the urban core, combined with the higher cost for housing, provide people with an incentive to move to lower density, suburban neighborhoods. While some downtown residents do stay, there are powerful incentives to pack up and move to the outlying areas. Poor schools, urban decay and other problems associated with the central city can be avoided by moving away and driving to the urban centers if absolutely necessary.

Businesses also gained this freedom. No longer were they forced to locate in areas within a mile or two of potential customers, but rather they can relocate in places with low density, cheap land. As long as they provide ample free parking and were close to major roads, retailers did not need to be within miles of the closest residential area. The automobile reduced the cost of distance, providing people with more freedom to choose where they live.

The downside of these trends is that people make decisions without calculating the true cost of transportation. Externalities such as environmental pollution, traffic congestion and loss of species habitat, are significant costs that are not calculated when people make their transportation decisions. Furthermore, government subsidies of the
automobile through highway and road construction always help hide the real transportation cost to the user. Thus the miracle of the automobile has significant hidden costs that impacts community sustainability.

The density positive index takes the long-term cost for the community into account. Because this index includes components such as crime and median household income, the ZIP codes with the higher population densities, often fail to score high on the composite index. It is the moderately dense ZIP codes along I-494 that score the best on this index. Many may debate that these ZIP codes within the “edge cites” should not be considered the most sustainable ZIP codes in Hennepin County. While these edge cities may not be sustainable, downtowns might be even less sustainable if crime is not brought under control.

*Air Quality Index*

Inherent in the concept of sustainable development is the goal of reducing environmental impacts of human activities in general and reducing automobile dependence along with vehicular emissions in specific. Communities seeking to develop and implement sustainable transportation practices would pursue development patterns and alternative transportation strategies that ultimately decrease dependence on automobiles. Given that most air pollution is caused by mobile not stationary sources, and most of the mobile source-generated air pollution is attributable to automobile use, such strategies would have profound effects on air quality overall, especially in tandem with changes in vehicle fuel technology. Recognizing the linkage between vehicular use, travel patterns, vehicle emissions and air pollution, an air quality index was developed as a proxy for assessing the air quality impacts of automobile use in the study area. The purpose of this exercise was to develop an initial air quality index and examine what it reveals about travel patterns and their relation to the level of air pollution generated by automobile use within the study area.

*Data Requirements*

The data used to compile this index was obtained from the Metropolitan Council’s 1990 Travel Behavior Inventory, which provided information on over 43,000 one-way trips by Twin City residents. The Inventory included information on vehicle trips, vehicle miles traveled, mode split, origins and destinations and trip purpose. To test the appropriateness of this index in a limited manner within the constraints of this study, only the travel mode and emissions implications of commute trips were examined which typically constitute slightly less than 30% of all vehicle trips. In the follow-on to this study, non-commute or discretionary trips would merit further analysis in order to provide a more complete picture of the air quality impacts of travel patterns within the Lake Street Corridor.

The units of analysis used in this exercise are Transportation Analysis Zones (TAZ). This unit of analysis was chosen by default because the data was classified by TAZ in the Met Council database.
Methodology

The indicators used to calculate this index are:
- Vehicle trips
- Vehicle miles traveled
- Mode split

To convert the indicators to an air quality index, other data was required:
- Vehicle occupancy factors
- Emissions factors (based upon average vehicle speed)

The following steps were taken to estimate and aggregate the commute travel mode and emissions impacts of vehicles traveling to and from the Lake Street study area:

First, Vehicle Miles Traveled (VMT) were estimated based upon the following formula:

\[ \text{Vehicle Miles Traveled} = \text{Average Trip Distance} \times \text{Mode Occupancy Factor} \times \text{Annual Trips} \]

Distance per trip was given in the survey database provided by the Metropolitan Council.

The Mode values used in this project were developed in a study conducted in California\(^1\) to evaluate transportation control measures. These Mode values, or "discount" rates, were used to calculate the emissions generated by various modes of travel. These values can be described as "discount rates" because they apply a discount to trips created by modes that emit fewer emissions. These values are as follows:

<table>
<thead>
<tr>
<th>Mode Type</th>
<th>Discount Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Occupancy Vehicle/Taxi</td>
<td>1</td>
</tr>
<tr>
<td>Carpool/Vanpool/Motorcycle</td>
<td>.5</td>
</tr>
<tr>
<td>Bus/Other (Eg. walking/biking)</td>
<td>0</td>
</tr>
</tbody>
</table>

The project team assumed the Annual Trips would be 251 for all drivers. Because of the survey methodology used by the Metropolitan Council, using 251, the number of days the average commuter spends at work, we could be satisfied that all trips, both trips to and from places of employment, were included in the calculation.

Next, the project team used the following formula to find the aggregate emissions using the VMT calculation found above. That formula is as follows:

\[ (\text{VMT}) \times (\text{NOx factor}) + (\text{VMT}) \times (\text{CO factor}) + (\text{VMT}) \times (\text{HC factor}) = \text{Emissions Generated} \]

\[ \begin{array}{c}
1000 \\
1000 \\
1000 \\
\end{array} \]

\(^1\) Pansing, Cynthia. COMSIS Corporation, prepared for the LA County Metropolitan Transportation Authority, "MTA Transportation Demand Management Evaluation," April 1997.
The following Mobile5 emissions factors were used which were obtained from the Met Council:

\[ HC = 2.11 \quad CO = 23.41 \quad Nox = 2.75 \]

Travel mode (i.e., vehicle trips and miles traveled) and emissions impacts for all trips originating from home or work in the study area were estimated for each individual survey entry alone and in aggregate. Because this aggregate number was simply based on the commute-related subset of survey data representing a sampling of residents in the study area, it cannot be truly considered the total travel mode and emissions impacts for the entire area. However, factoring in "person trips" available through the survey for all trips helped yield a close approximation of the actual aggregate emissions generated annually by commute trips to or from the study area. This number could be used alone as an indicator for a community.

However, it is more interesting to plot the emissions generated by TAZ using a map format. To do this, the project team aggregated the emissions-generated by individual TAZ. Then the team created an aggregate emissions/vehicle trips variable to serve as a proxy for trips per capita. In order to draw any conclusions about why some areas are producing more emissions than others are, it is important to produce this "per capita proxy." If this step is not taken, only the aggregate numbers would be shown, which is less revealing when presented in a map format because the TAZs with lower populations seem to be producing fewer emissions despite the fact that individual drivers may be actually producing more. Finally, the team mapped this variable using ArcView.

**Lake Street Emissions**

The following map shows the aggregate emissions-generated by the TAZ of residence. Not surprisingly, the results correspond with the travel pattern analysis of the corridor as described in Chapter 3, given the direct relationship between travel patterns and emissions generated. The blue TAZs represent trips produced by people living outside the study area, while the red TAZs represent trips produced by people living inside the study area. This map demonstrates that individuals living in outlying areas and drive into the Lake Street Area generate more emissions in total than individuals living closer to the Lake Street corridor as well as those living inside the Lake Street Corridor. This is true for two reasons. First, those living further from the Lake Street Corridor have a longer distance to travel to reach their destination inside the Corridor. In addition, it can be assumed that those living in the outer rim of the metropolitan area are most likely to be dependent upon automobiles to provide transportation to and from their places of employment. This is borne out by the mode split for the corridor as compared to the rest of the metropolitan area.
This map also underscores that individuals living inside the Lake Street study area make shorter commute trips or use transit or other modes of travel to reach employment centers more often than those living in the outskirt of the metropolitan area. Clearly, there are more alternatives to the single occupant vehicle available within the corridor. However, there are two areas within the Lake Street Corridor that seem to generate substantially greater emissions than other areas. Plotting this trend against local land use illustrates the possible underlying reasons for its occurrence. A map of the land uses for the Lake Street corridor shows that the areas in the Lake Street Corridor with the largest number of single occupant vehicles leaving the study area to work elsewhere are predominately comprised of low density, single family homes. Interestingly, fewer emissions seemed to be generated from trips beginning in the more affluent neighborhoods around the lakes than was expected. Because of the lack of transit access in this area, this trend leads the research team to suspect that individuals who reside in this part of the study area also work there or else in downtown Minneapolis, just north of the study area.
This index is useful in that it demonstrates how outer-ring, lower density, suburban development can create the biggest impact with regard to commute-related emissions generated than does compact, higher density, mixed use development with access to transit and other alternative modes. Assuming that discretionary trips are longer and/or more frequent in suburban areas than in higher density ones, this trend becomes even more pronounced. This index shows promise and may be further refined in the follow on project for this study.

**Equitable Transit Access Index**

This index attempts to examine how equitable is transit service and access within the corridor by measuring access to transit by corridor residents who most need it. This index can be used at the community or regional level and in an urban or rural context. In the following exercise, it was applied to the Lake Street Corridor. Data from the United States Bureau of the Census and from MetroGIS was used in this GIS-based analysis.\(^{52}\)

**Required Data**

As mentioned above, the data was acquired from primarily two sources: US Bureau of the Census and MetroGIS. Census Tiger Data can be downloaded by county for free from Environmental Systems Research Institute's website at [http://www.esri.com/data/online/index.html](http://www.esri.com/data/online/index.html). 1990 Census block group data for household vehicle ownership and individual age variables was acquired from this source. MetroGIS Data can be obtained through a licensing agreement with the originator(s) of the data.\(^{53}\) Data for land use, zip code, and street variables was acquired from this source.

**Transit Access Index**

This index combines several components in a multi-step process. The first step is to identify the areas with the largest number of people that cannot reach important centers without the use of transit. The identification of these areas was based upon an aggregation of young and old age cohorts that tend to be unable to drive single occupancy vehicles along with households with access to less than two vehicles.\(^{54}\) Then, the research team proceeded to identify major regional employment centers, regional- and community-serving basic goods and services, community and recreational centers and activities relative to the ability of individuals lacking easy access to automobiles.

---

\(^{52}\) MetroGIS is a Geographic Information Systems project that is helping local governments and other organizations share data in the seven-county Twin Cities Area. It provides access to many types of information including property records, natural resources, public works, demographics, education, and other areas.

\(^{53}\) The MetroGIS Data Finder project ([http://www.datafinder.org/](http://www.datafinder.org/)) demonstrates a stated goal of MetroGIS — to provide a mechanism for sharing GIS data. MetroGIS Data Finder is an index of geographically referenced data that provides a mechanism for sharing Geographic Information System (GIS) data among users in the Twin Cities Metropolitan Area of Minnesota.

\(^{54}\) Age cohorts 65 years and older, and between 10 and 19 years old.
within the study area. Finally, transit routes by type serving the study area were identified, as was the relative proximity of these routes to the identified destinations and populations. The results can be shown in tabular, chart or map format.

*Put Into Practice*

GIS was utilized to apply the index within the Lake Street Corridor. It is possible to calculate the index using other methods but most other methods tend to be more labor intensive. Due to the data's formatting in two different geographic projections and other complications, two separate databases of tables had to be created.

Using a block group boundary file and a block group demographic data file from the 1990 Census, the block groups within the study area were selected out with their corresponding data for the household vehicle ownership and individual age variables to create the Census-based database. (See Table 1 in Appendix A.1.)

Two new variables, *Young & Old* and *Limited Vehicle Access*, were created in the database by aggregating some of the existing variables. The value for the new variable, *Young & Old*, represents the number of residents between the ages of 10 and 19, and the age of 65 and greater by block group. The value of the new variable, *Limited Vehicle Access*, represents the number of households with access to less than two vehicles by block group.

Two more new variables, *Percentage of Young & Old* and *Percentage of Limited Vehicle Access*, were then created in the database by combining some of the existing variables with the two newly created variables. The value of the new variable, *Percentage of Young & Old*, represents the number of residents between the ages of 10 and 19, and the age of 65 and greater by block group. The value of the new variable, Limited Vehicle Access, represents the number of households with access to less than two vehicles by block group.

The two variables were then combined into a single variable to represent the population with the lowest access to single occupancy vehicles. The combination process was subjective in nature due to the differing scales of the two variables being combined. A matrix was constructed to assign a range of values to the combined variable, (See Matrix A below). The classification scheme for categorizing the values of the two variables, *Young & Old* and *Limited Vehicle Access*, was based upon standard deviation.

---

55 Transit route type, as defined here, is based on level of service (non-stop or limited express service, local/limited, etc).
56 The desktop mapping software, ArcView GIS v3.1, produced by Environmental Systems Research Institute (ESRI) was used to calculate the index.
57 ArcInfo, the premier geographic information system software produced by ESRI, has greater capabilities than ArcView including the ability to reproject data.
58 The study area consists of 153 block groups.
59 The upper ranges, middle ranges, and lower ranges are greater than 1 standard deviation, between -1 and 1 standard deviations, and less than -1 standard deviation, respectively.
Matrix A:

<table>
<thead>
<tr>
<th>Young &amp; Old (%) of POP</th>
<th>100%-87%</th>
<th>87%-49%</th>
<th>49%-12%</th>
</tr>
</thead>
<tbody>
<tr>
<td>60%-30%</td>
<td>I</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>30%-13%</td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>13%-7%</td>
<td>II</td>
<td>III</td>
<td>III</td>
</tr>
</tbody>
</table>

I = Low Vehicle Accessibility
II = Moderate Vehicle Accessibility
III = High Vehicle Accessibility

Using a zip code boundary file, a street centerline file, and a 1990 generalized land use file from MetroGIS member organizations, the four zip codes within the study area were selected out and used to clip the street and land use files to create the MetroGIS-based database. Employing the clipped street network file as a base and a hard copy of the regional transit system map and individual route maps, a new file, Transit Routes, was created by manually delineating as accurately as possible those transit routes with relatively high frequency and wide span of service. The records of the Transit Routes file were then buffered by ¼ mile, the distance that an average individual is willing to walk to a transit stop. From a similar clipped land use file and data on locations of major employers, goods and services, and recreational activities, a new file, Destinations, was created by manually delineating as accurately as possible those areas that are employment centers, retail and service centers, and community and recreation centers. The buffered Transit Routes, and Mobility Impairment files helped generate a new map, displaying access to transit for individuals with the lowest access to the single occupancy vehicle alternative was created. Due to the aforementioned problem with the projections of the data, the Destinations file could not be overlaid with the other two files.

Results

The Percentage of Young & Old variable reveals that the percentages of the population classified as young or old varies between 7% and 60% across the block groups of the study area with a mean of 21%. In 1990, most of the study area had 13% to 30% of their population between the ages of 10 and 19 or over the age of 65. There were five contiguous areas that had 30% to 60% of their population in the Young & Old category, including two that are adjacent to Lake Street Corridor. There were also five contiguous areas that had 7% to 13% of their population in the Young & Old category, with the largest such area at the west end of the Lake Street Corridor (Uptown Neighborhood).

The Limited Vehicle Access variable reveals that the percentages of households classified as having limited vehicle access varies between 12% and 100% across the block groups of the study area with a mean of 68%. In 1990, most of the study area had 49% to 87% of their households with access to zero or one vehicle. Almost all of those areas with 87% to 100% of their households with access to zero or one vehicle were located north of the Lake Street Corridor, while almost all of those areas with 12% to 49% of their households with access to zero or one vehicle were located south of the Lake Street Corridor.

---

60 Clipping is a ArcView GIS operation that cuts out a piece of one theme using another theme as a "cookie cutter".
Using either of the two variables measuring the proportion of the population with limited vehicle access alone gives a false portrayal of the situation.\textsuperscript{61} Using the combination of the two variables displays a distinctly different picture of low mobility within the study area.\textsuperscript{62} The Low SOV Access variable reveals that the majority of the areas most critically in need of transit access tend to be located along major transportation corridors (I-35W, I-94, Hwy. 55, Lake Street), while the areas that are the least in need of such access tend to be located around the lakes and other amenities.

The Destinations variable reveals a distinct spatial distribution of major employment (industrial land uses), goods and services (commercial land uses), and recreation and leisure (parks and water land uses) within the study area.\textsuperscript{63} The major employment centers are located along Hwy. 55 (northeast corner of the study area) and parallel to the Lake Street Corridor on the northside. High concentrations of goods and services are primarily located along the Lake Street Corridor and along Nicollet Avenue (running parallel just west of I-35W). The major recreation and leisure areas are located along the western edge and southeast corner of the study areas near the lakes with smaller areas sporadically spread throughout the interior of the study area.

The buffered Transit Routes variable reveals that almost 100\% of the study area is served by transit routes with relatively good frequency and span of service.\textsuperscript{64} The largest under served area is located in the southwest corner of the study area along the lakes. There are roughly eight major north - south transit corridors and four east - west transit corridors in the study area.

The two maps taken together reveals that almost all of the mobility impaired population and households of the study area can access the major employment centers, good and services providers, and recreational/community centers through public transit.\textsuperscript{65}

This index works well as a measure of how well a region is supplying travel alternatives for individuals with few travel options. Used in combination with the other indexes, as well as the core set of indicators, this index can add an access component to a community’s indicator analysis.

\textit{Section Summary}

Indexes can play a valuable role in a community’s efforts to establish baseline trends and track progress toward sustainable transportation and development. Based upon the analysis and findings presented in this chapter, some indicators applied in the exercises undertaken in this portion of the study provided value-added when transformed into an

\begin{itemize}
  \item \textsuperscript{61} See Appendices B and C.
  \item \textsuperscript{62} See Appendix D.
  \item \textsuperscript{63} See Appendix E.
  \item \textsuperscript{64} See Appendix F.
  \item \textsuperscript{65} See Appendix G.
\end{itemize}
index. Indeed, new trends and findings became apparent about the Lake Street Corridor by analyzing the results of these indexes.

CHAPTER SUMMARY

In the initial application of the sustainability indicators, it was found that the travel behavior in the Lake Street Corridor was significantly different from that of the behavior in low-density suburbs. The residents in the Lake Street Corridor, which is made up of high, medium and low-income cohorts, tend to rely less on single occupancy vehicles and use transit and other less intense transportation options more than in the suburbs. This can be attributed in part by the fact that there are more transit options available in this part of the County, however, there seems to be a connection between the travel behavior and the urbanization of an area, as measured by the impervious surface indicator. Our findings suggest that there may be a connection between the level of urbanization and travel behavior. In addition, urbanization, as measured by impervious surface, seems to be a better measure of sustainability than density. This is because it measures more than the compactness of an area as measured by the preponderance of urban residents, but rather the existence of commerce and retail, which are essential aspects of communities that are successful in reducing the resident trips.

