Monmouth County Transportation Audit and Sustainable Transportation Plan

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Monmouth County Planning Board

Submitted by:
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In association with
ICLEI USA
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EXECUTIVE SUMMARY

ES-1 Study Purpose

The *Monmouth County Transportation Audit and Sustainable Transportation Plan* was prepared to help Monmouth County understand the contribution of transportation-related greenhouse gas emissions (GHG) to climate change, inventory the transportation-related GHG emissions related to county government operations and the county as a whole, and develop recommendations for reducing GHG emissions. The project also included the creation of a "toolbox" to assist Monmouth County municipalities with undertaking their own GHG emissions inventories and emissions reduction planning activities.

This study is part of a larger effort being undertaken by Monmouth County. In 2009, the Monmouth County Board of Chosen Freeholders adopted a resolution designating the Planning Board as the Lead Agency for the preparation of a Monmouth County Greenhouse Gas Reduction Plan. This was partially in recognition that the State of New Jersey has mandated a statewide reduction of GHG emissions to 1990 levels by 2020, an approximately a 20 percent reduction, followed by a further reduction of emissions to 80 percent below 2006 levels by 2050. In addition, counties have a unique role to play in reducing GHG emissions through their regional jurisdiction over policy areas such as air quality, regional planning, transportation, environmental planning, water conservation, and wastewater and solid waste management as well as through operational reductions from county facilities. As a response to this mandate, the Freeholders established a "Greenhouse Gas Advisory Committee" to assist in this effort.

The *Monmouth County Transportation Audit and Sustainable Transportation Plan* is an integral part of that larger strategy to reduce GHG emissions. Many of the findings of this study will be incorporated into the Monmouth County Energy Action Plan that is currently under development.

In the development of the scope of work of the *Monmouth County Transportation Audit and Sustainable Transportation Plan*, it was agreed that the county should look at the impact GHG emissions and associated climate change may have on the county, evaluate what portion of those emissions are due to transportation and what actions the county is taking or can take to reduce GHG emissions in the future.

At the same time this study was being conducted, the North Jersey Transportation Planning Authority (NJTPA) was conducting a GHG emissions inventory and forecast for the NJTPA region. The data collected in that effort was used as a reference in this report as it relates to county-wide and municipal-level analysis.

ES-2 Understanding Climate Change and Greenhouse Gas Emissions

ES-2.1 What is Climate Change?

While long-term temperature and precipitation patterns have undergone natural variations in the past, modern human activities and the associated increased emissions of heat-trapping or greenhouse gases are causing rapid changes in global climate patterns. The burning of fossil fuels for transportation, electricity generation, and heating and cooling introduces large amounts of additional carbon dioxide and other greenhouse gases into the atmosphere. As a result, human activities intensify the natural greenhouse effect whereby a portion of the heat energy that would otherwise escape into space is absorbed by greenhouse gases and radiated back to the earth's surface.

The evidence of climate change over the past fifty years includes "increases in heavy downpours, rising temperature and sea level, rapidly retreating glaciers, thawing permafrost, lengthening growing seasons, lengthening ice-free seasons in the ocean and on lakes and rivers, earlier snowmelt, and alterations in river flows."[1] Climate change related impacts on the environment and economy are occurring now and are expected to intensify in the future. The ultimate extent of future climate change will be influenced by the choices humans make now to reduce greenhouse gas emissions.

ES-2.2 How will Climate Change Impact Monmouth County?

During the 20th century, average sea levels along the Jersey Shore rose by 14 inches, and are expected to rise further due to climate change. People have built boardwalks, summer homes and other structures along the Shore in the expectation that the shoreline will always be roughly where it is today. In 2008, Monmouth County tourists spent $1.78 billion in the county[2] and the industry employs 22,000 workers. Severe erosion caused by climate change will impact residents and businesses along the shore and may adversely affect Monmouth County's place as a tourist destination.

The combination of increased sea levels and increased frequency and severity of storms is a "double punch" to the Jersey shore. In addition to the direct economic impact of sea-level rise and increased storm activity, indirect economic impacts can result from the closure of vital transportation links for the movement of people and goods. Severe weather can cause tidal surges that increase the maintenance costs of public roadways and limit emergency evacuation routes.

Climate change also leads to extreme temperature fluctuations that can create a variety of infrastructure problems. Extreme temperature shifts can cause pavement to soften, create traffic-related rutting, as well as the migration of liquid asphalt (flushing and bleeding), fracture, and deterioration at a faster rate. Extreme temperature swings are also cited as a major cause of railway accidents and rail maintenance problems.

[1] U.S. Global Change Research Program. *Global Climate Change Impacts in the United States*. 2009

[2] NJ Department of Travel and Tourism. *NJ Department of Travel and Tourism Survey*, Global Insights, 2008

More frequent heat waves will increase the levels of air pollution in Monmouth County and increase the health impacts of air pollution. Climate change induced heat waves will amplify emissions from vehicles that contribute gases that are harmful. A study performed by Columbia University found that climate change could substantially increase smog levels across New Jersey by the 2050s, especially in more suburban counties such as Monmouth County.

Climate change will impact agriculture and fishery resources in Monmouth County, affecting both economic vitality of these industries and the environment. Although climate change may increase growing seasons for crops it may also increase the survival rate of pests. Aqua-cultural crops will also be impacted by an increase in CO_2 emissions which increases ocean acidity levels. A Woods Hole Oceanographic Institution study forecasts that mollusks harvests in the U.S. would drop 10 to 25 percent in 50 years' time as a result of increasing ocean acidity levels caused by climate change.

ES-2.2 What is the Role of Transportation in Climate Change?

Cars, trucks, planes, buses, trains and boats all emit carbon dioxide and other greenhouse gases from the combustion of fossil fuels. The transportation sector is a major source of greenhouse gas emissions, accounting for 40 percent of New Jersey's greenhouse gas emissions in 2008. Transportation is also among the fastest growing sources of greenhouse gas emissions in New Jersey and nationally as a result of the increase in vehicle travel associated with population and employment growth. Growth in greenhouse gas emissions related to freight movement has been particularly rapid—on-road diesel fuel consumption in New Jersey increased 81 percent from 1990 to 2005.[3] The growth in transportation greenhouse gas emissions is linked to reliance on automobiles for a large proportion of travel needs. In Monmouth County, 75.7 percent of workers drove alone, 9.2 percent carpooled and 8.9 percent used public transportation to get to work at the time of the 2000 Census.

ES-2.3 What Can Be Done to Reduce Greenhouse Gas Emissions From Transportation?

Since transportation is a major source of GHG emissions, governments are considering and implementing programs aimed at reducing transportation-related GHG emissions. Many of these programs are based on three basic strategies:

1. Reduce vehicle miles traveled. Examples include measures designed to encourage greater use transit, walking/biking, carpooling etc.;
2. Increase vehicle fuel efficiency. Examples include encouraging driving techniques that reduce fuel use and reducing traffic congestion (which results in lower fuel efficiency) ; and
3. Reduce carbon content of fuels. Examples include conversion to biodiesel and ethanol and the use of alternative fuel vehicles.

[3] NJDEP. *Draft Statewide Greenhouse Gas Inventory and Reference Case Projections 1990-2020*. 2008.

Over the past decade, governments around the world have begun to step up efforts to reduce their GHG emissions. In 2007 New Jersey enacted the *New Jersey Global Warming Response Act* (GWRA), which calls for reducing greenhouse gas emissions to 1990 levels by 2020 and to 80 percent below 2006 levels by 2050. At the regional level, the North Jersey Transportation Planning Authority (NJTPA) has completed a greenhouse gas inventory and forecast to inform policy decisions on reducing greenhouse gas emissions. At the local level, Monmouth County is undertaking a comprehensive study to measure transportation related greenhouse gas emissions and make recommendations for reducing these emissions.

For purposes of this study, it was decided to evaluate the transportation-related activities of the county operations to see what has been done and what could be done to further reduce GHG emissions in the future. Secondly, an important component of the county operation is the transportation emissions resulting from county employee commutes. A commuter survey was completed and measures were recommended to encourage the use of commuting strategies that would reduce GHG emissions. Finally, using data generated in the NJTPA inventory and forecast, the study evaluates at a general level what may be able to be done to decrease county-wide GHG emissions.

ES-3 Monmouth County Employee Commute Emissions Inventory

ES-3.1 Methodology

The employee commute GHG emissions were estimated based on a commuter survey that provided information on commute mode, distance traveled to work, vehicle type etc. The survey also gathered information the ability and willingness of Monmouth County employees to consider alternative transportation. The web-based survey was distributed to all Monmouth County employees by email in August 2010. A total of 1,337 people completed at least a portion of the commuter survey, representing an overall response rate of 38 percent of Monmouth County's approximately 3,500 employees.

The employee commute survey data on the use of alternative transportation to commute, vehicle fuel types (e.g. gasoline and diesel), vehicle types (passenger cars, light trucks and heavy duty trucks) and average distance travelled to work were used to represent the characteristics of the county employee population as a whole. This data was analyzed and entered into ICLEI's Clean Air Climate Protection (CACP) software to generate the final GHG emissions estimate.

ES-3.2 Results

Key findings from the employee commuter survey included the following:

- 21% of respondents lived within five miles of their work location.
- The mean one-way commute distance was 13.2 miles.
- 37% of respondents drove a SUV, pickup truck or minivan to work

- 92% of respondents typically drove alone to work, approximately 3% carpooled and less than 1% walked, biked or used public transit.
- The most often cited reason for the choosing their current commute mode was the lack of another viable option. Convenience and the need for a car at work were also important factors in deciding commute mode.
- Respondents indicated that emergency ride home options, improved transit service and better information on commute options could influence them to use alternative transportation instead of driving alone.

The survey information was used to estimate that the 3,500 county employee workforce travels total of 20.7 million vehicle miles per year in commuting to work. As shown in Table 1, total employee commute CO_2 equivalent emissions were 12,363 tons per year. To put this number in perspective, total direct emissions from on-road mobile sources in Monmouth County in 2009 were forecast to be 2.624 million metric tons according to NJTPA's regional inventory. The employee commute emissions from Monmouth County government operations are about 0.5 percent of the on-road mobile source emissions in Monmouth County. According to ICEI's GHG database, Monmouth County has higher employee commute GHG emissions per employee than other comparable counties[4] with a similar workforce size.

ES-Table 1: Employee Commute Greenhouse Gas Emissions Inventory

	CO_2 (tons)	N_2O(lbs)	CH_4 (lbs)	Equivalent CO_2 (tons)
Gasoline	11,891	1,578	1,329	12,149
Diesel	213	1	1	213
Total	12,104	1,579	1,330	12,363

ES-3.3 Recommendations

The recommended policies to reduce employee commute GHG emissions that appear the most feasible to implement in the near-term include the following:

- **Ridesharing programs**. Increased use of ridesharing options such as vanpools and carpooling could reduce GHG emissions by 44 to 132 tons of CO_2- equivalent (CO_2e)[5] per year assuming a participation rate of 5 to 15%.

- **Emergency ride home services.** Emergency ride home services make carpools, vanpools and transit services more attractive by providing employees an assurance that they will be able to get home promptly via a taxi in the event of a family emergency or the need to work late.

[4] Comparable counties were chosen using ICLEI's County GHG Database. Counties with similar demographics and county employee counts were the criteria for the comparison.
[5] CO2e is a metric used to compute total emissions greenhouse gases based on their global warming potential of the individual gases (e.g. the degree to which they trap heat from escaping the atmosphere).

- **Preferred parking**. Providing employees who carpool with preferred parking spaces close to their place of work is a benefit that can increase carpool participation. Preferred parking can also be used to promote certain types of vehicles, such as hybrid and electric cars.

- **Financial incentives to encourage the use of transit**. Financial incentives can include programs that allows pre-tax income to be set aside to purchase mass transit passes for commuting (e.g. TransitChek, NJ TRANSIT BusinessPass), Meadowlink's AdVANtage Program which pays for empty van pool seats for the first three months to allow new van pools to "ramp up", and subsidies to employees to use ridesharing.

- **Increasing walking/biking commute mode share.** Biking to work can be encouraged by providing secure bicycle parking facilities, other amenities such as lockers and showers, and infrastructure improvements to make biking safer and more attractive. Vehicular mileage would be reduced by 23,000 to 115,000 miles annual should between 20 and 100 Monmouth County employees bicycle to their place of employment. This would reduce GHG emissions by 11 to 55 tons of CO_2e per year.

Other policies considered as part of this study included parking pricing, flex time, reduced work week, and telecommuting.

ES-4 Monmouth County Vehicle Fleet Emissions Inventory

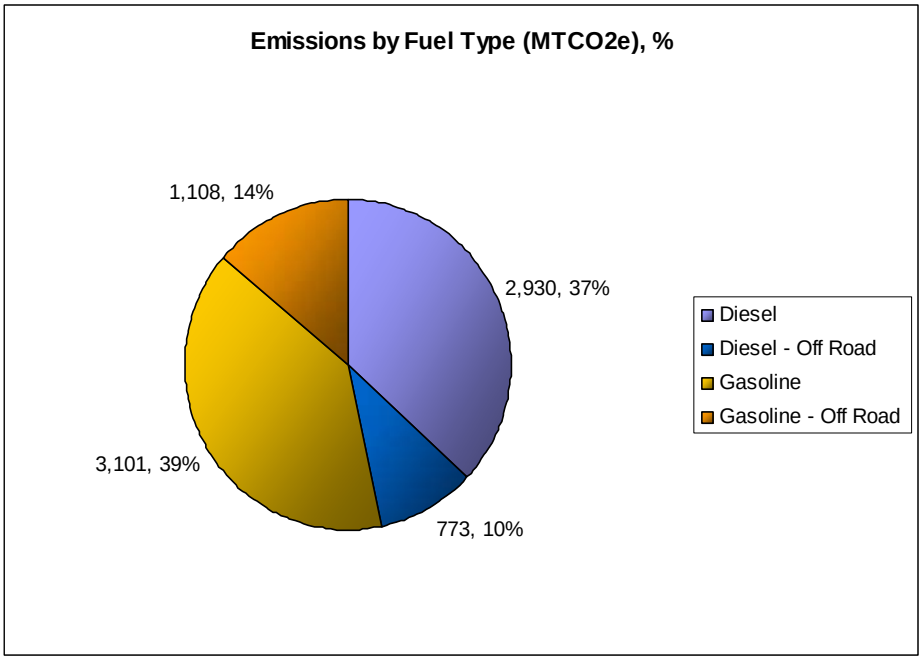
ES-4.1 Methodology

The GHG emissions from Monmouth County's vehicle fleet were estimated based on vehicle and fuel consumption data from fleet management databases maintained by the Public Works and Parks Departments. The base year for the inventory information was 2009. The study team used ICLEI's CACP 2009 software to calculate the GHG emissions from the Monmouth County fleet operations in accordance with the Local Government Operations (LGO) protocol.