When the economic viability index was applied, important patterns were revealed within Hennepin County. While these six indicators may not be the most important economic indicators of sustainability, they are significant ones. Individually, the component indicators displayed clear differences between the downtown areas, edge cities and rural areas. Each of these types of communities appeared to fair well under some indicators and poorly under others. Clearly, multiple indicators should be developed to capture the full range of assets and liabilities for each community. Used in tandem with multiple indicators, composite indicators or indexes could provide viable means of accounting for the tradeoffs these communities face. The relative ease with which data can be collected to support this kind of analysis is no small consideration in their selection, and therefore could be readily reproduced in future studies and in other communities.

Through the economic viability index it was found that there is a wide range of home values in the Lake Street study area. There is also a wide range of areas where homes are affordable; that is, that the homes are no more than three times the average income for the study area. In addition, the study area has mixed densities and variable percentages of impervious surface, but is higher in both of these areas than much of the rest of the metropolitan area. When the composite scores for this index were taken together, we found that when density was considered negative the western half of the metropolitan area scored very high and the downtown area and the Lake Street study area scored poorly. When density is considered positive, the study area scored a little better, while the area along the I-494/94 Corridor scored the best. Interestingly, the I-494/94 Corridor scored very well when density was considered a positive value as well as when it was scored as a negative variable.
Vehicle emissions in the study area were analyzed and mapped for all vehicle trips along the Lake Street Corridor. Per trip values revealed that individuals living the farthest from the study area contributed the most to the total level of emissions produced in the study area during peak driving hours. Widespread use of the air quality index could lead to decisions to change development patterns to decrease travel by single occupancy vehicles. It could also lead to policies that promote homeownership for individuals who work in the study area but currently live elsewhere. When combined with the equitable transit access index, it was indicated that those in the Lake Street Study area in the greatest need for transit service are being adequately served by the system.

Overview of the TAM

The TAM is a 21-step process requiring the participation of at least 25 community participants from broad segments of stakeholders and citizenry. Created to build a bridge between transportation planners and local leaders, the TAM has been a key tool in efforts to design a new model of responding to urban values and concerns in the age of automobility.

The application of the TAM with equal filter back assumptions:

1. Transportation must be engaged in informed local transportation planning actions.
2. Education and training are needed.
3. Planners need to work closely with community leaders if local plans are to be successfully developed and applied.
4. The process of education, reaching community consensus, and the development of new working relationships take time and should not be rushed when applied to complex transportation issues.

Detailed analysis is found in evidence relating between local leaders and transportation planners. It will rely on the interaction of the TAM stages to develop a plan for improvement without large changes. The TAM process is intended to create public confidence, identifying transportation issues, and developing solutions. Successful completion of the project by a community provides a positive example of participation in urban planning efforts.
CHAPTER 3: The Rural Context

In this portion of the research, the research team analyzed the extent to which indicator analysis is feasible in rural areas without substantial new data collection and whether or not it could be integrated into the Transportation Action Model (TAM) process, which is administered by the Minnesota Department of Transportation. In addition, this research sought to discover how applicable and relevant sustainable transportation indicators would be in cities that are candidates for the TAM and whether or not applicability and relevancy would be different among communities with very different physical characteristics.

Overview of the TAM

The TAM is a 21-week process requiring the participation of at least 25 community participants from a broad range of transportation stakeholders and citizens. Created to build a bridge between transportation planners and local leaders, the TAM has been a key tool in efforts to design a new model of responding to citizen values and concerns in the state of Minnesota.

The application of the TAM rests upon three basic assumptions:66

1. That to become truly engaged in informed local transportation planning, some education and training is needed.
2. Planners need to work closely with community leaders if local plans are to be successfully developed and applied.
3. The process of education, reaching community consensus and the development of new working relationships take time and should not be rushed when applied to complex transportation issues.

Designed as an approach to enhance dialogue between local leaders and transportation planners, it was not the intention of the TAM design team to develop a means to replace current transportation planning efforts, but rather to augment them. The steps of the TAM process are meant to create public dialogue, identifying transportation issues, and developing solutions. Successful completion of the program by a community provides a blueprint for local action as it relates to transportation planning.67

---

66 Ibid, Page ix.
67 Ibid.
The program includes the following action steps:

<table>
<thead>
<tr>
<th>WEEKS</th>
<th>ACTION STEPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Community Identification &amp; Selection</td>
</tr>
<tr>
<td>2</td>
<td>Sponsoring Agency Commitment</td>
</tr>
<tr>
<td>3</td>
<td>Initiating Committee Selected</td>
</tr>
<tr>
<td>4</td>
<td>Coordinator &amp; Facilitator Selected</td>
</tr>
<tr>
<td>5</td>
<td>Participants Recruited</td>
</tr>
<tr>
<td>6</td>
<td>&quot;Orientation Meeting&quot; (Meeting 1)</td>
</tr>
<tr>
<td>7</td>
<td>Technical Committee &amp; Public Input Committees Meet</td>
</tr>
<tr>
<td>8</td>
<td>&quot;A Look at Today's Transportation System&quot; (Meeting 2)</td>
</tr>
<tr>
<td>9</td>
<td>Public Input &amp; Issue Committees Meet</td>
</tr>
<tr>
<td>10</td>
<td>&quot;A Vision for the Community's Transportation Future&quot; (Meeting 3)</td>
</tr>
<tr>
<td>11</td>
<td>Public Input &amp; Issue Committees Meet</td>
</tr>
<tr>
<td>12</td>
<td>&quot;Developing a Transportation Action Plan&quot; (Meeting 4)</td>
</tr>
<tr>
<td>13</td>
<td>Writing the Transportation Action Plan</td>
</tr>
<tr>
<td>14</td>
<td>Final Plan Presentation</td>
</tr>
</tbody>
</table>

Section One: Two Harbors Case Study

The City of Two Harbors is located in Lake County on the North Shore of Lake Superior approximately 20 miles north of Duluth and 130 miles from the Canadian border. Two Harbors is a small town with a population of approximately 3,600. Because the town serves as a gateway to the North Shore, it has experienced increased traffic over the years as the popularity of the North Shore as a major tourist destination has grown, with new hotels and other tourist establishments springing up along the shoreline to Canada.

Two Harbors was selected as a case study site by the project team because the city was in the process of completing the TAM with the Minnesota Department of Transportation. This allowed the project team to participate in community meetings and witness the TAM in action. Not only did attendance in these meetings allow for a better understanding of how indicators could fit into the TAM in principle, but it also helped the project team access information collected during the course of the planning process for use in this study.

While indicators and indicator mapping are not currently part of the TAM process, they could provide useful community-specific tools that could enable community residents to make better informed planning decisions. The usefulness of these tools depends upon a complex set of factors: whether there is adequate fit between community values and the
indicators, whether the indicators are understandable within that context, and whether appropriate data and other resources are available for meaningful analysis over time.

Sustainability indicators are meant to complement and supplement more traditional measures that reveal useful information, albeit for one aspect of a community transportation system, and may not be readily understood by community members who are not engineers or technicians. For example, a commonly used measurement of road capacity is traffic counts. While this is a useful tool in transportation planning, traffic counts do not provide a complete illustration of the impacts of current or proposed transportation systems.

Sustainable transportation indicators proved useful for participants on several occasions during the Two Harbors TAM. For example, one of the Two Harbors TAM committees identified the provision of adequate parking for "Main Street" businesses, particularly during the peak tourist season, to be a problem. Indicators could have been used to portray a picture of the current situation, and to benchmark the goal of "adequate" parking - what shape adequate parking would take and what effect it would have on other community features and priorities in the longer term.

**Research Questions**

The Two Harbors case study applies the core set of indicators discussed in Chapter 1 and demonstrates the merit of defining the key sustainable transportation indicators that are best used in a rural environment.

To this end, the following research questions are addressed:

- To what degree can the core set of sustainable transportation indicators be used as a meaningful tool for informing decision-making in rural community-based transportation planning processes?

- What limitations or constraints are encountered in the usage of the core set of indicators in a rural context?

**Methodology**

For this case study, data was collected for Two Harbors and the immediately adjacent area. Various data sources were accessed to obtain the data to calculate the sustainable transportation indicators.
These sources included:

- 1990 U.S. Census
- City of Two Harbors
- Lake County
- National Decision Systems for household spending data
- Minnesota Department of Public Services for E85 flexible fuel vehicles
- Geographic Information & Mapping Unit of the Surveying and Mapping Section of the Office of Land Management in the Minnesota Department of Transportation for a Base Map of the State of Minnesota
- District 1A Office of the Department of Transportation for traffic-related accidents occurring on Trunk Highway 61
- Arrowhead Regional Development Commission for utilities, zoning, and land use data

After the data was collected several problems were encountered. These problems resulted in a limited and constrained analysis. These difficulties included: 1) different data collection systems, 2) different data presentation formats, 3) different geographic projections, 4) no geographic projections, 5) multiple sources, 6) variability in the timeliness, and 7) no accompanying metadata. As a result of the numerous problems encountered, much of the data could not be fully utilized for the application of the indicators.

Whenever and wherever appropriate, GIS was utilized in the analytical process. GIS aided in the conversion from one unit of analysis to another, and in the querying of the data. GIS also enabled the indicators to be spatially analyzed.

**Sustainable Transportation Indicators**

The point of departure for this study is the initial indicator set discussed in Chapter 1. While this list provides a good foundation for studying sustainable transportation, the project team needed to deviate from some of these indicators due to data constraints. (See Table 1). Overall, the team sought to be consistent with the intent of the original indicators and discovered important insights along the way. The use of proxy indicators was necessary due to the fact that a majority of the core indicators could not be applied due to data complications.

The unsuccessfully applied core indicators exhibited a range of failure for varying reasons. For example, the framework for applying the indicators, Ability of Non-Driver to Reach Employment Centers and Ability of Non-Driver to Basic Goods and Services, and Community and Recreational Activities, was sound. The primary obstacle was the fact that the street file for Two Harbors was incomplete. A few of the newer streets in Two Harbors were not included in the street file, therefore, efforts to geocode address locations was not possible. In addition, the data for the indicator, Percent of Traffic Injuries to Pedestrians and Cyclists, was acquired from a second-hand source and was missing or never had metadata attached to it.
**Initial Set of Sustainable Transportation Indicators or the Two Harbors Equivalents**

<table>
<thead>
<tr>
<th>Core Indicator Set</th>
<th>Two Harbor Equivalent Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Ratio of E85 FFV to Non-E85 FFV</td>
<td>Same</td>
</tr>
<tr>
<td>2) Percentage of Household Expenses Spent on Transportation</td>
<td>&quot;Major, Infrequent Transportation-Related Expenditures&quot; &amp; &quot;Minor, Frequent Transportation-Related Expenditures&quot;</td>
</tr>
<tr>
<td>3) Time Devoted to Non-Recreational Travel Per Capita</td>
<td>&quot;Time Spent Commuting Per Capita&quot;</td>
</tr>
<tr>
<td>4) Percent of Traffic Injuries to Pedestrians and Cyclists</td>
<td>None</td>
</tr>
<tr>
<td>5) Ability of Non-Drivers to Reach Employment Centers</td>
<td>None</td>
</tr>
<tr>
<td>6) Ability of Non-Drivers to Reach Basic Services and Recreation</td>
<td>None</td>
</tr>
<tr>
<td>7) Ratio of Street Intersections to Intersections and Cul-de-Sacs</td>
<td>None</td>
</tr>
<tr>
<td>8) Percent of Street Miles Designated for Bike Route Miles</td>
<td>None</td>
</tr>
<tr>
<td>9) Ratio of Trails to Streets and Roads</td>
<td>None</td>
</tr>
<tr>
<td>10) Percent of Street Frontage with Sidewalks</td>
<td>None</td>
</tr>
<tr>
<td>11) Land Per Capita Used for Transportation</td>
<td>None</td>
</tr>
<tr>
<td>12) Ratio of Low-Emission Vehicles to High-Emission Vehicles</td>
<td>None</td>
</tr>
<tr>
<td>13) Population Density</td>
<td>Same</td>
</tr>
<tr>
<td>14) Modal Split</td>
<td>Same</td>
</tr>
<tr>
<td>15) Vehicle Miles Traveled Per Capita</td>
<td>None</td>
</tr>
<tr>
<td>16) Vehicle Hours Traveled Per Capita</td>
<td>None</td>
</tr>
</tbody>
</table>

Note: The value "None" signifies that data constraint prohibited the successful application of the indicator in Two Harbors. The value "Same" signifies that the core indicator did not require modification in order to be used in the Two Harbors application.

**Sustainable Transportation in Two Harbors**

When the data permitted, the indicators were applied not only to the City of Two Harbors, but also to the rest of Lake County in order to make use of the fullest range of data in the area as possible. (See Table 2.)
Ratio of E85 Flexible Fuel Vehicles to Non-E85 Flexible Fuel Vehicles

The unit of analysis was the ZIP code. Data availability is not a problem for this indicator. For anywhere in the State of Minnesota, current year data on the number of E85 vehicles and total vehicles by zip code can be obtained from the Minnesota Department of Public Services. Geographic applicability, in terms of E85 refueling stations, is a primary constraint on the meaningful use of this indicator. As more E85 FFV models are introduced and as more E85 refueling stations are brought online, this indicator will become more valuable as a measurement tool for improvements attributable to changes in mobile source vehicle technologies.

Major & Minor, Infrequent Transportation-Related Household Expenditures

The following maps display the split in types of transportation-related expenses.

The unit of analysis was the zip code. A couple of assumptions were required for these indicators. In 1990, Two Harbors contained approximately 55% of the population and households within ZIP code 55616 while only consisting of approximately 1-2% of the total land area within the ZIP code. A more detailed analysis could have been done by using either 1) using a different unit of analysis, or 2) estimating the proportion of the expenditures directly attributable to the residents and households of the City of Two Harbors.
The map of Lake County demonstrates the fact that those who live outside of Duluth and Two Harbors have longer commute times than those who live in them, presumably because those with longer commute times are traveling to Duluth and Two Harbors for work. In the map that focuses upon Two Harbors, the trend shown demonstrates that those living in the northern parts of Two Harbors seem to be commuting to Two Harbors itself or a nearby town, while most of the people living south of Two Harbors are likely commuting to Duluth.

The unit of analysis for these maps was the block group. As with the other indicators, a couple of assumptions were also required. There are five block groups that fall partially or completely within the city limits of Two Harbors. Because of the configurations of these block groups it is impossible to distinguish between the population and households that fall inside the city limits of Two Harbors and those that fall outside. This demonstrates one of the reasons why it would be so important to find ways to provide smaller units of analysis, such as the parcel level or block face, for purposes of indicator analysis on the jurisdiction level and in rural areas.
These maps represent the split between single occupancy vehicle use and carpools. In nearly all of the block groups in Two Harbors and Lake County single occupancy vehicles were the primary mode of transportation. However, the use of carpools is not uncommon. In one block group north of Two Harbors and Duluth carpooling and transit both seem to be making some headway.

**Population Density**

The following two maps were prepared to illustrate the population density of Two Harbors and the surrounding area within Lake County. These maps could have been helpful in the community meetings during the TAM to help residents familiarize themselves with an aerial view of their community and its population density. Having the opportunity to view the areas with the largest concentrations of residents could lead to different decisions about the relationship between the transportation system and land use.
The unit of analysis in this exercise was the census block. No assumptions were needed for this indicator. This unit of analysis is useful for comparing findings inside the jurisdiction of a rural community like Two Harbors and the surrounding area. One of the limitations of course is missing data. The white sections in the maps are areas where there was no data available for the blocks represented.

**Table of the Results from the Two Harbors Case Study**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>City of Two Harbors</th>
<th>Lake County (Excluding Two Harbors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of E85 Flexible Fuel Vehicles to Non-E85 Flexible Fuel Vehicles</td>
<td>Through model year 1998, there were 6 privately owned, and 1 state-owned E85 Vehicles registered in the City of Two Harbors. In 1998, the nearest E85 refueling station serving the City of Two Harbors was in St. Cloud, Minnesota. It is safe to assume that the 7 E85 FFVs located in the City of Two Harbors are not being used as such currently.</td>
<td>No Data</td>
</tr>
<tr>
<td>Major, Infrequent Transportation-Related Expenditures</td>
<td>25% of HH had Brake Lining/Pad Replacement 10% of HH had Minor Engine Repair 9% of HH had Transmission Service 4% of HH had Major Engine Repair 4% of HH had a Paint Job</td>
<td>22% of HH had Brake Lining/Pad Replacement 8% of HH had Minor Engine Repair 8% of HH had Transmission Service 4% of HH had a Paint Job 3% of HH had Major Engine Repair</td>
</tr>
<tr>
<td>Minor, Frequent Transportation-Related Expenditures</td>
<td>7.2 Quarts of Oil per Capita 1.3 Oil Filters per Capita 1.2 Spark Plugs per Capita 1 Tire per Capita</td>
<td>8.5 Quarts of Oil per Capita 1.5 Oil Filters per Capita 1.4 Spark Plugs per Capita 1 Tire per Capita</td>
</tr>
<tr>
<td>Time Spent Commuting Per Capita</td>
<td>An average of 21 minutes</td>
<td>An average of 26 minutes</td>
</tr>
<tr>
<td>Modal Split</td>
<td>An average of 88% Drove Alone An average of 12% Carpooled</td>
<td>An average of 85% Drove Alone An average of 14% Carpooled An average of 1% Rode Transit</td>
</tr>
<tr>
<td>Population Density</td>
<td>An average of 4317 persons per square mile</td>
<td>An average of 424 persons per square mile</td>
</tr>
</tbody>
</table>

**Section Summary**

The Two Harbors indicator analysis tested the applicability of indicators as measures for painting a picture of the region in order to give community members and leaders a better understanding of the big picture. Most of the indicators that could be applied would be useful to consider in a community planning process. In particular, population density, time spent commuting per capita, and mode split drew out information about
the community that would be useful in analyzing proposals to change transportation infrastructure design in a rural area.