ES-4.2 Results

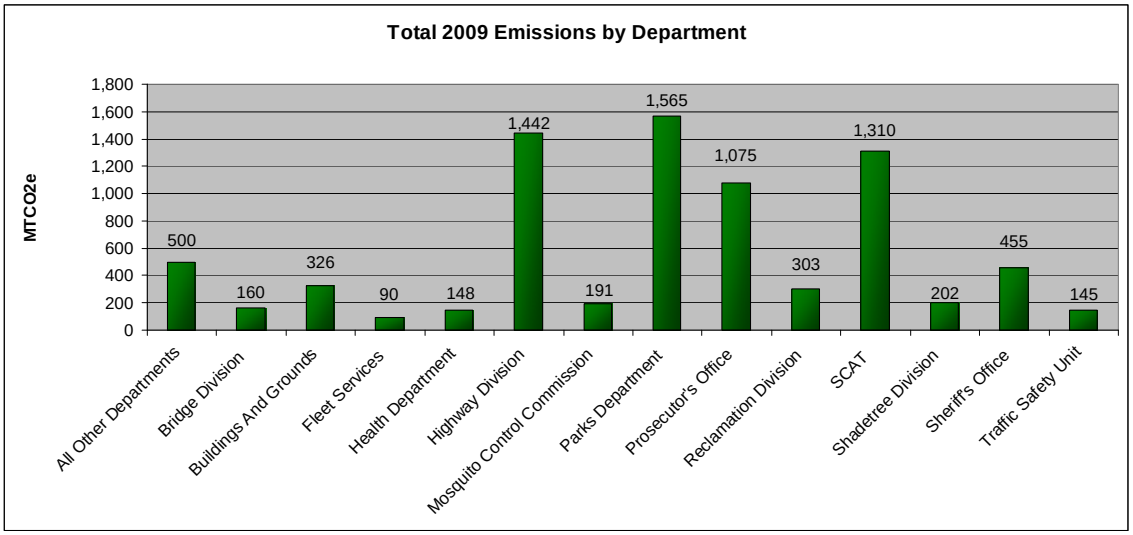
For the calendar year January-December 2009, Monmouth County fleet and vehicle related emissions totaled 7,904 tons of CO_2e. Figure 1 shows the breakdown of the total emissions by fuel type and on-road vs. off-road vehicles. On-road uses include typical fuel consumption for passenger cars, trucks and buses and other vehicles used on public roadways. Off-road uses include heavy equipment, such as tractors, and small equipment, like gas-powered grounds keeping equipment (e.g. mowers). Off-road equipment accounts for 24% of total emissions. The use of diesel fuel resulted in 47% of the total vehicle fleet emissions compared to 53% from gasoline.

ES-Figure 1



As shown in Figure 2, the Parks Department produced the highest quantity of emissions, 1,565 tons of CO_2e. Following that Parks Department were the Highway Department, Special Citizen Area Transportation (SCAT), and Prosecutor's Office; each of which require significant travel to perform their duties. The category called "all other departments" in Figure 2 includes departments with low numbers of vehicles and small emissions contributions. This category includes the Library, Fire Marshall's Office, John L. Montgomery Home, Social Services Department, Extension Services, Geraldine Thompson Medical Home, Information Services, and others.

ES-Figure 2 Total 2009 Emissions by Department



Monmouth County Public Works and Engineering Department (MCPW&E) has already instituted a variety of efficiency initiatives to reduce fuel consumption. The strategies being implemented are:

- tracking vehicle and equipment fleet and fuel consumption;
- using vehicles more efficiently as per daily assignments;
- using of more efficient, lower polluting alternative fuels and engines, where practical; and
- reducing idling

Most of the MCPWE initiatives have been implemented prior to the 2009 baseline emissions inventory and therefore are reflected in the overall emissions for the county's operations in this study. These efficiency gains were reflected in a comparison between Monmouth County fleet emissions and the fleet emissions of other counties on a per capita basis. Monmouth County's vehicle fleet emissions per capita were less than half that of any of the three comparable counties serving a similar population size (Sarasota County, FL, Watcom County, WA and Snohomish County, WA).

ES-4.3 Recommendations

Key recommendations for further reducing vehicle fleet GHG emissions are summarized below. Combined, these measures could reduce CO_2e emissions by 717 metric tons annually and save the county $244,000 annually due to reduced fuel consumption.

- Data collection. The tracking of fuel consumption and mileage by vehicle conducted by MCPW&E should be continued to allow for improvements in performance over time to be tracked. The Parks Department should consider adopting the tracking system used by MCPW&E to provide information on which

vehicles in the Parks Department fleet are using the most fuel and prioritize these vehicles for future replacement or other emissions reduction strategies.

- High Efficiency Vehicle Purchase. As the older vehicles in Monmouth County's fleet need to be replaced, there is an opportunity to reduce emissions through the purchase of hybrid and electric replacement vehicles. Based on analysis of the age structure of the vehicle fleet, this strategy could reduce emissions by 101 tons of CO_2e per year by 2015. The cost effectiveness of the purchase and use of hybrid vehicles would have to be evaluated prior to purchase. In some instances, the use of the vehicle would preclude a hybrid from being used.

- Law Enforcement Idle Reduction. Recent advances in power storage technology allow law enforcement vehicles to be outfitted with power supplies that do not require the vehicle to remain running to power the communications and other equipment used in the field. The implementation of alternate power supplies in 69 Sheriff's Department vehicles was estimated to reduce GHG emissions by 59 tons of CO_2e per year based on the fuel savings reported in other jurisdictions that have implemented this measure. This modification of law enforcement vehicles may not be possible.

- Route Optimization. GIS-based routing systems could improve the efficiency of many of the "on-demand" services offered by the county, particularly the SCAT bus service. Route optimization systems can reduce vehicle miles traveled by 20% in many cases. In total, 314 tons of CO_2e could be reduced assuming route optimization was implemented for 174 vehicles across departments that include SCAT, the Mosquito Commission and the Health Department.

- Efficient Driver Education. In-use fuel economy can be increased by obeying the speed limit, avoiding sudden starts and stops and generally reducing aggressive driving behavior. It is estimated that fuel economy can be improved up to 33% through changes in driver behavior alone.[6] Implementation of an efficient driver education program could save 246 tons of CO_2e per year, taking into account the fact this is a voluntary measure and not all employees would change their driving habits.

Additional strategies that are used elsewhere and were considered as part of this study included parking pricing, flex time, reduced work week, and telecommuting. Information on those strategies is included in Appendix D.

ES-5 Countywide Transportation-Related Greenhouse Gas Emissions Inventory

ES-5.1 Methodology

[6]EcoDriving USA. EcoDriving Practices. Accessed 12-20-2010. http://www.ecodrivingusa.com/#/ecodriving-practices/

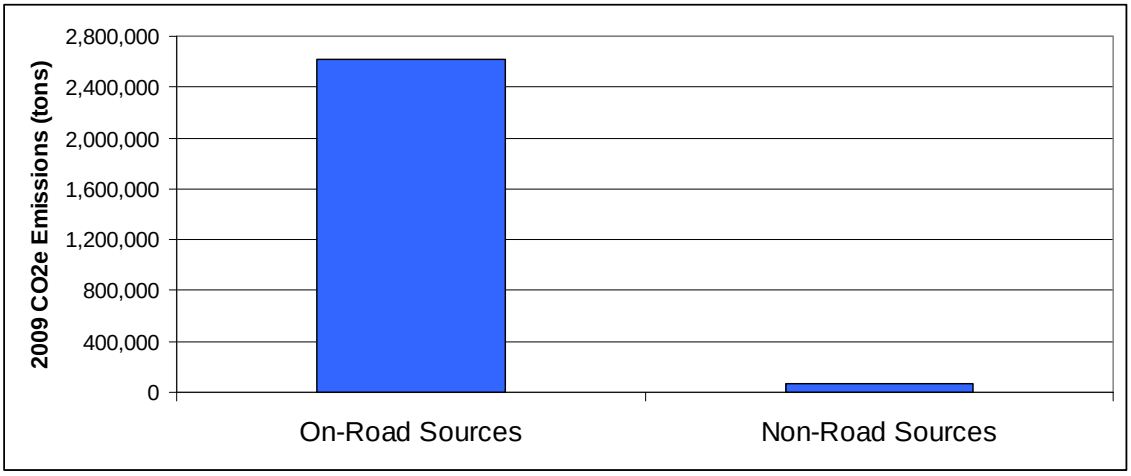
The purpose of the countywide emissions inventory was to estimate the total transportation-related emissions occurring in Monmouth County, including both private and public sources. A significant amount of data for this analysis was supplied by the NJTPA's Regional Greenhouse Gas Emissions Inventory and Forecast study. NJTPA's study estimated GHG emissions from mobile sources throughout the NJTPA's thirteen county region, which includes Monmouth County. The base year for the NJTPA's GHG estimates was 2006, with forecasts of emissions extending out to 2050. To remain consistent with the 2009 analysis year used for Monmouth County's operational inventory, the study team utilized the NJTPA's GHG emissions forecast for 2009.

For on-road vehicle emissions, the seasonal distribution of the NJTPA inventory data was refined based on an analysis of seasonal traffic patterns in Monmouth County municipalities. The NJTPA annual emissions at the municipal-level were held constant to remain consistent with the regional inventory, only the seasonal distribution of emissions within each year was adjusted.

ES-5.2 Results

Total transportation-related GHG emissions occurring in Monmouth County in 2009 are 2.7 million tons CO_2e according to the NJTPA inventory. As shown in Figure 3, on-road vehicles are the predominate source of the total emissions. Non-road emissions (airport, trains, off-road vehicles) are 1/36th of the on-road emissions.

ES-Figure 3 Comparison of Monmouth County 2009 On-Road and Non-Road Mobile Source Emissions



Source: NJTPA Regional Greenhouse Gas Emissions Inventory and Forecast

The on-road emissions are not distributed equally across the year. In the shore communities that attract substantial visitor traffic in the summer, vehicle miles traveled (VMT) are substantially higher (nearly 50% higher in some communities in July compared December. In contrast, the inland communities such as Freehold, Millstone and Marlboro actually have slightly lower VMT and emissions in the summer relative to the winter.

ES-5.3 Recommendations

A wide variety of alternative transportation improvements were considered in terms of cost, feasibility and emissions reduction benefits. The following six recommendations were identified as the highest priorities for implementation.

- **Develop a Comprehensive Bicycle and Pedestrian Master Plan.** The provision of safe and attractive pedestrian and bicycle accommodations is essential to increasing walking and biking, and has numerous co-benefits in terms of public health and livability. Monmouth County is already in the early planning stages for this project. The NJTPA has approved the development of the *Monmouth County Comprehensive Bicycle and Pedestrian Master Plan* as a part of their fiscal year 2012-2013 Subregional Studies Program. Once completed, the plan is expected to provide a strong basis for prioritizing future pedestrian and bicycle improvement projects in the county to create a connected bicycle and pedestrian network. The plan will also provide crucial baseline conditions information on available infrastructure and areas of concern based on the occurrence of accidents involving pedestrians. The plan will also be valuable to municipalities as they develop their own non-motorized facilities
- **Bike Sharing Pilot Program**- Bike sharing is a strategy for making bicycles available to people who may not own their own bicycle but would use a bicycle for short trips if one was available. The proposed summer season bike sharing pilot program would be targeted at visitors (including visitors arriving via NJ TRANSIT) and should be developed in partnership with a local shore community, NJ TRANSIT, and a bike enthusiast organization. The pilot program is estimated to cost $200,000 (including start-up costs) and would reduce GHG emissions by 138 tons CO_2e per year.
- **Exit 98 Park and Ride Expansion** – Expanding the over-capacity Garden State Parkway Exit 98 park and ride would promote carpooling along a highly desirable east/west/north/south interchange. The expansion could occur within existing state-owned right-of-way and is estimated to cost $450,000 to add 100 parking spaces. The additional carpooling this expansion would allow for could reduce GHG emissions by 229 tons of CO_2e per year.
- **Local Shuttles to Park and Rides and Seasonal Shuttles for the Shore Area**- There is potential to use a variety of federal and state funding sources to work with Meadowlink TMA and the private sector to provide shuttles that make it more convenient for people to use transit for all or part of their trip.
- **Run the NJ TRANSIT North Jersey Coast Line south of Long Branch on Bio-diesel**- Monmouth County should advocate the use of bio-diesel in the existing North Jersey Coast Line service that runs on the diesel only line south of Long Branch. Amtrak recently received a $274,000 grant from the Federal Railroad Administration to test the feasibility of using Bio-Diesel in one of its

lines. Amtrak found that stationary locomotive tests of burning B20 (which is 20 percent biodiesel and 80 percent diesel) cut hydrocarbons and carbon monoxide each by 10 percent, particulates 15 percent and sulfates 20 percent. If the same bio-diesel blend is used on the Coastline south of Long Branch and the same results occur, the estimated GHG emissions reduction would be nearly 1,600 tons of CO_2e annually, or the annual greenhouse gas emissions from 285 passenger vehicles, on that section of the line alone.

- **Monmouth-Ocean-Middlesex Line**-The MOM line would provide rail service to underserved areas in western Monmouth County, presenting an opportunity to substantially increase transit ridership. The most attractive alternative for Monmouth County, the Monmouth Junction Alternative, is estimated to have 41,000 boarding a day. Based upon this assumption, this could directly reduce GHG emissions by 204,054 tons of CO_2e per year. It assumed that the total GHG impact would be even higher than this number as a result of reductions in roadway congestion and the potential for transit to encourage compact development patterns near stations not accounted for in this estimate.

ES-6 Municipal Toolbox

In addition to the final report, the county has also produced a Municipal Toolbox that will assist municipalities in creating, funding, and implementing their own GHG emissions reduction strategies. The Toolbox is a ready to use package that combines national best practices, GHG emissions calculation tools, funding sources, and strategies for a variety of transportation-related topics.

ES-7 Conclusion

Climate change will affect the environment, economy and quality of life in Monmouth County over the coming decades. However, the extent of future climate of change impacts can be reduced by collective actions taken now by individuals and governments to reduce GHG emissions. Transportation-related emissions account for 28 percent of total direct GHG emissions in the North Jersey Transportation Planning Authority region and are one of the fastest growing sources of GHG emissions nationally. Reducing air pollutant emissions from transportation is not only beneficial in terms of climate change; it also has immediate co-benefits in terms of reduced smog forming emissions and particulate matter, among other pollutants with serious health impacts.

This study addressed the transportation-related GHG emissions from the Monmouth County's vehicle fleet, employee commuters and the Monmouth County transportation system as a whole. The 2009 base year emissions estimates prepared as part of this study provides an important benchmark against which the relative success of future energy consumption and GHG reduction activities can be measured. The study also provided a comprehensive review of the available strategies, policies and projects that could be considered to reduce transportation-related GHG emissions. The GHG mitigation options considered included changes in fleet management practices and incentives to encourage the use of alternative transportation by county employees. Monmouth County also developed a prioritized list of recommended planning and alternative transportation

projects to reduce GHG emissions. The results of this study will be useful not only to Monmouth County government, but will also aid in the GHG mitigation efforts of Monmouth County's municipalities. This study included the development of "toolbox" of resources and guidance to assist municipalities in planning, funding and implementing their own transportation-related GHG emissions reduction efforts.

1. Climate Change and Greenhouse Gas Emissions – Issues and Background

Climate change is arguably the paramount environmental issue of the 21st century, creating concern, interest, and action in all sectors and communities, globally and locally. In just a few years, climate change has captured the attention and interest of communities, agencies, businesses, and elected officials. According to *The Garden State in the Greenhouse*, a report issued by Princeton University researchers, under the worst-case scenario, climate change could cause the sea level off New Jersey's coast to rise nearly four feet by the end of the century, drastically impacting Monmouth County's economy, ecology, and its residents.