However, these indicators were not as revealing as they could have been had the data been available at a smaller level of analysis than the block group. The way the census data is collected does not currently allow for measurements that are focused enough to draw detailed conclusions about the effects of transportation and community design types on transportation behavior. While they begin to do so, a more finely tuned measurement tool is needed for such low-density development.

Section Two: Microcase Studies

There were three levels of inquiry into these questions. First, the project team tested the reactions to indicators on a small sample of planners in cities that were identified as potential micro case study sites. Next, the team applied the indicators in Nisswa and St. Peter to see the extent to which there was data available to apply the indicators. Then the team explored the types of analysis that could be drawn from the application of the indicators. Finally, a sustainability outreach tool was developed to be used during a community planning process and aspects of it were tested during a TAM process in St. Peter, MN.

The micro case study sites were chosen to test whether or not the data necessary to apply an objective menu of sustainability indicators was available for small and medium-sized cities outside of the Twin Cities metropolitan area. In contrast to both the Lake Street Corridor and the Two Harbors case studies, these studies were performed to demonstrate how indicators could be used in communities that do not have access to high tech data analysis resources, such as GIS. The sites chosen were all cities that had either participated in Mn/DOT’s Transportation Action Model or were in the process of participating in it.

The following indicators were used in the micro case studies.

- Commuters within 30 minutes from work
- Ratio of intersection types
- Ability of non-drivers to reach important centers
- Population density
- Modal split
- Ratio of car accident injuries to bike and pedestrian injuries
- Percent of E 85 vehicles
- Percent street miles designed to double as bike paths
- Ratio of bike trails to streets and roads
- Percent street frontage with sidewalks
- Land per capita used for transportation
- Average commuter travel time
The Air Quality Index, the Economic Development Index, the Equity Index and the Impervious Surface indicators were not applied in the micro case studies. This is partly because the project team lacked key data that would have been needed to apply these indicators, but also because the micro case studies were not intended to be as extensive as the following two case studies.

**Planner Interview Results**

To help identify which cities to use as micro case study sites and gain background information about micro case study candidates, the project team conducted interviews with planners in four cities. It was hoped that through these interviews information would be gained to help determine the extent to which the communities interviewed had characteristics in common or were distinct from each other. The team sought to detect whether or not differences in the community’s characteristics might or might not impact their interest in sustainability and using sustainability indicators in their jobs.

The cities interviewed were found to have several differences. The first candidate was an outer-ring suburb of the Twin Cities that concentrates on industry for economic development. The second was a freestanding city north of the Twin Cities with manufacturing as its core economic development tool. The third was a medium-sized town in southern Minnesota nestled along a curve in a river with a variety of institutions providing jobs, the college and state hospital among its top employers. This city is well known for its emphasis on historic preservation. Finally, the last candidate was a small town in northern Minnesota sprawled around and among several lakes and rivers that depended on tourism for its economic well being.

The communities interviewed also had a number of things in common. According to the planners surveyed, all of the cities had regulatory-prone community leaders, were either in the process of updating their comprehensive plan or drafting their first comprehensive plan, had a community participatory style and tried to involve community members in planning and decision-making to the greatest extent possible. In addition, they all had access to Geographic Information System (GIS) software to map data either within their office or through outside consultants. Those that had GIS in their office did not necessarily have anyone who was trained in its use; however, employees in their offices were in the process of learning how to use it. Despite the existence of these characteristics in the cities, none of them were currently using sustainability indicators. In addition, none of the cities had plans to implement the use of sustainability indicators in the near future.

The research team hypothesized that the community within the Twin Cities metropolitan area would be the most likely to be interested in the use of sustainability indicators and may already be implementing their use. Not only did this community have access to the most data through the Metropolitan Council; it was in the process of enhancing its downtown through development that seemed to be following new urbanist principles. The community that was hypothesized to be the least interested in sustainability indicators was the one surrounded by lakes and rivers deep in the woods.
of northern Minnesota. This was because sustainable development as an express
doctrine has generally been pursued in compact, metropolitan communities. Between
the two other cities interviewed, the city in the south was hypothesized to be more likely
to be interested in sustainability than the one in the north due to its historic preservation
bent.

Surprisingly, the opposite was found. The community with the least interest in the use
of sustainability indicators was the metropolitan suburb, while the community that
seemed the most positive about their use and even said that perhaps the city would use
them if they had more information about them was the small, northern Minnesota
community. Between the two other cities, the more city more to the north expressed
more interest in learning about indicators, while the community in the south was
slightly less interested in sustainability and was doubtful they would readily use them
with more information.

While some of the communities interviewed were more positive about the concept of
sustainability than others, all of them seemed to agree on a few points with regard to the
prospect of applying the list of sustainability indicators regularly in the course of their
planning work. Their overall perception of our indicator list was that it was too abstract
to be useful. They also said that they thought that they already used these calculations
in a sense and knew the results in an intuitive way, without having to go through the
trouble of finding the exact figures. They also thought it would probably take too long
to collect the data necessary, then calculate and store the results of the indicators. They
believed they already have access to the data and conventions they need to do their jobs
and that while the results of the indicators might be "interesting," and their level of
interest varied, none of them saw the activity as "necessary."

Because there were only four cities surveyed and only one person was interviewed in
each community, only preliminary analysis can be drawn from the results of these
interviews. In addition, whether or not the planners interviewed were reflecting a level
of interest representative of the members of the city councils or the community members
can not be determined from the data available. The fact that none of the planners
interviewed used indicators, nor did they believe that their use in the community was
needed, was of interest to the project team.

The team developed a few hypotheses about why the planners interviewed did not see
the use of indicators as a needed activity. The first was that the planners may not think
that they had the time needed to wade into census data, then calculate and store
information they are not currently required to apply given the scope of their current
work. Another hypothesis for why this reaction was the same across these cities is
because the emphasis on city planning has been safety and smooth traffic flow rather
than building sustainable transportation systems. Because defining what constitutes a
livable, efficient, sustainable community constitutes a broad range of opinions from
citizens in a community, it is more difficult to implement. Whereas safety and smooth
traffic flow are easily agreed upon by all. If the issue of improving the impact of the
system's design on livability in the community was less politically charged, then the usefulness of sustainability indicators might seem less elusive.

In response to these hypotheses, policy implications and possible remedies were also discussed. First, if the data were more easily accessible and user-friendly, planners might be interested in using it. In addition, if other communities made the results of these indicators accessible to the planning departments of their neighbors, it might convince communities to use the indicators to see how they compare. If these indicators were calculated for the entire state, county and/or transportation district, it would give cities a reference point with which to compare their indicator results. However, because different geographic characteristics are sometimes better suited for one kind of development over another, one city's indicator results may not be comparable to another's. Therefore it may be necessary to identify a number of appropriate ranges specific to different types of communities. For example, a rural community would likely have a different range for population density than an urban community.

Application of Sustainability Indicators

After the interviews were completed, the team began to apply the indicators to the micro case study sites. The sites chosen were Nisswa and St. Peter.

Because some small and medium sized cities do not yet have access to GIS, the research team wanted to test whether or not the analysis could be done without the use of this software. Therefore, GIS was not used in the micro case studies. Our findings demonstrate that GIS-type analysis can be done without the use of the software, though not to the same level of sophistication.

Collection of the census data was performed using the Environmental System Resources Institute (ESRI) web page (www.esri.com). ESRI has converted the census data to a GIS format that can be used in any database software package. The link to the census data is titled the "TIGER" files. While there were maps of the census boundaries on the web site, they were not helpful in identifying the census blocks within the study areas without the use of GIS. Therefore, the Census Bureau's maps from the University library were used to identify which blocks were inside the study area. Once the census blocks were identified, the census data needed to calculate most of the indicators were downloaded in spreadsheet format.

While most of the indicators were calculated using this data, almost all other data needed to calculate the indicators was obtained from each of the cities' planning departments or Mn/DOT. The calculations were not difficult. A document listing the indicators and how they were calculated was prepared. (Appendix C-1.)

There are two ways the indicators were cataloged once they were calculated. The first way was in a word document. This mode allowed more space to add details about the calculation of the indicator and was easier to read and understand by people who were not accustomed to using tables regularly.
Below are the results of the first two indicators for the Nisswa case study to demonstrate how the indicators were cataloged using a word format:

1. Number of commuters living within 30 minutes from work: 772 or 84%
   Total drivers: 919; drivers under 30 mins to work: 772; drivers over 30 mins: 147

2. Ratio of street intersections vs. intersections & cul-de-sacs:
   Ratio of cross intersections to total intersections: 18:97 or 18.6%
   Ratio of non-cross intersections and cul de sacs to total intersections: 79:97 or 81.44
   # of cul de sacs: 7; # of cross intersections: 18; # of non-cross intersections: 72

The second was an "at a glance" model using an Excel database. Any program that produces tables could have been used. The indicators are listed in the left column and the calculations of the indicators are listed in columns along the right. The advantage of the table format is that the calculations for more than one jurisdiction can be displayed at once. For example, the results of two cities can be compared side by side, or the results of the city can be compared to the results averaged over the county, district or state.

Below are a few of the results from the Nisswa and St. Peter case studies to demonstrate how indicators can be displayed at a glance:

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>ST PETER 90</th>
<th>NISSWA 90</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Commuters w/in 30 minutes from work</td>
<td>92%</td>
<td>84%</td>
</tr>
<tr>
<td>2 Ratio of intersection types</td>
<td>Cross/total:49% other/total: 51%</td>
<td>Cross/total:18.6% other/total: 81.44%</td>
</tr>
<tr>
<td>3 Population density</td>
<td>790/ sq mile</td>
<td>134.12/ sq mile</td>
</tr>
<tr>
<td>4 Modal Split</td>
<td>Drive alone:81% Car pool: 16.5% Public transit: .6% Work from home: 1.9%</td>
<td>Drove alone: 87.15% Car pool: 7% Public transit: .3% Work from home: 5.5%</td>
</tr>
<tr>
<td>5 Percent of traffic injuries to bikes and pedestrians</td>
<td>28:406 or 6.9%</td>
<td>3:68 or 4.4%</td>
</tr>
<tr>
<td>6 Percent street miles designed for bikes and cars</td>
<td>3.30%</td>
<td>3.30%</td>
</tr>
<tr>
<td>7 Ratio of trails to streets and roads</td>
<td>6:53 or 11.3%</td>
<td>6:53 or 11.3%</td>
</tr>
</tbody>
</table>

*To view the full table of results from the Two Harbors and Nisswa micro case studies see Appendix.

Only a few hand-made visualization maps were drawn to demonstrate that they could be made. Because St. Peter was in the process of completing the TAM, these maps were
used in a meeting to demonstrate for the group in St. Peter how this type of analysis is performed. (Map B-1.) The map that was the most useful during the presentation was the one that demonstrated the impact of the city’s plan to increase the number of bike paths and streets designed to double as bike paths. This map was used during discussions about bike paths during St. Peter’s planning process. Also, there was one indicator, the ability of non-drivers to reach important centers, that could not be depicted without the use of a map. Only with the use of a map can the relationship between where people live and where important employment and recreational centers are located vis-a-vis waterways and other impediments to walkers be fully understood. Therefore, to express this indicator, a hand made map of the city with dots representing important centers and shades of colored pencil depicting census boundaries with higher percentages of non-drivers was used. One of the drawbacks about not using GIS is that it is difficult to demonstrate areas of concentration or percentages visually without this software. For that reason, the map depicting the mode split was less useful.

Given St. Peter’s high percentage of drivers spending less than 30 minutes commuting to work, a good balance of grid patterned intersections and other intersections, good coverage of sidewalks, emphasis on historic preservation and high population density, the indicators seem to indicate that St. Peter was relatively sustainable. However, if the definition of sustainability entails a preponderance of development or land use designed to alleviate the need for automobile use, St. Peter may not qualify. As demonstrated by the town’s modal split, a paltry .6% of the residents use public transit to commute to work. While their car pool indicator at 16.5% is relatively healthy and could work to make up for the low transit use, there are other issues that residents identified during the TAM meetings that are not captured by the indicators applied in the micro case studies. For example, there is a heavy traffic highway running through the middle of the downtown that works to discourage pedestrian traffic on the main street (Hwy 169). In addition, most of the commercial enterprises are in buildings on the heavy traffic highway, some with large parking lots in the front, which are characteristics that encourage residents to drive to shop. Also, many of the residents in the region drive to Mankato to shop because there is not a wide selection of shopping in St. Peter. These factors tend to increase resident’s reliance on automobiles as their primary mode of travel, a reliance that works against a development style that could otherwise result in a decreased use of automobiles.

The need for acceptable ranges for the results of the indicators to help communities interpret the indicators and understand which ranges are appropriate for their size and location is reinforced by comparing the results of the indicators in St. Peter and Nisswa. For example, St. Peter’s population density is much higher than Nisswa’s because it is bigger and is located in a place better suited for centralized land use. Nisswa, literally a city of lakes, does not lend itself to high population density development because there is more water in Nisswa than there is land. For the same reason, Nisswa has fewer grid-patterned streets. However, Nisswa is not necessarily less sustainable than St. Peter. Instead, a use of different levels of land use ranges for indicators in these cities would likely be appropriate.
Chapter Summary

Rural areas present their own set of challenges for indicator analysis. Not only is there a lack of data with which to apply indicators in many rural areas, much of the data available is not formatted in such a way to readily allow for GIS analysis. In the case of Two Harbors, this jurisdiction is small and located in a relatively remote area on the North Shore. For these reasons, it is not surprising that there was not access to an abundance of GIS-ready data sets. This does not preclude preliminary spatial analysis via conventional mapping and overlays, as demonstrated by the micro case studies. However, it does present a barrier to making the transition to GIS absent funding and other resources to convert current data to GIS-ready formats or begin to collect new, GIS-compatible data.

Overall, the difficulties experienced by the research team when attempting to apply the core set of indicators in Two Harbors was less a result of a lack of relevance of the sustainable transportation indicators in rural areas and more a result of data constraints. Nonetheless, the ability to measure progress toward sustainable community practices does vary across the indicators and depends largely upon the combination of indicators used. Some of the indicators are naturally more applicable and relevant to areas with more compact development than those that are more spread out. This signals the need for revisiting the notion of distinct sets of indicators defined by community context.

Despite the absence of appropriate data for the Two Harbors case study, sustainable transportation indicators hold promise as tools for informing decision-making in community-based transportation planning processes. The usefulness and relevance of the indicators partly depends upon making data more readily available and user-friendly for communities, as well as ensuring that the indicators complement and are integrated with community planning approaches and oversight agency objectives.
### TABLE 1: Sustainable Transportation Indicators

<table>
<thead>
<tr>
<th>Core Indicator Set</th>
<th>Indicator Description</th>
<th>Potential Indicator Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Ratio of E85 FFV to Non-E85 FFV</td>
<td>The ratio of E85 flexible fuel vehicles to non-E85 flexible fuel vehicles is an indication of the mitigation efforts of some of the negative impacts on air quality resulting from a community's transportation system. It links transportation to economy (reduces cost of importing oil), society (healthier lungs from cleaner air), and environment (reduces greenhouse gas emissions).</td>
<td>Data on the number of E85 FFVs can be obtained from the Minnesota Department of Public Services.</td>
</tr>
<tr>
<td>2) Percentage of Household Expenses Spent on Transportation</td>
<td>The portion of household expenses spent on transportation is an indication of some of the economic and social effects of a community's transportation system. The portion of household expenses spent on transportation varies among socioeconomic groups. Household transportation expenses can include but are not limited to the capital cost of the vehicle, automobile insurance, parking costs, maintenance costs, and fuel costs.</td>
<td>Data on the amount of household expenses spent on transportation can be obtained from National Decision Systems.</td>
</tr>
<tr>
<td>3) Time Devoted to Non-Recreational Travel</td>
<td>The time devoted to non-recreational travel is</td>
<td>Data on the amount of time devoted to non-</td>
</tr>
<tr>
<td>Per Capita</td>
<td>an indication of loss economic and societal productivity. The time spent commuting is time that could better spent on more productive activities such as family activities, recreational and cultural activities, and employment activities.</td>
<td>recreational travel can be obtained the United States Bureau of the Census.</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>4) Percent of Traffic Injuries to Pedestrians and Cyclists</td>
<td>The percent of traffic injuries to pedestrians and cyclists is an indication of the tradeoff between traffic flow and traffic safety of a community's transportation system.</td>
<td>Data on the number of traffic injuries to pedestrians and cyclists can be obtained from the Minnesota Department of Transportation's (Mn/DOT) District Offices and from the Minnesota State Police.</td>
</tr>
<tr>
<td>5) Ability of Non-Drivers to Reach Employment Centers</td>
<td>The ability of non-drivers to reach employment centers is an indication of the level of accessibility of a community's transportation system.</td>
<td>Data on the top employers in a community can be obtained from the Minnesota Department of Trade and Economic Development (Mn/DTED). Data on the number of households without access to an automobile can be obtained from the United States Bureau of the Census.</td>
</tr>
<tr>
<td>6) Ability of Non-Drivers to Reach Basic Services and Recreation</td>
<td>The ability of non-drivers to reach basic services and recreation is an indication of the level of accessibility of a community's transportation system.</td>
<td>Data on the location of basic services and recreation can be obtained from the local government. Data on the number of households without access to an automobile and the number of persons under the age of 15...</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>7) Ratio of Street Intersections to Intersections and Cul-de-Sacs</td>
<td>The ratio of street intersections to intersections and cul-de-sacs is an indication of connectivity of a community’s transportation system.</td>
<td>and over the age of 75 can be obtained from the United States Bureau of the Census.</td>
</tr>
<tr>
<td>8) Percent of Street Miles Designated for Bike Route Miles</td>
<td>The percent of street miles designated for bike route miles is an indication of the level of multimodalism of a community’s transportation system.</td>
<td>Street network maps can be obtained from the public works department of the local government.</td>
</tr>
<tr>
<td>9) Ratio of Trails to Streets and Roads</td>
<td>The ratio of street miles designated for bike route miles is an indication of the level of support for alternative modes of a community’s transportation system.</td>
<td>Bike infrastructure maps and data from the public works department of the local government.</td>
</tr>
<tr>
<td>10) Percent of Street Frontage with Sidewalks</td>
<td>The percent of street frontage with sidewalks is an indication of the level of accessibility of a community’s transportation system.</td>
<td>Trail infrastructure maps and data can be obtained from the Minnesota Department of Natural Resources and the Minnesota Department of Transportation.</td>
</tr>
<tr>
<td>11) Land Per Capita Used for Transportation</td>
<td>The land per capita used for transportation is an indication of loss of open space.</td>
<td>Data on pedestrian infrastructure can be obtained from the public works department of the local unit of government.</td>
</tr>
<tr>
<td>12) Ratio of Low-Emission Vehicles to High-Emission Vehicles</td>
<td>The ratio of low-emission vehicles to high-emission vehicles is an indication of air quality.</td>
<td>Aerial digital orthoquadrs can be obtained from the United States Geological Survey.</td>
</tr>
<tr>
<td>13) Population Density</td>
<td>The population density is an indication of loss</td>
<td>Data on population density can be obtained.</td>
</tr>
<tr>
<td>14) Modal Split</td>
<td>The modal split is an indication of the level of transportation alternative usage.</td>
<td>Data on modal split can be obtained from the United States Bureau of the Census</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>15) Vehicle Miles Traveled Per Capita</td>
<td>The vehicle miles traveled per capita is an indication of the mix of land uses.</td>
<td>Metropolitan Planning Councils or</td>
</tr>
<tr>
<td>16) Vehicle Hours Traveled Per Capita</td>
<td>The vehicle hours traveled per capita is an indication of loss of time otherwise spent on more productive activities.</td>
<td></td>
</tr>
</tbody>
</table>
TABLE 2: TAM Outline