The purpose of this section is to provide a basic introduction to climate change and the potential impacts that can result from climate change in the future. This section of the report will:

- explain what climate change is,
- identify how climate change will impact Monmouth County specifically,
- identify national and state trends in transportation greenhouse gas emissions, and
- provide an introduction to the typical strategies used to mitigate transportation-related GHG emissions.

a. Climate Change Definition and Scientific Basis

Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."[7] The UNFCCC makes the distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes.

Climate change has been verified by a number of scientific bodies, such as the Intergovernmental Panel on Climate Change (IPCC), a scientific intergovernmental body tasked with evaluating the risk of climate change caused by human activity. The IPCC's 2007 report crystallized the overwhelming consensus within the global scientific community that the earth's climate is changing due in large part to the abundance of greenhouse gases in the atmosphere and that human activities are largely responsible for increasing concentrations of climate change pollutants.[8] Additionally, the National

[7] United Nations Framework Convention on Climate Change. 1994. Article 1: Definitions. http://unfccc.int/essential_background/convention/background/items/2536.php

[8] Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2007: The Scientific Basis*, Fourth Assessment Report 2007

Science Foundation, the National Oceanic and Atmospheric Administration, the U.S. Environmental Protection Agency, the National Aeronautic and Space Administration, and the U.S. Department of Energy have acknowledged the significant role of human activity in exacerbating climate change.

Also in 2007, Harris Interactive surveyed 489 randomly selected members of either the American Meteorological Society or the American Geophysical Union for the Statistical Assessment Service (STATS) at George Mason University. The survey found 97 percent agreed that global temperatures have increased during the past 100 years; 84 percent say they personally believe human-induced warming is occurring, and 74 percent agree that "currently available scientific evidence" substantiates its occurrence. Only five percent believe that that human activity does not contribute to greenhouse warming; and 84 percent believe global climate change poses a moderate to very great danger.[9]

Modern human activity, most notably the burning of fossil fuels for transportation, electricity generation, and heating and cooling, is introducing large amounts of additional carbon dioxide and other greenhouse gases into the atmosphere. Collectively, these additional gases are intensifying the natural greenhouse effect, causing global average surface temperature to rise, which in turn affects global climate patterns.

The Earth's atmosphere is naturally composed of a number of gases that help to trap heat from the sun, thereby keeping the Earth's climate stable and hospitable for life. This phenomenon, known as the greenhouse effect, is the primary reason why the Earth has historically had a relatively stable global average temperature of 60 degrees Fahrenheit. Of the identified greenhouse gases, carbon dioxide (CO_2) is the most abundant. Other notable greenhouse gases include water vapor, methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

When discussing climate change, it is important to note that the climate and the atmosphere do not react in a linear fashion to increased greenhouse gases. This means that one cannot simply predict that for each metric ton of CO_2 emitted from a power plant or a vehicle's tailpipe, the Earth will warm a proportional amount. This is because the Earth's climate has a number of feedback loops and tipping points, which scientists believe will accelerate global climate change beyond the rate at which it is currently occurring. For example, as CO_2 emissions have increased in recent human history, the oceans have been absorbing a significant portion of these gases and therefore becoming more acidic. But as the oceans become more saturated with CO_2, scientists anticipate they will reach maximum retention, after which they will be unable to absorb any more CO_2, meaning that each metric ton of man-made emitted CO_2 will be released directly into the atmosphere, leading to a more substantial impact on global climate patterns.[10]

The most commonly discussed impact of climate change is an increase in temperature. According to the National Aeronautic and Space Administration (NASA), global average

[9] Lichter, S. Robert , *"Climate Scientists Agree on Warming, Disagree on Dangers, and Don't Trust the Media's Coverage of Climate Change"*. Statistical Assessment Service, George Mason University April 24th 2008
[10] Ibid

surface temperatures increased since the 19th century by about 1 degree Fahrenheit, with the 1990s being the warmest decade of the century. According to the Goddard Institute for Space Studies (a branch of NASA), the six warmest years in the period when such records have been compiled have all occurred since 1998, and the 15 warmest years have all occurred since 1988.[11]

The climate change discussion is a high profile topic, perhaps attributable to the easily observable recent weather changes and events. Much of the public's discussion is centered on the reasons for these climate changes and scientific research has responded by attempting to better understand the underlying causes. Much of the scientific efforts have focused on changes when records are most reliable; particularly on the last 50 years, when human activity has grown the fastest and observations of the upper atmosphere have become available. Some of the key explanations behind recent climate changes have been attributed to human activity. They are:

- increasing atmospheric concentrations of GHGs;
- global changes to land surface, such as deforestation; and
- increasing atmospheric concentrations of aerosols – a suspension of fine solid particles or liquid droplets in a gas.[12]

The reasons climate change is thought to be attributable to human activity are:

- the observed climate change is not consistent with natural variability;
- the observed climate change is consistent with human influences (e.g., correlation with increases in carbon emissions); and
- known natural forces during this period would, if anything, have cooled the earth and decreased average temperatures.

Recent reports from IPCC have concluded that:

- "Most of the observed increase in globally averaged temperatures since the mid-20th century is *very likely*[13] due to the observed increase in manmade greenhouse gas concentrations."[14]; *It is extremely unlikely that the global pattern of warming during the past half century can be explained without external forcing* (i.e., it is inconsistent with being the result of internal variability), and very unlikely that it is due to known natural external causes alone. The warming occurred in both the ocean and the atmosphere and took place at a time when natural external forcing factors would likely have produced cooling.

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[11] *Climate Progress: http://climateprogress.org/2007/12/11/nasa-hansen-2007-second-warmest-year-ever-warmest-year-likely-by-2010/*

[12] Intergovernmental Panel on Climate Change Working Group I (WG I). *Climate Change 2007 - The Physical Science Basis*,Cambridge University Press, July 2007

[13] *The IPCC defines the likelihood of outcomes as: Virtually certain > 99% probability of occurrence, Extremely likely > 95%, Very likely > 90%, Likely > 66%, More likely than not > 50%, Very unlikely < 10%, Extremely unlikely < 5%*

[14] *Ibid*

- "From new estimates of the combined man made forcing due to greenhouse gases, aerosols, and land surface changes, it is *extremely likely* that human activities have exerted a substantial net warming influence on climate since 1750." [15]

In other words, the overall consensus of scientific research supports the notion that activities associated with energy production, manufacturing, and transportation from internal combustion engines since the 1950s have had a significant contribution to the rise in global temperatures. Although climate change is of great concern to the scientific and environmental community, without locally observable impacts it is perceived by many in the public as an academic or abstract topic.

b. Potential Climate Change Impacts in Monmouth County

Monmouth County will be impacted by climate change in the future. Some impacts will be more easily observed such as an increase in sea levels while other impacts may be more subtle, such as increased suburban smog, more difficult commutes due to deteriorating transportation infrastructure, and impacts on agriculture. Whether obvious or subtle, impacts due to climate change will affect the county's economy. As discussed below, these impacts include losses in tourism dollars, damage to private property, higher flood insurance rates, lower income from agriculture, increased health care costs for residents, and higher infrastructure maintenance costs.

i. Sea level rise and the Economy

The most obvious impact of climate change for many living in Monmouth County is an increase in sea levels and therefore higher storm surges and flooding. A climate change-induced sea-level rise of 16 to 31 inches, or 0.35 to 0.78 meters (within the range of what scientists forecast for New Jersey by the end of the century[16]) could inundate low-lying lands along the shore. Combined with the increase in sea levels is the threat of the increased frequency and severity of storms. The combination of increased sea levels and increased storms is a "double punch" to a coastline, particularly one that is as extensively developed as the Jersey Shore. Without appropriate planning and protection, large storms will have the potential to destroy vast swaths of development and thereby devastate regional economies and significantly impact the state economy. While the shore is ever present in Monmouth County, it is also delicate and vulnerable.