<table>
<thead>
<tr>
<th>WEEKS</th>
<th>ACTION STEPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Community Identification &amp; Selection</td>
</tr>
<tr>
<td>2</td>
<td>Sponsoring Agency Commitment</td>
</tr>
<tr>
<td>3</td>
<td>Initiating Committee Selected</td>
</tr>
<tr>
<td>4</td>
<td>Coordinator &amp; Facilitator Selected</td>
</tr>
<tr>
<td>5</td>
<td>Participants Recruited</td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>&quot;Orientation Meeting&quot; (Meeting 1)</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Technical Committee &amp; Public Input Committees Meet</td>
</tr>
<tr>
<td>11</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>&quot;A Look at Today's Transportation System&quot; (Meeting 2)</td>
</tr>
<tr>
<td>13</td>
<td>Public Input &amp; Issue Committees Meet</td>
</tr>
<tr>
<td>14</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>&quot;A Vision for the Community's Transportation Future&quot; (Meeting 3)</td>
</tr>
<tr>
<td>16</td>
<td>Public Input &amp; Issue Committees Meet</td>
</tr>
<tr>
<td>17</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>&quot;Developing a Transportation Action Plan&quot; (Meeting 4)</td>
</tr>
<tr>
<td>19</td>
<td>Writing the Transportation Action Plan</td>
</tr>
<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Final Plan Presentation</td>
</tr>
</tbody>
</table>
Table A-3: Results of the Nisswa and St. Peter Indicator Calculations

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>NISSWA</th>
<th>ST PETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commuters w/in 30 minutes from work</td>
<td>84%</td>
<td>92%</td>
</tr>
<tr>
<td>Ratio of intersection types</td>
<td>Cross/total:18.6% Other/total: 81.44%</td>
<td>Cross/total:49% Other/total: 51%</td>
</tr>
<tr>
<td>Ability of non-drivers to reach important centers</td>
<td>N/A</td>
<td>See map.</td>
</tr>
<tr>
<td>Population density</td>
<td>134.12/ sq mile</td>
<td>790/ sq mile</td>
</tr>
<tr>
<td>Model Split</td>
<td>Drove alone:87.15% Car pool: 7% Pub tran: 3% Home: 5.5%</td>
<td>Drive alone: 81% Car pool: 16.5% Pub tran: 64% Home: 1.9%</td>
</tr>
<tr>
<td>% of traffic injuries to bikes and peds</td>
<td>3.68 or 4.4%</td>
<td>28:406 or 6.9%</td>
</tr>
<tr>
<td>Number of E 85 vehicles</td>
<td>N/A</td>
<td>14 vehicles</td>
</tr>
<tr>
<td>St. Cloud is closest pump, &gt; 1 hr drive</td>
<td></td>
<td>Mankato is the closest pump, &lt; 1 hr drive.</td>
</tr>
<tr>
<td>% street miles designed for bikes and cars</td>
<td>3.30%</td>
<td>3.30%</td>
</tr>
<tr>
<td>Ratio of trails to streets and roads</td>
<td>6:53 or 11.3%</td>
<td>6:53 or 11.3%</td>
</tr>
<tr>
<td>% street frontage with sidewalks</td>
<td>No data gathered.</td>
<td>45.68%</td>
</tr>
<tr>
<td>Time devoted to work related travel</td>
<td>20.6 minutes</td>
<td>27.46 minutes</td>
</tr>
</tbody>
</table>
Table A-4: Table of Two Harbors Results

**Table of the Results from the Two Harbors Case Study**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>City of Two Harbors</th>
<th>Lake County (Excluding Two Harbors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of E85 Flexible Fuel Vehicles to Non-E85 Flexible Fuel Vehicles</td>
<td>Through model year 1998, there were 6 privately owned, and 1 state-owned E85 Vehicles registered in the City of Two Harbors. In 1998, the nearest E85 refueling station serving the City of Two Harbors was in St. Cloud, Minnesota. It is safe to assume that the 7 E85 FFVs located in the City of Two Harbors are not being used as such currently.</td>
<td>No Data</td>
</tr>
<tr>
<td>Major, Infrequent Transportation-Related Expenditures</td>
<td>25% of HH had Brake Lining/Pad Replacement</td>
<td>22% of HH had Brake Lining/Pad Replacement</td>
</tr>
<tr>
<td></td>
<td>10% of HH had Minor Engine Repair</td>
<td>8% of HH had Minor Engine Repair</td>
</tr>
<tr>
<td></td>
<td>9% of HH had Transmission Service</td>
<td>8% of HH had Transmission Service</td>
</tr>
<tr>
<td></td>
<td>4% of HH had Major Engine Repair</td>
<td>4% of HH had a Paint Job</td>
</tr>
<tr>
<td></td>
<td>4% of HH had a Paint Job</td>
<td>3% of HH had Major Engine Repair</td>
</tr>
<tr>
<td>Minor, Frequent Transportation-Related Expenditures</td>
<td>7.2 Quarts of Oil per Capita</td>
<td>8.5 Quarts of Oil per Capita</td>
</tr>
<tr>
<td></td>
<td>1.3 Oil Filters per Capita</td>
<td>1.5 Oil Filters per Capita</td>
</tr>
<tr>
<td></td>
<td>1.2 Spark Plugs per Capita</td>
<td>1.4 Spark Plugs per Capita</td>
</tr>
<tr>
<td>Time Spent Commuting Per Capita</td>
<td>An average of 21 minutes</td>
<td>1 Tire per Capita</td>
</tr>
<tr>
<td>Modal Split</td>
<td>An average of 88% Drove Alone</td>
<td>An average of 85% Drove Alone</td>
</tr>
<tr>
<td></td>
<td>An average of 12% Carpoled</td>
<td>An average of 14% Carpoled</td>
</tr>
<tr>
<td>Population Density</td>
<td>An average of 4317 persons per square mile</td>
<td>An average of 1% Rode Transit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>An average of 424 persons per square mile</td>
</tr>
</tbody>
</table>
### Table A-5: Equity Index Lake Street Study Area Tracts and Block Groups

<table>
<thead>
<tr>
<th>TRACT90</th>
<th>GROUP 90</th>
<th>TRACT9</th>
<th>GROUP90</th>
</tr>
</thead>
<tbody>
<tr>
<td>0046</td>
<td>3</td>
<td>0073</td>
<td>1</td>
</tr>
<tr>
<td>0046</td>
<td>4</td>
<td>0074</td>
<td>3</td>
</tr>
<tr>
<td>0047</td>
<td>2</td>
<td>0077</td>
<td>1</td>
</tr>
<tr>
<td>0053</td>
<td>1</td>
<td>0077</td>
<td>2</td>
</tr>
<tr>
<td>0053</td>
<td>2</td>
<td>0078</td>
<td>1</td>
</tr>
<tr>
<td>0054</td>
<td>1</td>
<td>0078</td>
<td>2</td>
</tr>
<tr>
<td>0054</td>
<td>2</td>
<td>0078</td>
<td>3</td>
</tr>
<tr>
<td>0054</td>
<td>3</td>
<td>0078</td>
<td>4</td>
</tr>
<tr>
<td>0056</td>
<td>1</td>
<td>0079</td>
<td>1</td>
</tr>
<tr>
<td>0057</td>
<td>1</td>
<td>0079</td>
<td>2</td>
</tr>
<tr>
<td>0057</td>
<td>2</td>
<td>0079</td>
<td>3</td>
</tr>
<tr>
<td>0057</td>
<td>3</td>
<td>0080</td>
<td>1</td>
</tr>
<tr>
<td>0058</td>
<td>1</td>
<td>0080</td>
<td>2</td>
</tr>
<tr>
<td>0058</td>
<td>2</td>
<td>0080</td>
<td>3</td>
</tr>
<tr>
<td>0059</td>
<td>1</td>
<td>0080</td>
<td>4</td>
</tr>
<tr>
<td>0059</td>
<td>2</td>
<td>0081</td>
<td>1</td>
</tr>
<tr>
<td>0060</td>
<td>1</td>
<td>0081</td>
<td>2</td>
</tr>
<tr>
<td>0060</td>
<td>2</td>
<td>0081</td>
<td>3</td>
</tr>
<tr>
<td>0060</td>
<td>3</td>
<td>0081</td>
<td>4</td>
</tr>
<tr>
<td>0060</td>
<td>4</td>
<td>0081</td>
<td>5</td>
</tr>
<tr>
<td>0061</td>
<td>1</td>
<td>0082</td>
<td>1</td>
</tr>
<tr>
<td>0061</td>
<td>2</td>
<td>0082</td>
<td>2</td>
</tr>
<tr>
<td>0062</td>
<td>1</td>
<td>0082</td>
<td>3</td>
</tr>
<tr>
<td>0062</td>
<td>2</td>
<td>0082</td>
<td>4</td>
</tr>
<tr>
<td>0062</td>
<td>3</td>
<td>0083</td>
<td>1</td>
</tr>
<tr>
<td>0063</td>
<td>2</td>
<td>0083</td>
<td>2</td>
</tr>
<tr>
<td>0065</td>
<td>1</td>
<td>0083</td>
<td>3</td>
</tr>
<tr>
<td>0065</td>
<td>2</td>
<td>0084</td>
<td>1</td>
</tr>
<tr>
<td>0066</td>
<td>2</td>
<td>0084</td>
<td>2</td>
</tr>
<tr>
<td>0066</td>
<td>3</td>
<td>0084</td>
<td>3</td>
</tr>
<tr>
<td>0067</td>
<td>2</td>
<td>0085</td>
<td>1</td>
</tr>
<tr>
<td>0067</td>
<td>3</td>
<td>0085</td>
<td>2</td>
</tr>
<tr>
<td>0067</td>
<td>4</td>
<td>0085</td>
<td>3</td>
</tr>
<tr>
<td>0068</td>
<td>1</td>
<td>0085</td>
<td>4</td>
</tr>
<tr>
<td>0068</td>
<td>2</td>
<td>0085</td>
<td>5</td>
</tr>
<tr>
<td>0068</td>
<td>4</td>
<td>0086</td>
<td>1</td>
</tr>
<tr>
<td>0069</td>
<td>1</td>
<td>0086</td>
<td>2</td>
</tr>
</tbody>
</table>
APPENDIX B: MAPS
Map 1: Hand-Drawn Maps of St. Peter

St. Peter Bike Paths

With bike path plan implemented:

- Walking trail
- Bike path
- Road shoulder expansion

Major, infrequent Transportation Expenditures

Interstates
Map B-2:

Major, Infrequent Transportation Expenditures
Two Harbors

Source: National Data

Produced by the State & Local Policy Program
Map B-4:

Time Spent Commuting Per Capita, Two Harbors

Source: U.S. Bureau of the Census, 1990

Produced by the State & Local Policy Program
Map B-5:

Time Spent Commuting Per Capita, Lake County

Legend:
- Street Network
- Water Bodies
- Time Spent Commuting Per Capita
  - 32 - 32
  - 24 - 25
  - 22 - 23
  - 20 - 21
  - 18 - 19

Source: U.S. Bureau of the Census, 1990

Produced by the State & Local Policy Program
Map B-7:

Modal Split,
Lake County

Source: U.S. Bureau of the Census, 1990
Produced by the State & Local Policy Program
Map B-8:

Population Density, Two Harbors

- City of Two Harbors
- Street Network
- Railroads
- Water Bodies

Population Density (Persons per square mile):
- 0-111
- 111-1428
- 1428-4355
- 4355-6111
- 6111-12222
- 12222-4355
- 4355-6111
- 6111-12222
- No Data

Produced by the
State & Local Policy Program, 1999

Source: United States Bureau of the Census, 1990
Map B-10:

Lake Street Study Area
Map B-11:

Map 2

Commercial Areas
Around Minneapolis

Maple Grove
Osseo
Minnetonka
Brooklyn Center
Eden Prairie
Lake Street Corridor
Map B-12:

Map 3
Residential Population and Daytime Population 1998 by ZIP Codes

- Study Area
- Residential Population over Daytime Population
  - Over 2 times more Daytime Pop
  - Between 1.5 to 2 times more Daytime Population
  - Up to 1.5 times more Daytime Population
  - Up to 1.5 times more Residential Population
  - Between 1.5 to 5 times more Residential Population
  - Over 5 times more Residential Population

Source: National Decision Systems 1995
Map B-13:

Map 4

Difference in Street Layout

Suburban Sprawl (Plymouth)
Curve-liner pattern, and cul-de-sacs

Traditional City Pattern (Lake Street Corridor)
Traditional Grid pattern with many street intersections
Map 5

Percent of Households with either no Vehicle or only One Vehicle by ZIP Code 1990

- Lake Street Study Boundary
- Downtown Minneapolis
- Lake Street Corridor

Legend:
- Percent of Households with no Vehicles
  - Less than 10%
  - 10% - 20%
  - 20% - 40%
  - 40% - 60%

- Percent of Households with one Vehicle
  - Less than 10%
  - 10% - 20%
  - 20% - 40%
  - 40% - 60%
Map B-15:

Map 6
Percent of Households with either 2 Vehicles or 3 or more Vehicles by ZIP Code 1990

Legend:
- Lake Street Study Boundary
- Percent of Households with 2 Vehicles
  - Less than 10%
  - 10% - 20%
  - 20% - 40%
  - 40% - 60%
  - 0.6 - 0.8

- Percent of Households with 3 or more Vehicle
  - Less than 10%
  - 10% - 20%
  - 20% - 40%
  - 40% - 60%
Map B-16:

Map 7
Population per Square Mile
by ZIP Code 1990

Lake Street Corridor

Lake Street Study Boundary
Population Per Square Mile
27.12 - 1500
1500 - 5000
5000 - 7500
7500 - 10000
10000 - 125000
Map B-17:

Map B
Landuse & Liability Responses

- Corridor Boundary
- Areas of High Liability Responses
- Landuse:
  - Single Family Residential
  - Multi-Family Residential
  - Commercial
  - Industrial
  - Public/Semi-Public
  - Parks & Recreation
  - Vacant/Agri/Cultural
  - Major Four Lane Highways
  - Open Water Bodies

2  0  2  4
Miles

N

Claremont
Map B-18:

Map 9
Asking Home Prices in and around the Lake Street Rail Corridor

$39,900
$67,900
$29,900
$82,900
$65,000
$64,900
$103,900

1000 Feet Rail Corridor Buffer

$24,900
$30,000
$52,888
$52,000

Claremont

Lake Street Corridor Study Area
Map 10

Impervious Surface in Hennepin County 1990

- Downtown Minneapolis
- Lake Street Corridor Study Area
- Airport

[Map showing the distribution of impervious surfaces with labeled areas]
Map 11

Percent of Area Covered by Impervious Surface by ZIP Code 1990

- Lake Street Study Boundary
- Percent Impervious Surface
  - Less than 10%
  - 10% - 20%
  - 20% - 30%
  - 30% - 40%
  - Over 40%

Claremont Graduate University
Map B-21:

Median Household Income in 1990

Median Household Income
- Under $20,000
- $20,000 - 35,000
- $35,000 - 45,000
- $45,000 - 55,000
- Over $55,000
Map B-22:

Median Home Value Over Median Household Income

Home Value Times Income

- 1.91 - 2
- 2 - 2.5
- 2.5 - 3
- 3 - 4
- 4 - 15.12

Lake Street Corridor
Map B-24:

Population Density

Population per Mile
- Less than 1,000
- 1,000 - 2,500
- 2,500 - 5,000
- 5,000 - 10,000
- Over 10,000

Claremont
GRADUATE UNIVERSITY
Map B-25:

Percent Impervious Surface

- Under 15%
- 15% - 25%
- 25% - 35%
- 35% - 45%
- Over 45%

[Map showing the distribution of percent impervious surface with legend and scale]
Map B-27:

INDEX - Density Positive

Study Boundary

Index-Density Positive
-3.72 - -1.5
-1.5 - -0.75
-0.75 - 0.25
0.25 - 1
1 - 7.41
Map B-28:

Lake Street Emissions

Traffic Analysis Zones

Emissions from trips beginning in the study area
- 0 - 50
- 51 - 75
- 76 - 100
- 101 - 150
- 151 - 161

Emissions from trips beginning outside the study area
- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 251 - 300
- 301 - 503
Lake Street Land Use Map

Land Use

- Lake Street
- Single Family Residential
- Multi Family Residential
- Commercial
- Industrial
- Public Semi-public
- Parks and Recreation
- Vacant/Agricultural
- Major Highways
- Bodies of Water
- Regional Parks
- Traffic Analysis Zones
Map B-30:

Low Mobility Population
Young & Old

Source: 1990 Census

Produced by State & Local Policy Program
Low Mobility Population
Limited Vehicle Access

Source: 1990 Census

Produced by Ohio & Local Policy Program
Vehicle Access

Map B-32:

[Map showing vehicle access and study area]

Legend:
- Four Zip Code Study Area
- Railroads
- Lake Street Corridor
- Street Network
- Water Bodies
- Mobility Impairment
  - High Vehicle Inaccessibility
  - Moderate Vehicle Inaccessibility
  - Low Vehicle Inaccessibility

Source: [Source Information]

Produced by [State & Local Policy Program]
Map B-33:

Destination
Map B-34:

Transit Infrastructure

- Four Zip Code Study Area
- Transit Service
- MetroTransit
- Street Network
- 1/4 mile buffer of the Transit Routes

Source: 1000 Census

Produced by State & Local Policy Program
APPENDIX C: DOCUMENTS
DOCUMENT C-1: Steps used in the micro case studies to calculate the indicators

1. Time devoted to work-related travel

This indicator can be found using census data. There may scale problems involved. This information can be calculated or mapped on a per capita or aggregate basis.

2. Number of commuters living within 30 minutes from work

This indicator can be found using the census data. Add up the people who live within 30 minutes of work.

3. Percent of street miles designed for bike route miles

This indicator can be found using the Mn/DOT data. First find out which streets were designed to connect bike paths or to act explicitly as bike routes by adding extra shoulder room, etc. Then add up the miles of street, divide it by the total miles of street in the city and multiply by 100.

4. Ratio of trails to streets and roads

This indicator can be found using the Mn/DOT data. Divide total miles of bike routes by total miles of streets and roads.

5. Percent of traffic injuries to pedestrians and bicycles

This indicator can be found using Mn/DOT data. Divide number of injuries to pedestrians and bicycles by the total number of injuries then multiply by 100.

6. Ratio of cul-de-sacs and t-intersections to total intersections

Use a map of the city or community to calculate this indicator. First, count the number of cul-de-sacs and t-intersections. Next count the number of cross-intersections. Then add the number of cul-de-sacs and t-intersections together. Then add all of the intersections together. Finally, divide the number of cul-de-sacs and t-intersections by the total number of intersections.

7. Percent of total street frontage with sidewalks

This data will likely need to come from the city planner or engineer. Find out the miles or square feet of frontage with sidewalks, then divide it by the miles or square feet of total street frontage and multiply by 100.

8. Land per capita used for transportation

Obtain information for this indicator from Mn/DOT and/or the city engineer. Add up the total square feet of road then the total square feet of parking lots. (To find the parking lot data the average size of a typical parking space would be needed and multiplied by the number of parking spaces in each parking lot in the city.) Then find the square feet of road and the square feet of parking lots and divide by the population of the community.
9. Portion of household expenses spent on transportation

This information can be found by conducting a survey. This information for this study was obtained by purchasing it through a survey firm. Add up the average car related expenses and find out the average income of the community - divide automobile expenses by average income.

10. Ratio of E 85 vehicles to non-E 85 vehicles

This information can be obtained from the Department of Public Services E 85 coordinator. The information is available by zip code. This indicator is not be very telling currently, but there should be as many as 250 E 85 fuel pumps in MN in the next few years.

11. Ratio of high emission vehicles to low emission vehicles

This indicator can be found using survey data. To calculate: Add up the number of high emission vehicles, then the number of low emission vehicles. Then divide the number of high emission vehicles by the number of low emission vehicles.

12. Ability of non-drivers to reach employment centers, services and recreation

This indicator can be found using the census data. This indicator can not be calculated without the use of a map. Just take a map of the study area, i.e. community, city, etc. Next, identify the residential areas, employment centers, services and recreation areas. Calculate which residential areas are within walking distance to these areas or walking distance to transit. (Walking distance is considered about 1/4 mile.) Identify the areas that are not easily-accessible without a vehicle. Try to determine approximately how many non-drivers live in those areas.

13. Population density

This indicator can be found using the census data. Divide population by square feet or miles of land.

14. Modal split in vehicle type

This indicator can be found using the census data. It is best used with GIS because of the ability of GIS to overlay pie charts and street maps. Can also be found by simply highlighting the block groups with higher levels of certain modes with colored pencils or markers.
4. Are there any measures or data about your current transportation system that would help you make decisions about which changes would help your community meet its goals? Are there any measures that you think would make good benchmarks to measure your progress in reaching the goals you noted above? (Examples of indicators attached)
Sample Definitions of Sustainability:

"Sustainability is a combination of four elements: economic security, ecological integrity, quality of life, and empowerment and responsibility. These elements provide a framework for a stable economy and a community that lives in harmony with its natural environment, supports a high quality of life, and gives people a decision-making responsibility."
-Elizabeth Kline, Tufts University

A sustainable community is "one that persists over generations and is far-seeing enough, flexible enough, and wise enough to maintain its natural, economic, social and political support systems."
-City of Olympia, WA. "Sustainable City Philosophy"

"To enhance Oregon's livability, foster integrated land use and transportation planning, and encourage development that results in compact, pedestrian/bicycle/transit-friendly communities."
-Oregon's Transportation and Growth Management Team Mission

"Development that meets the needs of the present without endangering the ability of future generations to meet their own needs."
-The Brundtland Commission, organized by the United Nations

"It is a tool to help Minnesotans create the future they want for themselves and for their children and grandchildren. It lays out long-term goals. It takes periodic readings of the state's progress toward those goals."
-Minnesota Milestones

"Long term cultural, economic, and environmental health and vitality."
-Seattle, Washington

"A sustainable transportation system is one that allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations. It is also affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy. Finally, a sustainable transportation system limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, reuses and recycles its components, and minimizes the use of land and the production of noise."
-The Centre for Sustainable Transportation, Canada

"As a community, we need to create the basis for a more sustainable way of life both locally and globally through the safeguarding and enhancing of our resources and by preventing harm to the natural environment and human health."
-Santa Monica, California

"The ability of the community to utilize its natural, human and technological resources to ensure that all members of present and future generations can attain high degrees of health and well-being, economic security, and a say in shaping their future while maintaining the integrity of the ecological systems on which all life and production depends."
-Cambridge, Massachusetts

"...development that maintains or enhances economic opportunity and community well-being while protecting and restoring the natural environment upon which people and economies depend. Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs."
-Minnesota State Legislature

"Sustainable communities foster commitment to place, promote vitality, build resilience to stress, act as stewards, and forge connections beyond the community."
-Northwest Policy Institute, University of Washington, Graduate School of Public Affairs
“To enhance development that fosters integrated land use and transportation planning, and to encourage development that results in compact, pedestrian, bicycle, transit-friendly communities.”
- Oregon’s Transportation and Growth Management Team

For more information on sustainability, look up the following websites:

<table>
<thead>
<tr>
<th>Organizations</th>
<th>Website addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Seattle</td>
<td><a href="http://www.scn.org/sustainable/susthome.html">www.scn.org/sustainable/susthome.html</a></td>
</tr>
<tr>
<td>Redefining Progress</td>
<td><a href="http://www.rprogress.org">www.rprogress.org</a> (contains links to sustainability projects around the world)</td>
</tr>
<tr>
<td>Center for Excellence for Sustainable Development</td>
<td><a href="http://www.sustainable.doe.gov">www.sustainable.doe.gov</a></td>
</tr>
<tr>
<td>Sustainable Communities Network</td>
<td><a href="http://www.sustainable.org">www.sustainable.org</a></td>
</tr>
<tr>
<td>National Town Meeting for a Sustainable America</td>
<td><a href="http://www.sustainableamerica.org">www.sustainableamerica.org</a></td>
</tr>
<tr>
<td>Towards Sustainable Transportation</td>
<td><a href="http://www.the-commons.org/vancouvr/papers.htm">www.the-commons.org/vancouvr/papers.htm</a></td>
</tr>
<tr>
<td>Minnesota Department of Natural Resources</td>
<td><a href="http://www.dnr.state.mn.us/eii">www.dnr.state.mn.us/eii</a></td>
</tr>
<tr>
<td>Environment and Sustainable Living at St. Cloud State</td>
<td>condor.stcloudstate.edu/~dmichael/eco</td>
</tr>
<tr>
<td>International Institute for Sustainable Development</td>
<td>iisd.ca</td>
</tr>
<tr>
<td>Transportation for Sustainable Communities Network</td>
<td><a href="http://www.tlcnetwork.org">www.tlcnetwork.org</a></td>
</tr>
</tbody>
</table>
Examples of Transportation Indicators:

General
- Traffic counts and congestion measures
- Time devoted to non-recreational travel
- Number of commuters within 30 minutes of work
- Average commute times
- Ratio of cars to inhabitants
- Total number of residents exposed to traffic noise above 50 dB (A)
- Portion of household expenses used on transportation
- Population density
- Vehicle miles traveled per capita
- Personal transportation costs as % of income
- Travel distance to commercial services
- Percent of surface area devoted to motorized transportation (i.e. parking lots, streets, garages, ramps, driveways, alleys, etc.)

Land Use
- Average number of patron parking spaces per business
- Ratio of street intersections vs. intersections and cul-de-sacs
- Availability of downtown parking and employees w/free parking
- Land per capita used for transportation
- Accessibility to buildings and streets for people with disabilities

Intermodal
- Percent of total street frontage with sidewalks
- % Traffic injuries to pedestrians and bicyclists
- Bike and pedestrian accident rates
- Ability of non-drivers to reach centers of employment
- Rate of bicycle use/number of licenses
- Miles of completed commuter bicycle routes as a % of total plan
- Availability of bike lockers
- Carpooling rates
- Transit - use/miles/access/effectiveness/cost/quality
- Single occupant vehicle (SOV) use
- Expenditures on transit versus roads
- Costs of personnel working on transit vs. roads
- Cost and effectiveness of services for disabled

Environment
- Percent of vehicles powered by renewable energy
- Percent of road material recycled
Talking Points for St. Peter TAM Meeting 4

I. Introduction:

First of all, the analysis I have completed is only very preliminary. But with regard to the information I was able to obtain, it seems, like Governor Venture's opening line from the State of the State Address -- the state of sustainability in St. Peter seems to be great!

Of course, I was able to identify areas that could be improved, which were very similar to the areas you all addressed when we did the sustainability definition brainstorming activity. In general, however, St. Peter's transportation behavior seems to be more sustainable than many cities in Minnesota and you can all give yourselves a pat on the back!

II. Intro:

First I will give you an overview of the impetus for sustainability indicator studies, including some background on national trends. Then, I'll share some ideas on how you can use these performance measures to inventory your current transportation system and as tools for benchmarking progress toward the plan you established tonight and in future planning activities. Finally, I will give you some examples of indicators as applied to St. Peter and an brief analysis of these initial findings.

III. National:

-Al Gore has decided to make sustainability a key piece to his campaign for President. This movement is often referred to as "Smart Growth" and you may catch references to it in his speeches as the Presidential race gets underway. Despite your political leanings, I thought I should mention this because it demonstrates the visibility of this topic on a national level.

- This is also a hot topic in Congress. The Minnesota Congressional Delegation is particularly interested in this issue and many studies in Minnesota received funding to study it through the recent transportation funding bill, the Transportation Equity Act, TEA-21.

- In addition, many groups such as an organization called, "Redefining Progress" and the non-profit "Sustainable Seattle" in Washington State are clamoring for planners to look beyond current measures like Gross National Product and other purely economic measures as a guide to progress in the United States. In response to these calls for new measures, the University of Minnesota and others are developing indicators like the ones I will share with you tonight. These indicators attempt to weave together mobility, livability, accessibility and sustainability: all critical issues to communities.

- The performance objectives these indicators aim to measure include many of the things you guys indicated as priorities during our brainstorming exercise, including:

  - Improved community livability including access to employment, markets, services, recreation and social opportunities
  - Increased access to a choice of transportation modes, including non-motorized transportation and other alternatives to the single-occupant motor vehicle. (esp. bike paths in St. Peter)
  - Reduced economic losses due to roadway location.
  - Extended useful life of transportation infrastructure.
• Reduced overall noise produced by the transportation sector.

• Increased safety for transportation users, operators and the general public.

• Reduction in the proportion of land devoted to transportation, promoting land use-transportation coordination.

• Improved conservation of the environmental, scenic, aesthetic, historic and cultural resources.

IV. Inputs and Outputs:

Researchers like to refer to uses of indicators as inputs and outputs. In essence, this means you can use indicators to inform planning activities, like the TAM process you are all just completing now, and then as performance measures to see whether or not you are progressing toward these goals.

These indicators can be used as an input to inventory a community’s current transportation system. In the future we are hopeful that many cities will produce such inventories and provide this information via the Internet so that communities can compare their systems to others. You may consider using indicators in this capacity in the future for city planning processes.

Indicators can also be used as an output. In this capacity, indicators are used to measure progress toward goals. As you proceed toward the goals you laid out tonight you may want to identify a few indicators that you think are high priority and re-calculate them on regular intervals to see whether or not you are progressing toward those goals, or conversely, losing ground in areas where you are doing well. In addition, while many cities are beginning to require that their city planners provide this analysis, anyone can do it. For example, the Chamber of Commerce may decide to take on this project. Or maybe a non-profit or volunteer community group may want to do it. In any case, much of the data needed to calculate these indicators is public and available on the Internet for public use.

V. Application of indicators to St. Peter:

As you can see in the handout, St. Peter is relatively sustainable. Keep in mind that some of the data is a little out of date because it is from the last census, but assuming there have not been major changes in St. Peter’s demographics since 1990, they are pretty reliable. Another inventory should be performed after the new 2000 census data comes out.

With the use of these indicators, you can see that 92% of the commuters in St. Peter drive less than 30 minutes to work. This is number is relatively high, quite a bit higher than many communities in Minnesota and indicates that there are likely fewer numbers of commuters to the Twin Cities living in St. Peter than may have been expected.

There is a very high ratio of "cross" intersections, as opposed to "t" intersections and cul de sacs, due to the city's grid design. This increases the accessibility of places in St. Peter and decreases travel time for residents, resulting in higher mobility.

The ability of residents to reach employment centers, services and recreation in St. Peter is very high. Because St. Peter is less than 4 miles long, nearly everyplace is within walking distance. The hospital is the only workplace that is not within walking distance from the core residential area.

The population density is high for a non-urban community and the majority of residents living within walking distance to the downtown.

The modal split is pretty evenly distributed throughout the city.

Drivers with E85 vehicles have access to alternative fuel in Mankato.
Two of the areas that would clearly add sustained value to St. Peter’s transportation system are bike trails and an increased use of public transit. While the option of using public transit is available to everyone through your dial-a-ride service, very few residents in St. Peter seem to use it. Increased use of this resource could take some wear and tear off the roads and reduce fuel emissions in St. Peter.

Bike trails are another area that could add a great deal of value to the community. Currently, there are only 6 miles of path of any kind. There are 2 miles of unpaved pathway, 2 miles of unpaved snowmobile trails and 2 miles of street surface designed for both car and bike use - though those two miles are only in the process of being completed. Should St. Peter complete the proposed bike path plan, you would jump to 20 miles of paved bike paths. This would be a significant increase and add sustained value to your transportation system.

I hope this presentation has been helpful to you. I had a good time applying these measures to St. Peter and learning more about your community. If any of you have taken an interest in this study or would like more information on how to collect this data for St. Peter, feel free to give me a call anytime. Now, does anyone have any questions?
DOCUMENT C-4: Post TAM Meeting 1 Participant Survey Results

**Question 1:** Was the presentation too technical, understandable, or oversimplified? Did the content of the presentation make sense to you?

<table>
<thead>
<tr>
<th>Respondent #</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Answer</td>
</tr>
<tr>
<td>2</td>
<td>Understandable. It was very broad and somewhat oversimplified. Not understood by the entire audience. Needed to be tied together better with examples.</td>
</tr>
<tr>
<td>3</td>
<td>Understood by everyone there.</td>
</tr>
<tr>
<td>4</td>
<td>Not quite on target, geared more toward academics.</td>
</tr>
<tr>
<td>5</td>
<td>Understandable.</td>
</tr>
<tr>
<td>6</td>
<td>Good presentation.</td>
</tr>
<tr>
<td>7</td>
<td>Understandable.</td>
</tr>
<tr>
<td>8</td>
<td>Understandable.</td>
</tr>
<tr>
<td>9</td>
<td>Understandable.</td>
</tr>
<tr>
<td>10</td>
<td>Understandable, but perhaps slightly too technical.</td>
</tr>
</tbody>
</table>

**Question 2:** Did the presentation flow smoothly?

<table>
<thead>
<tr>
<th>Respondent #</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes, it flowed.</td>
</tr>
<tr>
<td>2</td>
<td>Yes.</td>
</tr>
<tr>
<td>3</td>
<td>Yes, did a nice job of delivery.</td>
</tr>
<tr>
<td>4</td>
<td>Yes.</td>
</tr>
<tr>
<td>5</td>
<td>Jumped around some.</td>
</tr>
<tr>
<td>6</td>
<td>Flowed, well coordinated.</td>
</tr>
<tr>
<td>7</td>
<td>It flowed, concept was valid. They did a nice job.</td>
</tr>
<tr>
<td>8</td>
<td>The presenters did their homework, they did well.</td>
</tr>
<tr>
<td>9</td>
<td>Did a nice job.</td>
</tr>
<tr>
<td>10</td>
<td>Flowed fine.</td>
</tr>
</tbody>
</table>

**Question 3:** Was the presentation too long, too short or just right?

<table>
<thead>
<tr>
<th>Respondent #</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>About right.</td>
</tr>
<tr>
<td>2</td>
<td>Probably not long enough.</td>
</tr>
<tr>
<td>3</td>
<td>About right.</td>
</tr>
<tr>
<td>4</td>
<td>About right.</td>
</tr>
<tr>
<td>5</td>
<td>Ok.</td>
</tr>
<tr>
<td>6</td>
<td>About right.</td>
</tr>
<tr>
<td>7</td>
<td>About right.</td>
</tr>
</tbody>
</table>
Probably too long for the gathering. The history part set things up.

It was fine.

A bit too long.

**Question 4:** Did the presenters speak clearly? Was their presentation style smooth?

Yes.

Yes.

Fine.

Yes.

Fine.

Fine.

Good, nice to have fresh voices.

Liked them.

Liked them.

Fine.

**Question 5:** Recommendations for changes to presentation styles, format or content?

Add more meat to the content in terms of making a better definition of sustainability and how it's been used in implementing sustainable transportation in other communities.

What the presenters are about, why they are there, what they have to offer, and what is expected of the community.