One sector of Monmouth County's economy that will be impacted from shore depletion caused by climate change is tourism. In 2008, tourists in Monmouth County spent $1.78 billion in the county[17] and the industry employed 22,000 workers. In addition, the tourist industry provides a robust demand for summer vacation home rentals which are estimated to number 8,000 homes. With little or no beach to visit many of these visitors would go elsewhere for their summer vacations. Although the impacts are not fully clear, there is no doubt that a loss of tourists would have a significant impact on the county's economy.

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[15] *Ibid*

[16] Environmental New Jersey Research & Policy Center. *An Unfamiliar State Local Impacts of Global Warming in New Jersey*, May 2007

[17] NJ Department of Travel and Tourism. *NJ Department of Travel and Tourism Survey*, Global Insights, 2008

The loss of beach due to more severe erosion caused by climate change would impact the attractiveness of Monmouth County as a tourist destination and have the additional impact of reduced municipal revenues from beach badge sales. Studies conducted in other states for estimating the economic impact of beach erosion point to a beach's recreational benefits that are based upon the premise that the beach has a measurable dollar value to the people who use it. In Monmouth County this premise is apparent since many of Monmouth County's beaches have beach badges which provide a proxy for a person's valuation of basic daily, weekly or monthly, beach access.

The loss of beach can also dramatically reduce economic and community benefits that may not directly be attributable to the tourist industry. These types of negative impacts may include:

- Reduced Business and tax revenues;
- Diminished Property values;
- Decreased Property tax revenues;
- Job losses;
- Degraded Environment; and
- Less aesthetic quality.

Aside from land based tourism, climate change can impact the ability of boaters to navigate, store, and maintain their boats in Monmouth County. New Jersey's recreational boaters spend $2.1 billion a year and support some 18,000 jobs.[18] Monmouth County accounts for approximately 10 percent, or 17,710 of the state's registered boats. Approximately 12 percent of all boats registered in the state are docked in Monmouth County during the boating season. Additionally, 14 percent of survey respondents listed Monmouth County locations among the most popular places to visit during boating outings.[19]

With extensive development and tourism along its shore, Monmouth County has a well established policy that encourages shore protection along its coasts. New Jersey generally prohibits new hard structures, such as sea walls and jetties, along the ocean front; but that was not always the case. A large portion of the Monmouth County shoreline was once protected with seawalls, resulting in a partial or total loss of beach in some areas. Today, beach nourishment (or replenishment) is the preferred method for reversing beach erosion and providing ocean front land with protection from coastal storms.[20] While beach nourishment has been effective, the costs of completing a project can be fairly high. Table 1 illustrates the costs for Monmouth County's previous beach nourishment projects.

[18] Marine Trades Association of New Jersey. *Recreational Boating Economic Impact Study for New Jersey*, 2006

[19] Monmouth County Planning Board. *Monmouth County 2009 Profile,* August 2009

[20] U.S. Environmental Protection Agency. *Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region,* Washington D.C. January 15, 2009

1-Table 1 Monmouth County Beach Nourishment Projects and Costs

Year	Project Name	Estimated Project Cost *(in 2009 $)*	Quantity Placed *(Cubic Yards)*
1983	Sandy Hook	$23,656,269	2,370,000
1984	Sandy Hook	$8,862,592	800,000
1990	Sandy Hook	$2,291,296	3,300,000
1995	Sandy Hook - Deal	$27,912,303	4,400,000
1995	Sea Bright - Ocean Township Sandy Hook To Barnegat Inlet Monmouth	$204,593	4,600,000
1996	Sandy Hook - Deal	$23,119,416	4,100,000
1996	Sea Bright - Ocean Township Sandy Hook - Barnegat Inlet Sea Bright	$198,572	3,800,000
1999	Sea Bright - Ocean Township Sandy Hook - Barnegat Inlet Long Branch	$187,751	4,300,000
1999	Section 2: Asbury - Manasquan South Reach	$93,875	4,100,000
2001	Section 2: Asbury - Manasquan North Reach	$88,634	3,100,000

Source: U.S. Army Corps of Engineers

Although a portion of the dollar amounts shown have been offset by the state's Coastal Protection Trust Fund[21] or federal funding, these funds are not guaranteed to be there if there is consistent beach erosion over a number of years. The U.S. Army Corps of Engineers estimates that beach protection programs in Monmouth County alone will cost the federal government approximately $140 million until 2012, as illustrated in Table 2.

1-Table 2 Estimated Federal Costs for Beach (Nourishment) Projects

Project	Phase of Project	Estimated (Federal) *2008 to 2012 costs*
Highlands	Study	$937,500
Leonardo	Study	$2,000,000
Port Monmouth	Partial Funding Received	$29,250,000
Keansburg 506	Re-nourishment Initiated	$22,932,000
Union Beach	Pre-Construction and Design	$58,500,000
Keyport	Study	$937,500
Sea Bright	Re-nourishment Initiated	$5,330,000
Monmouth Beach	Re-nourishment Initiated	$5,330,000
Asbury to Avon	Initial Construction Complete	$6,500,000
Belmar to Manasquan	Initial Construction Complete	$8,450,000

Source: U. S. Army Corps of Engineers

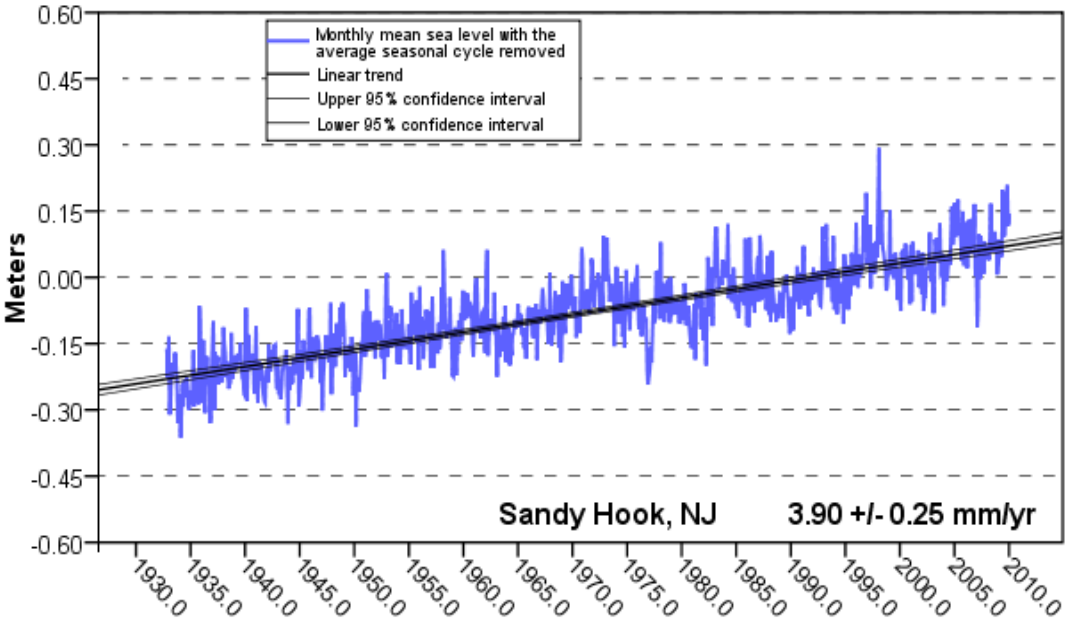
While people have built boardwalks, summer homes and other structures along the shore in the expectation that the shoreline will always be roughly where it is today, nature is constantly reshaping the shoreline in ways large and small. Climate change – which is

[21] *The "Coastal Protection Trust Fund" is a completely separate fund that receives monies from the sale of special coastal protection license tags. The primary purpose of the Coastal Protection Trust Fund is to fund the New Jersey Adopt-A-Shore program. However, license plate fees collected in excess of $1,000,000 during the year are placed into a special emergency reserve account and used to finance emergency shore protection projects.*

expected to bring higher seas and more frequent and intense storms – could bring even greater changes to the shore, in some cases wiping out beloved places, eroding beaches, inundating coastal marshes and causing significant damage to private and public property.