They were concise and clear, good job!

Good points were made and enjoyed the written material. Emphasize the three categories more.

Quit showing bias (what's good and what's not, like bikes are a better vehicle than automobiles).

It wasn't outstanding, didn't understand where they were coming from at the beginning.

It was pretty good.

Liked the dual presentation style, complemented each other well.

Appreciated the use of definitions in explaining sustainability. Did not understand all of the technical terms.

Overall good but the language used did not seem to fit the audience well. Most people do not connect too well with the environmentalist's language of sustainability.
Document C-5: Sustainability Brainstorming Activity

The purpose of this activity is to start the TAM participants actively thinking about how sustainability relates to their community. The component is approximately 15-20 minutes in length. This exercise will allow the participants to share their views on how sustainability applies to their community by designing a working definition of sustainability and/or list of sustainability performance objectives for their community.

Materials needed:
- Flip board
- Black markers
- Light colored cards
- Color dot stickers (3/4") - optional

Opening Remarks
(Approx. 3 minutes)
During the opening remarks, the facilitator should introduce him or herself and give a brief overview of the exercise (including the expected duration).

Creating a Sustainability Definition and/or List of Performance Objectives
(Approx. 10 minutes)
At this time, the facilitator should ask questions and write the responses on a flip chart. The facilitator can either ask whether or not the community wants to design both a definition of sustainability and a list of performance objectives or decide which to do on his or her own in advance. This decision will predicate which questions the facilitator asks.

These questions may include but are not limited to:

- Which of the definitions or words and/or phrases within the given definitions of sustainability are most applicable to your community?
- Are there any other words or phrases that you believe would represent sustainability in your community?
- Which performance objectives best reflect the transportation issues of importance to your community?
- How do those performance measures and the issues you raise relate?

The facilitator may then post the flip chart pages with the previously recorded comments on the wall.

1) Participants should then be asked to write the key words and/or phrases that they believe should be included in a definition of sustainability for their community on the cards. Alternatively or in addition, they could write down the top few performance objectives they believe best reflect the needs/culture of the community.
2) Participants will then be asked to post their cards in the front of the room on a flip board or dry erase board.

3) If necessary and if time permits, the facilitator may conduct a vote to identify the words/phrases and/or performance objectives that the community members believe fit their community the best. The voting may take place either by a show of hands with the facilitator tallying the votes for each word or phrase or the participants may place colored dots next to their top one or two words or phrases and/or performance objectives in each category.

Wrap Up
(3 minutes)
During the wrap up, the facilitator will review what they did and how the definition and/or list of performance objectives they built through consensus will help them identify their critical issues and select meaningful indicators. Between the end of this meeting and the beginning of the next meeting, the facilitator will be responsible for writing up a summary of key elements of sustainability and/or list of performance objectives for use as a reference for the rest of the process.
TO: Sustainable Transportation Initiatives Group
FROM: State and Local Policy Program
DATE: June 21, 1999
RE: Recommendations for Revising the TAM

Our recommendations for improving the Minnesota Department of Transportation's Transportation Action Model (TAM) respond to the four goals of the current TAM process:

1. Build a generation of broad public dialogue
2. Identify local transportation issues
3. Develop solutions
4. Create action plans.

The recommendations are based on our observations of TAM meetings in the cities of Two Harbors and St. Peter and will be included in the final report of the current SIS project.

In general, we find that the TAM is relatively successful at achieving goals 2-4 and less successful at achieving goal 1, that is, attracting broad public participation in the TAM process. Based upon conversations with MN DOT staff, there seems to be a hesitance on their part to play a strong role in community organizing in order to ensure broad-based participation. This seems to stem from a general reluctance to appear to be the driver of the planning process. However, because city staff often have little time to conduct effective community organizing campaigns around single issues, shortcomings in this area will likely continue if this issue is not addressed. Grappling with this tension will be a key component to successful efforts to strengthen the TAM in the long run.

We also find that the concept of sustainability should be infused into the TAM process. Interest in sustainability in Minnesota is not new. However, its use and influence have not yet reached the grassroots. The TAM could be an effective vehicle for dissemination and training on the benefits of incorporating the use of sustainable practices and indicators into transportation planning activities in communities. While the current goals of the TAM do not mandate the incorporation of sustainability in the process, the changing mission of MN DOT away from new highway construction and toward community enhancement lends itself to the incorporation of this important concept.
Recommendations for Improving the TAM Process

Goal I: Build a generation of broad public dialogue

This goal represents a large and difficult task, especially considering the low number of people who consider redesigning the placement of pavement an engaging way to spend an evening. The TAM process has been successful in attracting upper middle class community or business leaders who are already active in community affairs and would likely participate in the planning process regardless of its presentation format. The TAM has not been successful in reaching most of the other community stakeholders, such as families, neighborhoods, seniors, and schools: the very groups of people the process was designed to reach.

- **Sustainability could play a part in helping to generate interest in participating in the process.** If community groups were asked to join a dialogue to "enhance livability, mobility, accessibility and sustainability in their community," they might be more likely to actively participate.

- **One easy way to enhance the amount of community organizing that goes into the TAM process is to designate the facilitator as the chief community organizer.** Because many consultants have experience in community organizing, this would be a good fit. It would also allow MN DOT to avoid coming across as the main driver of the process. To do this would require bringing the facilitator on board earlier in the process and redesigning the RFP to include this responsibility.

- **The process for broadcasting information to targeted groups needs to be more systematic.** One possible tool the facilitator could use to achieve this goal is MN DOT's public involvement manual designed as a guide for environmental justice outreach.

- **Picking a convenient location and time of day to hold the meetings could also enhance participation.** The meetings should take place early in the evening so that people with children can get home early enough to get them to bed by around 8:30 p.m. You might consider suggesting that the meetings be held in a school, university or college or other conveniently located meeting forum. In many small communities the most highly frequented meeting center is the church and it should not be ruled out. Schools, universities and colleges would be particularly good because the meeting could be held near the gym or other type of room where activities could be set up for children. A community member could volunteer to supervise the children so parents who would not otherwise participate in the meeting could attend.

These suggestions are only preliminary. We understand that tackling this problem is a long-term goal and may play a significant part in the follow-on project.

Goal II: Identify local transportation issues
Under the current TAM process, this goal is carried out in meeting 2. We recommend that the process of issue identification begin in meeting 1.

Meeting 1 is currently long and drawn out. It provides little ability for the participants to feel empowered. As a result, the number of participants drops off after the first meeting.

Making the process more responsive to the desires of community participants requires engaging them in the process. Some suggestions to do this include:

- **Provide an overview of the TAM first.** People need to know how the first meeting fits into the process and why it is important for them to be there. Frame the meeting in terms that make them feel like their contribution is critical and that the decisions that will be made in this process are important. Make sure they know how they will be able to contribute in the following meetings and committees.

- **Ask them to announce their top transportation concerns during the get acquainted exercise.** Currently, they are asked to discuss this topic with a partner and only to announce it to the small group at their table. You could try to frame the question in the context of sustainable transportation concepts, asking them their top concerns with regard to livability, accessibility, mobility and sustainability. In order to ease their ability to do this, post the definitions of these concepts in the front of the room. (Appendix A) It would be helpful if the facilitator wrote the issues people announced on an easel pad, saving the pages for use by the technical committee in deciding what data to collect for the trends in the community section in meeting 2.

- **We recommend that you consider adding a written survey tool a community could use to help clearly identify the views and concerns of the community members, as well as identify the perceived assets and liabilities of the transportation system.** A survey tool could supplement the information gained in the face to face meetings as well as generate interest among community members, resulting in better attendance in the following meetings. The assets and liabilities section of the survey would be very helpful to the public input committee as they prepare their visual presentation of the community for meeting 2. Administration of the survey could even commence prior to meeting 1.

- **Add an overview on sustainability.** This overview can be used as an introduction to the funding discussion, emphasizing the four concepts of sustainable transportation: livability, accessibility, mobility and sustainability. In this section the presenter should talk about how this concept is being discussed on a national level, the state level and by community groups. The different performance objectives sustainability indicators aim to measure, such as improved community livability and reduction in proportion of land devoted to transportation, should be discussed in this section. (Appendix B) Educational materials on sustainability should be distributed at the end of the session (Appendix E).

- **Frame the conversation about transportation funding (TEA-21) in a context that communities can understand, that are relevant to the community, and that refer back to the discussion on sustainability.** Make it multi-modal and multi-jurisdictional. Address
the linkage between the plan they will put together, funding, and the plan's implementation. Talk about all of the funding sources available to cities, not just federal funding. Discuss the timing that goes into applying for these programs and how to frame a good proposal. Let them know that part of your job in this process is to answer their questions on funding as they identify the projects they hope to pursue and help them put together strategies to obtain the necessary resources. Reiterate how the current array of funding can help address sustainable transportation objectives. (A good resource for a presenter who would like to research innovative financing approaches is a report called, *Making the Exception to the Norm: Innovative Planning and Financing* prepared by the State and Local Policy Program in conjunction with Hennepin County in Minnesota.)

- **Ask the historian to explain why changes to the transportation system have occurred; in addition to what changes have taken place.** This is important because the changes have little relevance if no one knows what precipitated them. This is particularly true in the context of a planning process in which the group is looking for trends and preparing for future ones. Finally, allow time for questions from the participants.

- **The wrap up from meeting 1 should make the participants feel like they accomplished a lot and make them want to come back for more.** The facilitator should ask the group to announce what they learned from the presentations (the St. Peter facilitator did this well). Then she/he should repeat what the group will do in the following three meetings. Finally, the facilitator should ask the group if there were anything that they would have liked to hear about in this meeting that was not covered. If so, let them know that it may be covered in one of the following meetings and that if not, it can be incorporated into one of them. For example, there may be a guest speaker someone would like to hear from, like someone from a neighboring city where they have been struggling with the same issues. Promising to incorporate items the group wants will help convince them you are sincere in pursuing their interests rather than some pre-set agenda.

**Goal III: Develop solutions**

This goal represents the component of the TAM that has been most successful. Developing solutions is the most important aspect of the TAM, requiring the synthesis of useful technical information with community decision-making. This goal is achieved through multiple committee meetings and group meetings 2 and 3. We believe that these meetings are working relatively well and only make the following recommendations:

- **Between meetings 1 and 2 the technical committee should collect data based on the interests raised by the community in meeting 1 during the "get acquainted" exercise and the issues raised through the survey information, if the community opted to use the survey tool.** They should use the data to calculate sustainability indicators (Appendix C) to be used in meeting 2 as inputs for the planning process. The indicators they pick to calculate should reflect the performance objectives the community seems to be most interested in, given the discussions from meeting 1. Ask the facilitator to play a key role on the technical committee, helping to collect the needed data. Because most of the facilitators are skilled planners, they should have the expertise needed to perform this task.
• The technical committee's findings based on the indicators should be presented in meeting 2 during the trends in the community section. GIS mapping could be incorporated in this presentation. The technical committee could also prepare an assets and liabilities inventory based on the assets and liabilities identified by the survey tool. They could also prepare a GIS map of the assets and liabilities. The public input committee could use the maps during their visual presentation.

• The slide show section in meeting 2 should be renamed. The community should be encouraged to use whatever medium those choose to examine their system visually. For example, they may want to record a video instead of a slide show. Or they may prefer to do a power point presentation. It is strongly advised that aerial view photos be incorporated into this portion of the presentation so that people can get a feel for the part their transportation system plays in defining land use in their community. GIS maps prepared by the technical committee highlighting the assets and liabilities of the transportation system could also be incorporated here. It would be helpful to the community to see how and where the transportation system is impacting their community and this is difficult to interpret from photos taken from the ground.

• Put the sustainability brainstorming activity in the agenda right after the slide show. (Appendix D) Having just looked at their community and identified its assets and liabilities would inform their discussion in the brainstorming exercise. It would also help inform how they evaluate their existing transportation plans, which currently comes right after the slide show. Also, rather than asking them to define sustainability for the community, which St. Peter residents found somewhat confusing, a better option may be to frame the activity as asking the community to choose the performance objectives of sustainability they believe best represent the goals of the community. The facilitator may want to ask the participants which activity they would prefer or if they want to prepare both.

• The future's quotient in meeting 3 can be eliminated. While it seemed to be added as a warm up for the visioning exercise, we believe the visioning exercise works well without it. It could be replaced with another sustainability activity; however, no such activity has been developed at this time. If sustainability were successfully integrated into all aspects of the process, however, there would be no need for another activity on sustainability at this point.

• Spend more time on the "Welcome to the year 2015" exercise and the best case/worst case scenarios in meeting 3. These are very popular activities and are the most effective means for coming to the desired solutions.

• Replace the spheres of influence exercise with something more affirming. The spheres of influence exercise effectively downplays the excitement that is generated in the preceding exercises and erases all of the feelings of empowerment that were generated there. You could replace this exercise with one that ties back to the issues identified, the sustainable transportation concepts, and the funding discussion from meeting 1. For example, the
facilitator could post the list of sustainability performance objectives adopted by the community, the sustainable transportation concepts and a funding flow chart in the front of the room. Then she/he would lead the group in a discussion about which of the initiatives could be most effectively implemented and the steps that would need to be taken. They could complete the exercise with a downsized list of scenario combinations to consider.

**Goal IV: Adopt an action plan**

This goal in the process is reached in meeting 4. Because it is always difficult to sustain community interest in an issue when doing community organizing, attendance often drops off in this meeting. The trick is to make the participants feel like their views have been heard along the way and that they see the final meeting as the culmination of the work they have done over the past several weeks. Because these things can only be achieved by hard work on the part of the community organizer(s) and process leaders, there are few suggestions for process change for the final meeting that could do much to effect this. However, we do have the following recommendations for improving the flow and success of the final meeting:

- **Increase the number of minutes for the issue committees to discuss their proposals for action.** Currently they are only given 10 minutes each. They need at least 5 more minutes each to present, bringing the total number of minutes for this section to 45 minutes.

- **Beef up the implementation and feasibility section.** Because attending these meetings is a substantial investment in people's time, this section should be a grand finale. There are three things we believe are critical in raising the level of importance to participants in meeting 4.

  1. **Give people in the community the opportunity to take ownership of the plan that is adopted by giving them responsibility for its implementation.** The individuals who volunteer to serve on the action plan committee should be asked to see the plan through (not just the project coordinator), including partnering up with the necessary state and local officials.

  2. **Include development of a financial plan in the action plan process.** Writing the action plan should be more than just compiling the decisions made at the meetings and prioritizing the issues selected. It should outline the steps necessary to obtain funding to see the priorities through.

  3. **Consider linking the TAM to the ATP process or use the TAM as a replacement for the ATP process in cities where the TAM is used.** This will show the participants that their input will be acted upon and give their action plan a niche in the MN DOT system.

  4. **The panel formed by the technical committee in meeting 4 should discuss funding, as well as technical feasibility of the strategies outlined.** It should also include
Proposed Goal V: program evaluation and improvement

Finally, while there is not currently an official meeting 5 in the TAM process, we recommend that it be officially added to the program. A fifth meeting would provide the opportunity for both MN DOT and city officials to gather feedback from the participants on the process. It would also enable any loose ends to be tied up. Finally, it could be used as an opportunity to organize the action plan committee. The committee members, with the help of any other participants who wish to join, could outline the implementation and evaluation process needed for the action plan they developed. If this meeting is officially adopted, you may want to save the discussion of sustainability indicators as an output until this meeting.
APPENDIX D:
SUSTAINABLE TRANSPORTATION TECHNOLOGY

In conclusion, it is essential to consider and incorporate sustainable transportation technologies into our urban planning and development strategies. These technologies can significantly reduce air pollution, decrease traffic congestion, and improve overall quality of life for residents. As cities continue to grow and urban areas become more densely populated, the importance of sustainable transportation solutions cannot be overstated. By investing in green technologies and infrastructure, we can create a more sustainable and livable future for all.
APPENDIX D: SUSTAINABLE TRANSPORTATION TECHNOLOGY

THE MULTIMEDIA NEXUS

There is a wide range of presentation mediums that have been used to communicate characteristics of communities throughout the course of human history. Even early civilizations used maps and written collections of data to guide their actions and plan for the future. Today, as the digital revolution works to reshape and recombine common concepts and practices, our abilities to communicate the relationships between the data collected and the characteristics of our world are enhanced. While such technological mediums will never replace need for "hard copy" formats, they now must compete or at least be used in combination with rapidly advancing digital multimedia presentation and analysis systems. Indeed, as computer prices and component sizes shrink, the means to conduct such analysis is quickly reaching the grassroots.

In Chapter 2, the ability to apply sustainable transportation objectives through "hard copy" format was discussed. Despite our new digitally enhanced lives, hard copies of maps and tables will often continue to be the most tangible and easily applied tools for communicating community characteristics as they relate to transportation planning, land use decisions and community design. However, as the means to use enhanced, multidimensional planning tools spreads, so will the interest in applying tools with such capabilities. In this chapter, the range of such computer-aided visual presentation and modeling approaches is discussed.

Software programs that have utilized geospatial-modeling techniques, such as Geographic Information Systems (GIS), in conjunction with other computer-aided tools, are at the forefront of efforts to enhance our ability to combine visual presentation and analytic techniques. For example, digital photograph analyzers and urban simulations are examples of such recombinations. Examples of some of the programs that can be used in conjunction with GIS include CAD, Power Point, Media Player, Real Video & Audio, and Map Point 2000.

There is a distinction to be made between visual impact, however, and indicator analysis. Visual impact analyses come in many forms with varying levels of sophistication. Some are based on static one-dimensional digital representations of a community’s landscape, while other place-based software programs provide three-dimensional digital, or “virtual,” environments that can be toured or changed by a user. A key development in the evolution of computer-aided analyses has been the employment of indicators. Using GIS, indicators that measure critical changes in such things as water use, land use, and pollution levels, can be coupled with place-based analyses to help highlight areas where attention is needed most.

In contrast, Computer Aided Design (CAD) is primarily a visual presentation tool. While CAD is an important design tool for communities, it does not have the capability to perform complex indicator analysis, which requires the ability to relate multiple facts
to multiple sites. However, CAD is a tool that is being used alongside and in conjunction with GIS to enhance the analysis that can be drawn from either medium on its own. In fact, because CAD images can be imported into GIS, and conversely, GIS can be incorporated into a CAD system. GIS add-on packages such as ArcCAD and CAD extension AutoCAD Map are two software add-ons that will be discussed in greater detail later in this chapter. Altogether, both GIS and CAD are two visual modeling mediums are quite complimentary with the distinction between the two becoming less clear.
What is CAD?

CAD systems were developed primarily for architects and engineers who need to create and analyze two and three dimensional designs, keep track of a large volume of design-related data and understand how a change to one aspect of the design will affect the whole. The newest versions of the CAD data model were optimized to handle graphic features organized into layers. They have become more intelligent and include the capability to store, query and manipulate nongraphic descriptive data. CAD systems can be run on both mainframes and PCs. However, CAD can not relate multiple facts with multiple sites. For this reason, GIS is the tool that is better suited for sustainable transportation indicator analysis.

What is GIS?

Simply put, Geographic Information Systems (GIS) add space and location to a database. With GIS, spatial features such as cities, parks, addresses, habitats, and hazardous waste sites are not just a line on a spreadsheet, but places on a map that represent locations relative to each other. This added dimension enables researchers to add a to their data. Though many consider GIS simply a computer-mapping tool, there are many of components of GIS. According to the Environmental Systems Research Institute, GIS can be defined as:

An organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture store, update, manipulate, analyze, and display all forms of geographically referenced information.

GIS is truly a system that requires many levels of inputs and provides many outputs, only one of which is a map. Spatial questions such as, “How many buffalo cross national park boundaries?” and “Are the poor being redlined?” can be answered with GIS without creating a single map. Instead these spatial questions are answered internally within GIS providing the user with only the information requested. Despite its misconception as a mapping program, GIS is truly an information system with the unique ability to handle spatial queries. The output can come in the form of traditional tabular information or a map depending on the needs of the user.

The most commonly known use of GIS, however, is in fact its ability to clarify the relationship between information and location. Fundamental as it may sound, most information is specific to a place. For example, in 1995 there was about 208 million tons of waste produced in the US. As information becomes more specific the significance of place can be highlighted using GIS. To narrow our example, with GIS a map of regions

---

3 Allen, Eliot.
4 Environmental Systems Research Institute, Inc. 1990. p. 1:2
in California could be color-coded based on compliance with waste diversion policy (i.e. AB 939). GIS can also be used to “zoom in” on a city to assist in locating high through low recycling rates at the neighborhood level. This can help waste management professionals in the public and private sectors focus their attention on problem areas. This can potentially help free up precious resources for other equally important community concerns.

GIS can also be used to integrate multiple variables or indicators. For example, public transportation access within a certain area, traffic flows and bottlenecks, business vacancies, housing affordability, graduation rates, distribution of pollution, watershed quality, habitat availability for threatened and endangered species, and many other key community characteristics can be analyzed using GIS’s statistical capabilities. After completing a map identifying the areas of concern, the findings can be presented online, using computer terminals or printed out in hard copy format.

One indisputable reality of GIS is that its use is growing. Gone are the days that GIS was the sole domain of Geologists on expensive Unix machines. Increasingly, applications of GIS are found on laptops throughout all disciplines. Ten years ago the collection of spatial data was out of reach. Extremely tight security laws against the sale of high-resolution satellite images and the phenomenally high cost of digitizing data into a GIS, reduced the practicality of this new system for most people. Today, there is a massive amount of data available free on the Internet. High-resolution images of the entire planet are now available with more detailed data being continually added to the wealth of digital data available everyday. The hardware, software, and data problems of GIS are quickly becoming a thing of the past. Today, as the means to conduct the kind of analysis that is so critical to achieving sustainable communities becomes available, one of the biggest challenges is convincing those who would benefit most from using GIS to apply it.

At its best, GIS potentially offers the aspiring sustainability program (SP) a means to better assess challenging issues more effectively. It allows for such things as the production of informative visual displays of multiple layers of data for a given place, enhanced monitoring capabilities, pressure impact environmental assessments, the evaluation of indicators, and modeling alternative use scenarios (or simulations). At its very worst, GIS can be time, money and knowledge intensive, and require a lot of desktop memory and mega-hertz for what can sometimes be crash prone use. However, as access to data, the capabilities of desktop computers, and GIS software all continue to improve, these issues will gradually be upgraded from hindering to easily overcome. In the mean time, there are plenty of down-to-earth examples of how GIS can be used in efforts to advance sustainability.

GIS can serves as a platform for simulations and high impact visual modeling/presentations that include but are not limited to:

- Interactive digital maps
- Still photos
• Video clips (or MPEGs) for key location and time, i.e. ‘rush hour’ or lunch on main intersections

• Audio

• Key indicators can be included as part of the presentation or available for user interaction upon demand. For example, SmartPlaces’s Radix function provides this function.

• Create virtual cities accessible via the Internet. One example of such a virtual city is the City of Vallejo, California.5

One of the potential drawbacks of a GIS with all the bells and whistles is that it requires an investment in digital equipment, such as a digital camera, conversion equipment, microphones, and appropriate software. However, for many communities there would be no need to purchase all of the add-ons and a simple GIS station without every additional feature can be a practical investment. At the same time, while the initial cost of a camera and other components can be high, these investments could be very beneficial and the cost may be spread out or amortized over a 5 to 10 year period and several projects.

There are several basic stand alone GIS software programs that offer comparable visual and analysis capabilities. These include, for example, MapInfo, GeoMedia, and Arcview. These software programs serve as the basis of a GIS system from which “add-ons” or “extensions” are stacked. Even at the basic level, as discussed above, GIS offers an array of spatial and statistical analysis tools and visual capabilities. However, GIS alone is only so powerful. What has made GIS so useful for transportation planning and other areas are add-on software programs and the increasing ability to provide information over the Internet. The following section reviews some of the most innovative and useful ways in which other media and GIS can be integrated for more powerful presentations and analyses.6

The Multimedia Nexus: Using Technology for Analysis, Simulation, & Presentations

One of the useful features of multimedia computers is that even complex systems like GIS can be integrated with other media to enhance their capabilities at analyzing and presenting information. This section will discuss some of the GIS software programs that can be used for analysis, simulation, and presentations, respectively.

5 The virtual City of Vallejo can be reached at http://209.21.13.19/sites/Vallejo/Maproom.html
6 The software and other commercial products reviewed in this paper are not endorsed by any of the authors of this report. They are discussed for illustrative purposes and results will vary with use.
GIS Analysis Functions

As an increasing number of communities, counties and states have begun to consider or adopt sustainability principles to overcome the challenges of perpetual population and economic growth, a range of software programs have been developed to help meet their demands for information analysis and evaluation tools. The programs discussed below represent a sample of some of the more widely used GIS based analytical tools that are being employed in the field. While these tools include INDEX, SmartPlaces, and What if?, SmartPlaces will be given the most attention in this report. Overall, these programs work in a similar way. They all utilize place-based information for systematic assessments of current trends and can be presented in standard GIS formats, as well as in conjunction with other media for enhanced effects.

Except for a handful of examples, few sustainability projects have yet to utilize most of the capabilities of computer-aided analyses, presentations and other related tools -- though there combined use is on the rise. One of the most notable exceptions have been projects headed up by Criterion, a Portland, Oregon based consulting firm, using INDEX.

INDEX starts with a geographical database that makes it possible to visually represent the physical attributes of a given community. For example, a digital map of a city with roads, schools, industrial sites, waterways, wetlands, wilderness areas, and any other characteristics of interest for the community. This information can be manipulated so as to see the potential effects that different growth patterns or proposed ‘development’ projects might have in a community. With the use of indicators, which can be defined by the client, INDEX also allows for the evaluation of different land use scenarios. For example, the impact of a 50,000 square-foot industrial site can be considered not only for its building footprint, but also assessed using potential traffic, pollution, and other relevant indicators. The results can then be presented using a combination of such multi-media attributes as digital photos and streaming video (MPEGs).

Overall, INDEX provides a way to carry out analyses and presentations that include GIS and other multi-media. Though the labor involved in generating “thick” data-bases and doing indicator analysis can be highly specialized and can often be relatively expensive, depending on the case, the results may far outweigh the costs.

In contrast, SmartPlaces (SP) is a less knowledge intensive and expensive alternative to INDEX. A land and resource use planning tool, SP has two main uses. These are Scenario building and Radix evaluation. Like, INDEX, SP starts with a geographical data base that makes it possible to visually represent the physical attributes of a community. Scenario building is based on malleable empirical models that are linked to a geographic database of a place. Like other GIS based programs this can include housing, roads, open space and so on. Upon this foundation, new land uses can be drawn, copied, pasted, dragged, and resized. For example, to see what a greenway might look like along corridor, the relevant category is highlighted, in this case
greenspace, and with a few point and click mouse maneuvers the greenway can be put onto an existing digital map of the community.

One of the useful features of SP is that it allows for different land use categories to be embedded with "pocket attributes". For example, with each new housing unit that is added to the visual model of the community (or "drawn onto" the model), there are automatic changes made that correspond to pre-set community characteristics, such as population, density, land use, tax revenue, transportation, recreational attributes and so on. This type of embedded information is critical for indicator analysis, or "Radix evaluation" in the SmartPlaces software.

Radix Evaluation Simulation

Radix evaluations are somewhat more difficult to set up than the scenario features of SmartPlaces, but provide the means for systematically analyzing a community’s descriptive information (or aggregation of pocket attributes). Each Radix is user defined. The base of a Radix may be the environment, for example, and the associated categories can include such things as water, energy, and native habitat use. Linked to each category is an indicator. Indicators are defined in terms of maxim and minimum (or more specifically more than and less than) amounts specified by users. See example below:

![Radix Evaluation Diagram]

Using Radix evaluation, a community could decide that water use beyond the sustainable yield of the local aquifers is a critical indicator of environmental sustainability. Using historical data on water use and housing it may be determined that each new home requires an additional 1,000 gallons of water a day. It all comes together when using SmartPlaces to evaluate alternative land uses. Every time a new house is added to a scenario, the pocket attributes are added to the community database.
If the number of households added results in overuse of the aquifer, SmartPlaces, initiates an on-screen alert to the user that an indicator (or sustainability) criteria has been exceeded. (See example below.)

Screenshot of SmartPlaces: “Warning Screen” signals that with proposed additions total residential units has exceeded user specified target.

One interesting aspect of SP is its ability to be used in tandem with the ‘Collaborative Negotiation System’ (CNS) so that community members can participate in the defining of the sustainability criteria to be embedded in their community’s SP planning process. CNS combines the geographic tools of Smart Places into a networked planning application. Focus groups are provided access to a computer that is networked via the CNS. This program captures and summarizes participants’ votes, comments, or preferences on sustainability related issues via the network interface. Participants can develop their own recommendations, which can then be shared or combined and analyzed using SmartPlaces scenario and evaluation tools.
Taken together, multi-media presentation techniques as discussed above, SmartPlaces, and Collaborative Negotiation System provide one of the most practical and effective ways for assessing and presenting substantive information as it relates to transportation and sustainability.

The advantages of this approach are:

- Community input – can add legitimacy, diversity of insights and approaches in establishing and meeting sustainability objectives;

- Effective communication of key implications resulting from alternative planning scenarios in a visually appealing way and analytically useful way; and

- Opportunity for users to select the areas and way in which the information is transmitted --for example, text, maps, or video.

The final software package that will be discussed is the What if? Planning Support System. What If? software is similar to INDEX and SmartPlaces, except the discretion given to users is based solely on land use as opposed to broader social-economic-environmental factors. There is a great deal of leeway in how land use criteria is assessed. What If? allows users to select their preferred land use attributes for their community. This information can then be assessed against land use alternatives. The program evaluates how proposed projects might affect community attributes, such as highways, wetlands, paved space, and greenspaces.

The pros of this program are that it allows users to define the factor weights for different planning alternatives. The output is a series of maps and reports that show how different land uses impacts the area under study. The information is useful for gaining information about how much land by type will be used given the users pre-specified weights to such things as agricultural land, density, and endangered species habitat. The down side is that the program is computer memory intensive and each scenario takes 5-10 minutes to process on a fast computer, i.e. 200 MHz. However, the point and click features require much less GIS savvy than INDEX and SmartPlaces and thus have a competitive advantage in user-friendliness.

**Simulations and Virtual Cities**

Virtual cities have been rapidly becoming a popular way in which to communicate or make available GIS presentation and analysis tools over the Internet. There are basically three types of virtual cities: 1) Flat; 2) Two dimensional; and 3) Three dimensional.

The flat virtual cities are the most common on the Internet. They typically include a list of weblinks to text information on an array of topics pertaining to city's business,
government, and demographic information and so on. One example of a flat virtual is Virtual Flagstaff.7

Two dimensional (2D) virtual city websites usually contain much of the same information, but also include a 2D visual representation of the city. In some cases, specific areas of the virtual city can be toured or zoomed in upon for more detailed information. A good example of a site that utilizes the interactive features of the Internet and digital mapping is the City of Vallejo’s business development website. The site allows users to select certain streets, for example, and will upon request provide profile information on traffic counts, business vacancies down to square foot, and demographic information.8

Three dimensional (3D) virtual cities provide more intriguing visual displays and increasingly are being integrated with useful data. Portland, Oregon, New York, Bologna, Italy and Virtual Tokyo provide several such examples.9

MultiGen provides one of the most elaborate virtual city modeling schemes that can and has been used by urban planners and developers. The urban simulation approach allows entire cities to be reproduced in three dimensions creating powerful 3D visual imagery. Setting it apart from most other virtual city simulators, MultiGen can also include community specific settings depending on the users (community members/policy makers) preferences or proposed changes in transportation or other land use policies.

MultiGen requires that specific data sets be accessed and thus format options are limited to what has been collected. However, as discussed earlier, geo-coded data is becoming increasingly available and MultiGen is currently putting together a ‘virtual world data server’. MultiGen allows users to create 3D simulations of such things as bike paths, parks, roads, using real-time 3D modeling and simulation/projection tools. Bill Jepson, who teaches and does research on urban design and technology at UCLA states MultiGen has “the ability to interactively move through very high-definition, very large urban environments on the computer and in an interactive fashion.”10 On the ground, MultiGen has been used by developers and city planners, for example, to help plan the Westwood Village Project in Los Angeles.

Urban simulation programs such as those discussed above can require extensive data. A typical simulation of one city block for example requires information on street addresses, linear map of the block, precise geo-coordinates of the building addresses, digital photographs of building fronts, landscaping, and so on. Once obtained there are several programs that can be used to pull all the information together to generate a 3D simulation of the area under study. Despite what can sometimes be initially high start up cost in terms of information gathering, once the data is collected and entered into the

7 This site can be found at www.virtualflagstaff.com
8 The City of Vallejo website can be found at 209.21.13.19/sites/Vallejo/Maproom.html
9 Several three dimensional presentations of virtual cities can be accessed at www.net-cities.com.
10 CNN, June 13, 1999
database, it can be easily updated and used for alternative use scenarios. Thus, costs could conceivably be amortized over the tenure of a general plan, for example.

The following table summarizes some of the capabilities of six software packages that can be used for analysis and presentation of findings. As the table shows, all of the programs are capable of doing spatial analysis. For example, examining the relationship between traffic congestion and public transportation in a given area. As discussed above, INDEX has some of the most advanced features for integrating GIS, multi-media, and indicator analysis. However, as the table shows there are also some potential drawbacks.

<table>
<thead>
<tr>
<th>Analysis Alternatives for Sustainable Transportation</th>
<th>Spatial Analysis</th>
<th>Forecasting</th>
<th>Simulation</th>
<th>Indicator Analysis</th>
<th>ADD ON MEDIA</th>
<th>Format Flexible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arcview</td>
<td>Y</td>
<td>Y</td>
<td>LI (3D)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>MapInfo</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Geo Media</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>MapPoint</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Index</td>
<td>Y</td>
<td>LI</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>S</td>
</tr>
<tr>
<td>SmartPlaces</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>--------------</td>
<td>--------------</td>
</tr>
<tr>
<td>MultiGen</td>
<td>Y</td>
<td>Y</td>
<td>Y (3D)</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>What if?</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

KEY:  Y = Yes;  N = No;  S = Somewhat;  LI = Labor Intensive;

**Chapter Summary**

As our communities transition from reliance on hard copy formats to digital, flexible community planning and design techniques, our ability to make decisions that will lead to sustainable transportation choices will be heightened. The use of indicator analysis within the framework of community design plans is one crucial component needed to improve the abilities of community members and leaders to make informed, sustainable transportation choices. The means needed to make this shift, including widespread use of computers and GIS by planning institutions, are becoming increasingly commonplace. The analysis, simulation, and presentation packages presented in this chapter are tools that are being used today primarily by the technologically advanced but are finding their way into community outreach projects and even people's homes via the Internet.

Among the most innovative applications of new planning technologies are those that combine the use of GIS in combination with text, audio, photographs, and video clips. The interaction of GIS maps with multimedia add-ons can provide a very powerful tool for weighing the pros and cons of proposed land use designs. The appendix contains an application of GIS Internet Map Server to the data developed on Lake Street.

Programs, like Index and SmartPlaces, are designed to take this concept one step further by integrating GIS land use scenarios and indicator analysis. The information foundation provided by these programs can for the basis of a community's understanding of the impacts a proposed development project can have on agreed upon
sustainability objectives. There are numerous presentation formats that can be used to present the findings found thought the use of these mediums. While paper reports will never be replaced, visually enhanced platforms are often more appealing and more telling. At the leading edge of the transportation and technology nexus are urban simulators that allow for the real-time visual presentation of different land uses. Virtual cities, which can be toured over the Internet, are examples of such platforms. The next step, making virtual cities truly interactive in terms of making real time changes to the virtual environment, is not far off given the fact that high resolution three-dimensional urban simulation programs with user interface capabilities are already available to assist in making urban land use decisions.
APPENDIX E: OUTREACH MATERIALS
APPENDIX E: Sustainable Transportation & Community Planning

Sustainability at the Grassroots Level

Who decides what constitutes a sustainable community? This question cannot be answered within the context of this research; however, it is fundamental to the implications for implementation of our findings and was the driving force behind this portion of the research. What this question is really asking is, should planners at the state level, the district level, or the local level make decisions about which measurements of sustainability to use in a community-based planning process? Also, is it better to use an objective menu of indicators to be applied across the state? Or should community members pick the indicators that they believe are indicative of the direction that they want development in their community to move?