Climate change has already contributed to a measurable rise in sea level along New Jersey's coastline. During the 20th century, relative average sea levels along the Jersey Shore rose by 14 inches, or about .35 meters. Approximately half of that rise was due to human-induced climate change, and the other half due to land subsidence.[22,23] The National Oceanic and Atmospheric Administration's (NOAA) sea levels at Sandy Hook show a continual rise from 1932 to the present as illustrated in Figure 2.

1-Figure 2: Sandy Hook Sea Levels (1932-present)



The mean sea level trend is 3.90 millimeters/year with a 95% confidence interval of +/- 0.25 mm/yr based on monthly mean sea level data from 1932 to 2006 which is equivalent to a change of 1.28 feet in 100 years.

Source: National Oceanic and Atmoshperic Administration

Although recent changes in FEMA's flood zones have increased the amount of Monmouth County residents who are required to pay for flood insurance, FEMA's decision still does not account for the impacts of climate change. If the sea level does increase, FEMA will most likely increase the area in flood zones, requiring affected residents and businesses to participate in its flood insurance program.[24]

[22] *Land subsidence is the sudden sinking or gradual downward settling of land with little or no horizontal motion, caused by a loss of subsurface support which may result from a number of natural and human caused occurrences including subsurface mining or the pumping of oil or ground water.*

[23] Environmental New Jersey Research & Policy Center. *An Unfamiliar State Local Impacts of Global Warming in New Jersey*, May 2007

[24] "New Flood Rules, With a Price Tag" *New York Times*, September 4, 2009

ii. Impacts on Infrastructure

Sea-level rise also puts Monmouth County's vital transportation links with New York City and the world at greater threat of flooding or being disabled during severe storms. Higher seas could put significant portions of the NJ Coast Line at risk of flooding. Newark Airport, the Lincoln Tunnel and Holland Tunnel and key highway and rail links would also be increasingly vulnerable to flooding. Scientists estimate that increased flooding could triple the amount of flood damage faced by the region in an average year, with a maximum one-time loss of $250 billion possible from a direct impact by a Category 4 hurricane. This would ultimately impact Monmouth's County's attractiveness as a convenient place to live.

An example of the vulnerability of the regional transportation system to a major storm occurred in December 1992, when a severe northeaster bore down on New Jersey and New York City, causing a tidal surge of up to 12 feet.[25]

The storm impacted the region by:

- Leading to power outages for 250,000 Jersey Central Power & Light Co. customers;
- Flooding a runway at LaGuardia Airport (NY), shutting down all flights;
- Closing the Staten Island Ferry (NY);
- Shutting down PATH train service from New Jersey to New York;
- Flooding the Hoboken Train terminal, (tracks underwater); and
- Short-circuiting electric generators for the New York subway system, shutting down service for several hours and causing major delays.

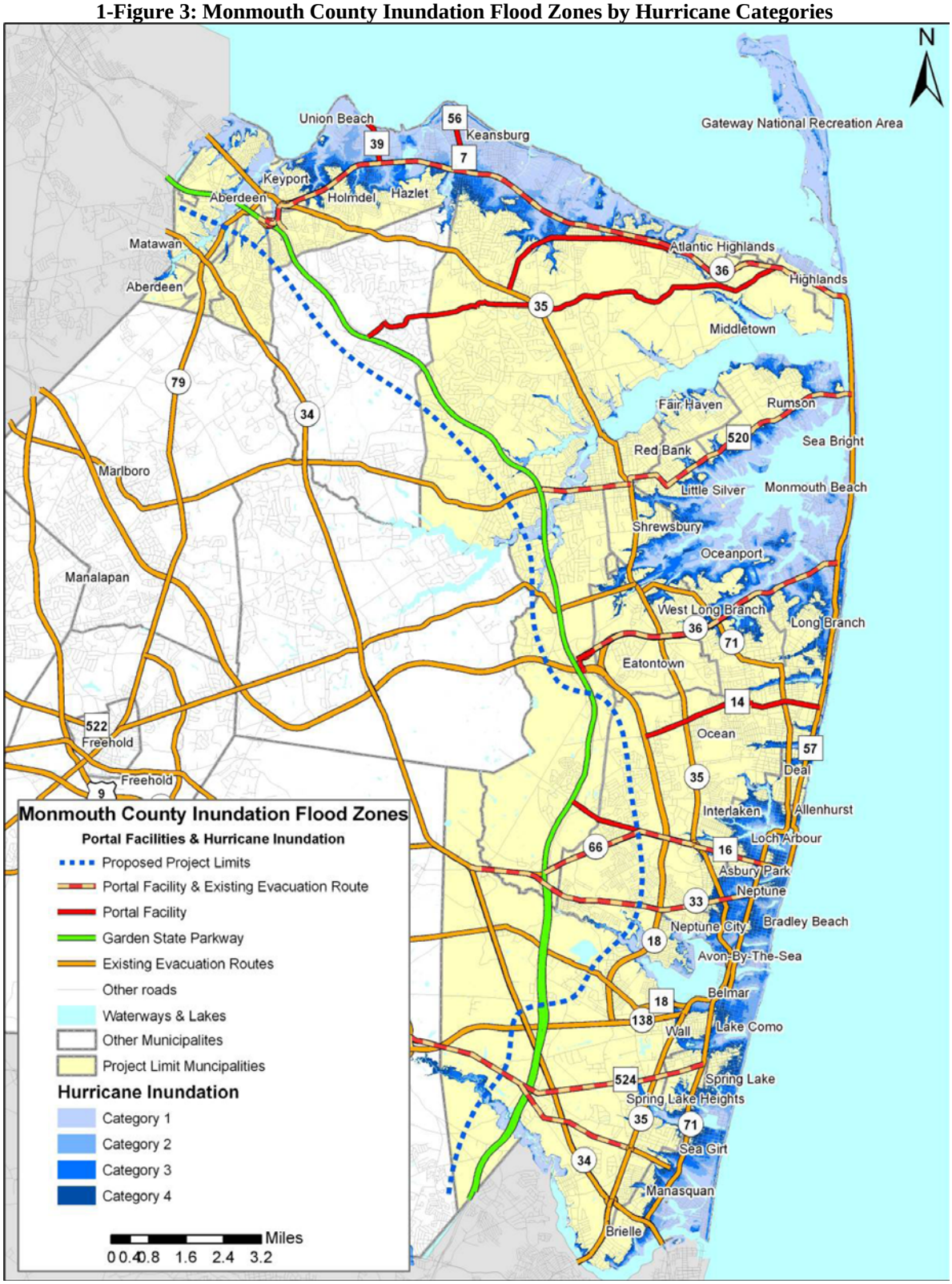
Locally the storm had the impact of:

- Shutting down New Jersey Transit's North Coast line due to flooding and debris;
- Closing the Garden State Parkway in the area of Cheesequake;
- Closing parts of Routes 35 and 36; and
- Prompting the evacuation of 15,273 people in Monmouth and Ocean Counties.

Severe weather that causes tidal surges can also impact primarily costs associated with maintaining and keeping open public roadways used for disaster evacuation. Roadways that wash out during major storm events may result in additional evacuation costs to local governments, especially if the roadway is the only means of access to the area. Examples of such roadways are Route 36, Ocean Avenue, in Monmouth Beach and Sea Bright and Route 71 in Manasquan as shown in Figure 3.

[25] "The Storm's Havoc: Commuting; Going from Point A to Point B Becomes a Mission of Chaos," *New York Times*, December 12, 1992.