To illustrate this point, it is useful to consider the Atlantic Steel project, which has been heralded as a model of planning to improve sustainability.1 The Atlantic Steel team chose indicators to demonstrate the benefits of the proposed project to the community, the region, the state and the country through resulting decreases in reliance on automobiles caused by urban infill, mixed use development. The indicators selected by the Atlantic Steel team were based on the team’s past experience in developing and applying community indicators in metropolitan areas throughout the nation, including in a mixture of objective and subjective community forums. This use of indicators worked well to help the project team meet their goals for this project.

However, in most community planning processes, the tasks are not as clear cut and the vision for the development is not made by a team of planners but rather by the community as a whole. Instead of a cadre of like-minded consultants, decisions are made by a group of individual citizens who often have varying hopes and concerns for the future of the neighborhood in which they live. One concern of our project team was that sustainability might be too vague to be understood by a group of community members. Another was that it might not be applicable to community planning processes, or that sustainability indicators could be difficult to implement in non-metropolitan communities because of data inavailability, lack of direct relevance to communities or other yet unforeseen barriers to implementation. Finally, the team sought to find out whether or not community planners were interested in sustainability indicators and had access to the data necessary to calculate them.

Outreach Component

When a community takes ownership of the idea of sustainability and sets certain values for indicators as goals or benchmarks, the indicators gain meaning within the context of the planning process. However, not all towns may be interested in incorporating the concept of sustainability within their planning process. If given the option to employ principles of sustainability in their planning process, how many towns will do so? Can

and should sustainability indicators be made a standing part of Minnesota's TAM process? To what degree should a higher planning body, such as Minnesota Planning or a Department of Transportation District Office encourage cities or towns to adopt them as integral tools for community planning? What benefits would be gained for the state or district if they did? These are all questions that merit further study and discussion.

To begin to address these questions, we designed a sustainability education piece to be used within the context of MN's Transportation Action Model (TAM) process, but which indeed could be incorporated into almost any community-based transportation planning process. Aspects of this education component were given a dry run in St. Peter, Minnesota and community reactions were noted.

Methodology

These educational pieces were developed to fit into the Transportation Action Model (TAM) developed by Minnesota's Department of Transportation. As mentioned earlier in this report, this model is a 21-week transportation planning process. (See Table 1.) The process includes four participant/group meetings. The first meeting is designed to orient the participants to the overall process and the issues involved in transportation planning. The next meeting is designed to help the participants become more familiar with their current transportation system. The third meeting involves visioning exercises to assist community representatives in developing a plan for changing their transportation system. The fourth meeting provides a forum through which the participants decide upon a transportation action plan. There are subgroups that meet in committee during the entire course of the TAM, compiling materials together for presentation or further discussing issues identified to date.

The research team developed three educational pieces to be shared with residents of St. Peter who participated in this process. These pieces were presented during the TAM meetings in the first, second and fourth meetings where the team believed they would complement the other activities scheduled for the day.
<table>
<thead>
<tr>
<th>WEEKS</th>
<th>ACTION STEPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Community Identification &amp; Selection</td>
</tr>
<tr>
<td>2</td>
<td>Sponsoring Agency Commitment</td>
</tr>
<tr>
<td>3</td>
<td>Initiating Committee Selected</td>
</tr>
<tr>
<td>4</td>
<td>Coordinator &amp; Facilitator Selected</td>
</tr>
<tr>
<td>5</td>
<td>Participants Recruited</td>
</tr>
<tr>
<td>6</td>
<td>&quot;Orientation Meeting&quot; (Meeting 1)</td>
</tr>
<tr>
<td>7</td>
<td>Technical Committee &amp; Public Input Committees Meet</td>
</tr>
<tr>
<td>8</td>
<td>&quot;A Look at Today's Transportation System&quot; (Meeting 2)</td>
</tr>
<tr>
<td>9</td>
<td>Public Input &amp; Issue Committees Meet</td>
</tr>
<tr>
<td>10</td>
<td>&quot;A Vision for the Community's Transportation Future&quot; (Meeting 3)</td>
</tr>
<tr>
<td>11</td>
<td>Public Input &amp; Issue Committees Meet</td>
</tr>
<tr>
<td>12</td>
<td>&quot;Developing a Transportation Action Plan&quot; (Meeting 4)</td>
</tr>
<tr>
<td>13</td>
<td>Writing the Transportation Action Plan</td>
</tr>
<tr>
<td>14</td>
<td>Final Plan Presentation</td>
</tr>
</tbody>
</table>

The first meeting was designed to be an introduction to the topic of sustainability. An overhead presentation was produced which included a discussion of sustainability as a way to think about achieving progress in three areas: social, economic and environmental. The symbol of sustainability used to illustrate its meaning was a picture of three interlocking circles labeled “social, economic and environment.”

Next, several definitions of sustainability were discussed to illustrate how different organizations have defined sustainability and how each community can define sustainability in terms that are most appropriate for their needs and values. Finally, a brief overview of sustainability indicators was given. At the end, a worksheet was distributed and the group was asked to take it home and fill it out, then bring it to the next meeting to help the participants define sustainability in concrete terms and consider how it may fit into their planning process. (See Appendix C-2.)

For the second meeting, a brainstorming activity was designed to help the community build a definition of sustainability that fit their community characteristics, values and development objectives. Flip chart pages were hung on the walls, each with a different heading: social, environment, economic, land use and intermodal. A brief description of the activity was provided, then the participants were asked to share the priority areas they believed should be focused upon subsequent discussions that fit under those
headings. Next the group was asked if they agreed with all of the ideas shared thus far. None of the ideas were eliminated but some editing of phrases occurred. At the end the participants were asked if they wanted to combine all of the phrases into one definition of sustainability for the community. Because none of the participants felt comfortable doing so, the presenters took the information from the exercise and drafted a definition of sustainability for St. Peter that incorporated all of the elements agreed to in the brainstorming exercise. The definition that was developed was ultimately shared with all TAM coordinators in St. Peter.

The following definition was the definition arrived at by the participants in St. Peter:

"To help foster community building, tourism, a people-friendly downtown and tie the community back to the river while encouraging integration of the old modes of transportation with the new and enhancing the opportunities of the next generation while meeting the needs of the present."

The third educational piece included a demonstration of how indicators could be applied. Because this demonstration did not occur until the last meeting in the planning effort, the presentation began with a review of sustainability. A new approach was used to discuss sustainability, opening with information about why the topic was important from the perspective of federal and state agencies and how this concept provides a way to weave together the equally important aims of accessibility, livability, mobility and environmental sustainability. (Appendix C-3.) Next, the results of the application of the indicators were shared with the participants and a very brief, preliminary analysis of the data was given. The limits of the data, including the fact that they were obtained from the last census and were therefore almost 10 years old, were also brought to their attention. The participants seemed receptive to the use of the indicators and understood their relationship to helping create community sustainability in several areas. Only insights on St. Peter's progress toward sustainability that were revealed by the results of the indicator analysis were discussed in this demonstration.

Community Reception to Sustainability

First Educational Piece

Community response to sustainability as an orienting concept for community planning at the first meeting was mixed. A few days after the presentation, community members were surveyed to better gauge how helpful the participants perceived the presentation was perceived to be. The results of the survey demonstrated the range of interest in and understanding of the concept. Some of the participants understood the concept of sustainability and felt that its discussion was a positive contribution to the meeting. Others felt that the presentation was too academically-inclined and that the language used was not appropriate for the audience. There were also a few participants who
perceived the presenters to be biased against automobile use in favor of non-motorized modes of transportation, such as bicycles. After the St. Peter TAM was completed, a few participants expressed their view that they would have preferred to discuss sustainability only once during the beginning of the planning process. (Appendix C-4.)

Due to the overall project schedule and where the St. Peter TAM process fell within it, the St. Peter TAM provided the project team with the only opportunity to test sustainability educational materials. Ideally, however, such a first presentation would allow an open-ended introduction to the option of sustainable development, and at the end there would be a discussion about whether or not the group would want to proceed with this kind of development.

Also, the presenters approached the issue of sustainability as something that could be adapted to any community. While the project team may have been convinced of this at the outset, it may not necessarily be true. If given a choice and no incentives to do otherwise, many communities might choose a development pattern that continues to encourage automobile dependence. Livability to some is a grocery store within a 10 minute drive, not a 10 minute walk. It is wide boulevards and ample parking space, not pedestrian scale streets and ample bike trails. Sustainability is not whatever everybody in the room agrees that it should be; it is an intentional development style aimed at decreasing people's dependence upon automobiles and thereby saving money, resources and improving environmental conditions. While it is true that a community can decide to only pursue some of the objectives of sustainable development and still be working toward sustainability, the overall goal of sustainability should be made clear at the outset of a planning process. To do otherwise will only exacerbate the perception that sustainability it too vague and confusing to be useful.

Upon reviewing the findings of the first meeting, the project team concluded that an alternative approach in the first meeting might have been to begin with a definition or a few definitions of sustainability, then discuss the performance objectives sustainable development seeks to attain, rather than the ways to measure the objectives through indicators. (Appendix C-5.) Next the presenters could have demonstrated the interest in sustainability at the federal and state levels and the part it plays in achieving the performance objectives of Mn/DOT and MN Planning. Finally, the benefits it would provide could have been discussed, such as improved air quality, decreased automobile costs, and decreased commute times resulting in more free time. At the end, there could have been open-ended discussion about the place of sustainable development within the priorities and values of the community.

The key difference between the approach taken in the introduction to sustainability delivered in St. Peter and this alternative approach is the explicit discussion of performance objectives. There is an important distinction to be made between performance objectives indicators seek to measure, such as "improved community livability," and "reduced economic losses due to roadway locations," and the measures themselves. Discussing the objectives explicitly would be useful for two reasons. First, people who are not technicians, engineers or planners may not use quantitative measures on a regular basis. Therefore, discussing how to measure something may
seem redundant if they have difficulty conceptualizing what it is that the measure or "indicator" is designed to measure. Second, once the group becomes familiar with the generally recognized list of objectives they can discuss whether or not they are goals they are interested in pursuing. Once the objectives are well understood and possibly narrowed to fit the culture and values held by the community, it would be much easier to identify indicators that would quantify whether or not they are heading in the right direction with regard to sustainability. In fact, it would empower the participants to decide whether or not they believe the indicators are good measures of the objectives they have chosen. Such empowerment is not only important in helping the participants understand the concept, but in encouraging them to apply it as well.

Second Educational Piece

The second meeting was effective in the sense that it provided both a context and an opportunity for the group to brainstorm initially about their objectives and priorities for their community's future transportation system. However, how this exercise related to sustainable development was unclear to many of the participants. The presenters stressed that this was simply a brainstorming exercise and that participants should focus upon aspects of community development and the relationship to the transportation system that were important to them. While this response helped stimulate participation in the exercise, it did not provide a means for making the concept of sustainability sufficiently concrete to most participants. Developing a workable, concrete definition of sustainability in concert with community representatives can be a useful exercise. However, another way to achieve this end would be to ask the group to identify the performance objectives they believe are appropriate for their community. Once the group agrees to a list of performance objectives, indicators can be identified that would help them measure their progress toward the objectives agreed upon.

Third Educational Piece

The sustainability indicators demonstration in the third meeting was well received, though it was seemingly incorporated too late in the process to contribute meaningfully to the decisions made by the participants. By the time that this meeting took place, the participants were more familiar with the concept of sustainability. The meeting involved a smaller group of participants due to attrition. In addition, the presentation was condensed at the last minute to only about 10 to 15 minutes long because an earlier presentation of the TAM committee findings took longer than the group had anticipated. The presentation on sustainability indicators could have been more effective if it had been given before the group selected its priority planning topics.

General Observations

From the beginning, the receptivity of St. Peter TAM participants to incorporating the concept of sustainability and indicators into the planning process was colored partly by the participants' skepticism about the intentions and objectives of Mn/DOT throughout the TAM. This was partly due to the fact that Mn/DOT representatives were not consistent in the language used to express agency objectives for the TAM in St. Peter.
For example, when asked what criteria Mn/DOT uses to fund transportation projects, a Mn/DOT representative answered mobility. On another occasion, a Mn/DOT representative announced that the Governor had plans to increase growth along the Twin Cities/Mankato corridor, a move that may require increased capacity on the highway running through St. Peter’s main street (Hwy. 169).

Throughout the entire TAM, St. Peter participants raised concerns that their effort to calm traffic on their main street directly conflicts with Mn/DOT’s goal of smoothing traffic flow and expanding transportation capacity. The participants were understandably confused about Mn/DOT’s aims in the process. Has Mn/DOT moved beyond capacity building and mobility into a new generation of enhancing accessibility and helping to build sustainable communities? While sustainability is an integral part of the direction Mn/DOT is moving as demonstrated through its mission statement, Mn/DOT representatives do not always articulate these goals in public.

In defense of the apparently conflicting comments by Mn/DOT representatives, balancing livability, accessibility, mobility and sustainability in community transportation planning is an extremely difficult task and understandably difficult to articulate. That aside, future efforts by Mn/DOT to incorporate sustainability into a community planning process will require an effort by all of the presenters to be consistent about the goals of the agency and of the process, and how they relate to community values and objectives.

Summary

Overall, the project team found that sustainability is in principle a useful orienting concept that should be formally incorporated into the TAM process. The team also found that the educational materials designed could be incorporated in wide-ranging community transportation planning processes. These findings were articulated in a memo to Mn/DOT reviewing the TAM overall. (Appendix C-6.) However, caution should be used in employing this concept and indicators: both need to be framed within the context of community needs and values in a participatory manner. In the future, the TAM could provide a vehicle for educating communities about the benefits of incorporating sustainable practices and indicators into transportation planning activities. Finally, while the team recognized that the current goals of the TAM do not mandate the incorporation of sustainability in the process, the changing mission of Mn/DOT away from new highway construction and toward community enhancement lends itself to the incorporation of this important concept.
Chapter Summary

In summary, the project team makes the following recommendations in order to improve the likelihood that communities use sustainability tools and practices, such as indicators, in planning activities on a regular basis:

- Provide means for developing subregional and community databases and data-sharing arrangements so that communities have the data necessary to apply the indicators widely.

- Provide an online forum for cities to use to display the results of their indicator analyses so they can compare their progress to others.

- Provide the results of the state, county or transportation district overall for cities to use as a means, or "average," for them to compare their results.

- Establish ranges within which communities of various sizes and/or geographic characteristics normally fall. Again, this would give cities a point of reference with which to compare their results and help planners better understand relationships between these features and indicators.

To incorporate sustainability into a citizen-driven planning process, key components needed for an effective sustainability outreach effort work include:

- Be clear about what sustainability is and what sustainability indicators seek to measure. Unless presenters of educational activities are clear about the meaning of sustainability, while at the same time remaining attentive to its relationship to community values, it will seem too vague a concept to be useful.

- While this seems to be a truism, incorporating sustainability into a community-based transportation planning process will occur more readily in communities that are interested in pursuing sustainable practices. Other communities may require more protracted discussion and debate, as well as concrete examples of the relationship between sustainability and community values, before laying the groundwork for sustainable development. Although a community can move toward sustainability without pursuing all of the objectives one might associate with the concept, unless the community believes that the concept in general fits the culture of their community, sustainability education and outreach efforts will be less effective.

- When working with a community group to select sustainable transportation indicators, communication will be more free-flowing if participants are asked to narrow the range of things they want to change first. It is easier for most community members to conceptualize and develop priorities for what they would change in their communities than how to measure it.
The organization initiating and/or convening the planning process needs to be sure to be consistent about the aims of the process. If the process is going to incorporate the concept of sustainable transportation, for example, all of the representatives of the hosting body need to be sure to be consistent about the language they use with regard to how this concept fits into the overall objectives pursued by that body.
SUSTAINABILITY

What is it, How can it be incorporated into a transportation plan, and What tools are available?
“In a real sense all life is interrelated… Whatever affects one directly affects all indirectly.”

Why are you participating in the TAM process?

- Rebuilding your community
- Enhancing your community’s future
- Making the best use of the resources you have
What is Sustainability?

- A new approach to development that encourages long-term planning
- Brings communities together
- Promotes citizen participation in decision-making
- Can be used in different contexts
- Is unique to each community
A Sustainable World Where Transportation Fits In

Sustainable development

Environmental preservation & regeneration

Transportation systems

Economic development & vitality

Social & economic equity

Comprehensive sustainability

Community livability
What Your Community Could Do To Make Your Transportation System Sustainable

- With respect to **society**:
  1) Meet basic **human needs** for health, comfort, and convenience.
  2) Allow and **support development** at a human scale.
  3) Provide for a reasonable **choice of transport modes**, types of housing and community, and living styles.
  4) Produce no more **noise** than is acceptable by communities.
  5) Be **safe** for people and their property.
What Your Community Could Do To Make Your Transportation System Sustainable

- With respect to the environment:
  1) Make a minimal impact on land
  2) Use renewable or inexhaustible energy sources whenever possible
  3) Produce no more emissions and waste than necessary
What Your Community *Could Do To Make Your Transportation System Sustainable*

- With respect to the *economy*:
  1) Provide *cost-effective* service and capacity.
  2) Be *financially affordable* in each generation.
  3) Support *vibrant, sustainable economic activity*. 
Definitions:

Minnesota State Legislature

"...development that maintains or enhances economic opportunity and community well-being while protecting and restoring the natural environment upon which people and economies depend. Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs."
Definitions:

- "Sustainable communities foster commitment to place, promote vitality, build resilience to stress, act as stewards, and forge connections beyond the community"

Northwest Policy Institute,
University of Washington,
Graduate School of Public Affairs
Definitions:

“To enhance development that fosters integrated land use and transportation planning, and to encourage development that results in compact, pedestrian, bicycle, transit - friendly communities.”

Oregon’s Transportation and Growth Management Team
How Do You Measure Sustainability?

• With Indicators!
  – A way to measure progress and show direction

= OR

• Sustainable Transportation Indicators
  – Percent of Street Miles Designated for Bike Routes
  – Ratio of Trails to Streets and Roads
  – Ability of Non-Drivers to Reach Basic Services & Recreation