1-Figure 3: Monmouth County Inundation Flood Zones by Hurricane Categories



Source: Monmouth County Coastal Evacuation Routes Study. 2009

Aside from severe storms and tidal surges, extreme temperatures can have an impact on Monmouth County's infrastructure as well. An increase in the frequency and severity of hot days raises concerns that Monmouth County's roads could experience more problems related to pavement softening and traffic-related rutting, as well as the migration of liquid asphalt (flushing and bleeding) to pavement surfaces from older or poorly constructed pavements. Asphalt rutting may become a greater problem during extended periods of summer heat on roads with heavy traffic, whereas some flushing could occur with older pavements and/or those with excess asphalt content.

On the other extreme, cold temperatures in winter are just as much of a concern for transportation as summer heat. Cracking of pavements related to low-temperature frost action and freeze-thaw cycles is a well-recognized problem. Premature deterioration of roads is related to high frequencies of freeze-thaw cycles. Volatile winters, with more freeze-thaw cycles, would accelerate road deterioration and increase maintenance costs.

Rail infrastructure is also susceptible to temperature extremes. Weather adversely affects railroad safety, efficiency, and infrastructure in many ways. Intermodal crossing points, such as grade crossings and waterway/railroad trestle intersections are vulnerable. In addition, railway tracks may buckle under extreme heat, and this has been suggested as a possible contributing factor in the July 29, 2002 Amtrak rail incident in Maryland.[26] As with roads, extreme cold conditions are currently more problematic for railways than severe heat, and result in greater frequencies of broken railway lines and frozen switches, and higher rates of wheel replacement. Railroads may also be subject to sudden weather induced mode shifts (e.g. a change in the mode of travel, in this case rail to auto), such as occurred during the East Coast blizzard of January 1996.

iii. Health Impacts

Climate change will have an impact on summertime temperatures. More frequent heat waves will increase the levels of smog pollution, especially in suburban counties, such as Monmouth. Emissions from vehicles contribute to ground-level ozone, sulfur dioxide, nitrogen dioxide and carbon monoxide and are especially harmful for senior citizens, children, and people with heart and lung conditions such as emphysema, bronchitis, and asthma. Ground-level ozone can inflame breathing passages, decrease the lungs' working capacity, cause shortness of breath, pain when inhaling deeply, wheezing, and coughing. Ground-level ozone can cause eye and nose irritation, dry out the protective membranes of the nose and throat and interfere with the body's ability to fight infection. The number of smog-related deaths,[27] a benchmark for more widespread damage to public health, could increase.

Extended heat waves will create conditions that lead to the formation of more ground level-ozone (i.e., smog). Although smog is usually associated with urban landscapes

[26] "Dozens hurt in U.S. train derailment" *Toronto Star*, July 30, 2002.

[27] *A smog related death in defined as exposure to smog related gases, even short-term, that triggers a chronic respiratory disease, such as asthma and decreased lung function.*

scientists now forecast that the increase in smog will affect New Jersey's more suburban counties.

Currently, 18 counties in the state are in non-attainment status under the federal Clean Air Act because of high levels of summer smog pollution. In the years between 2002 and 2006, smog levels in New Jersey have exceeded federal health standards on as few as 13 and as many as 45 days per year.[28] Fortunately, due to proactive efforts from agencies such as NJTPA, air pollution levels for the criteria pollutants (including ground-level ozone) in Northern New Jersey have been exhibiting a downward trend in recent years.[29]

A study performed by Columbia University found that climate change could substantially increase smog levels across New Jersey by the 2050s, especially in more suburban counties. The model predicted small decreases in smog levels in the urban core, perhaps because of increased NO_x emissions soaking up excess ozone.[30]

Increased levels of smog would harm public health in New Jersey. Smog exposure damages lung health, triggering asthma attacks and long-term structural damage to the lungs. It is especially dangerous for the young and elderly. In addition, poor air quality results in alerts that cause people to stay inside and not exercise. This ultimately makes Monmouth County a less attractive place to live, work, and play.

The habitat range and prolificacy of pervasive pests that can cause damage to health can also increase due to climate change. One pest that is present in Monmouth County is the deer tick (which carries Lyme disease). According to the Department of Health and Human Services Centers for Disease Control and Prevention, Lyme disease is "highly endemic" in Monmouth County, particularly in the northeast portion of the county such as Middletown, Holmdel and Red Bank. In the 2008 Communicable Disease Report, the county reported 521 cases of Lyme disease, one of the highest in the state.

The seasonal cycle of feeding for each stage of the tick's life is what determines the severity of infection in a given region. Researchers at Yale University[31] found that this cycle is heavily influenced by climate. The study finds that long gaps between feeding times throughout the ticks life cycle stages caused by climate change directly correlates to more cases of Lyme disease reported in the northeast.

iiii. Agricultural Fishing, and Aquaculture Impacts

Monmouth County has over 47,000 acres of farmland and ranks second in the state in the number of nurseries and nursery stock acreage, and fourth in acres harvested for both bell peppers and sweet corn. Monmouth County also has the largest number of horses and ponies in the state and is second in number of horse farms.[32]

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[28] U.S. Environmental Protection Agency, *8-Hour Ground-Level Ozone Designations: Region 2, 5* Washington D.C. March 2007

[29] NJTPA. Status of Air Quality within the NJTPA Region, February 2006.

[30] K. Knowlton "Assessing Ozone-Related Health Impacts under a Changing Climate", Environmental Health Perspectives. 112 (5):1557–1563, 2004.

[31] "The Season of Ticks: Could Climate Change Worsen Lyme Disease?" *Yale Bulletin,* April 21, 2009

[32] New Jersey Department of Agriculture

Due to climate changes, farmers may have longer growing seasons and higher carbon dioxide concentrations in the air to make their crops grow faster. However, changes in climate can also create or aggravate risks to their crops that could pose serious challenges to their livelihood in the future. Among those risks are agricultural pests (such as corn borer and corn earworm), weeds (such as kudzu), and excess heat.[33] If winters become warmer, pests will have a higher survival rate and thereby increase damage to spring planting and summer crops. Pests are already responsible for destroying about a third of the crop production in North America. Farmers may find pressure to increase pesticide applications, some of which are petroleum based, in the future to control larger pest populations.

Besides insect, rodent, and other pests, weeds will also be more pervasive with climate change. Although crops have a longer time to mature, so do the weeds that can choke off crops. In addition, other pests such as mold can destroy crops including corn and peaches. An increase in hot weather can increase the risks of these types of pests.

Along with the agricultural impacts, aqua-cultural and fishing will experience impacts. An increase in CO_2 concentration in the ocean would increase ocean acidity and result in serious environmental damage to New Jersey's aquatic life. This is especially true for mollusks, clams, and oysters harvested in New Jersey's coastal waters. The National Marine Fisheries Service states that New Jersey is one of the leading suppliers of surf clams for the country and the world. A Woods Hole Oceanographic Institution study forecasts that the mollusk harvests in the U.S. will drop 10 to 25 percent in 50 years time as a result of increasing acidity levels.[34] In addition, species that spend part of their life-cycle in coastal waters will be impacted by degradation of near-shore nursery environments, such as marshes and estuaries, because of sea-level rise, pollution and habitat destruction. Increased rainfall, and therefore stormwater flow, will alter coastal freshwater currents, affecting the transport of eggs and larvae.

According to a 2007 National Marine Fisheries Service Study, commercial fishery landings in New Jersey in 2006 exceeded 175 million pounds with an estimated value of $145 million.[35] Local ports also support a large commercial sector catering to the fishing and boating industry, including ship chandlers, boat builders, repair yards and boat sales offices. Monmouth County's small ports experience intensive recreational and commercial fishing and boating activity. All of these activities would be adversely impacted by climate change.

[33] U.S. Global Change Research Program. *Global Climate Change Impacts in the United States*. 2009
[34] Sarah R Cooleyand Scott C Doney. Environmental Research. Letters. 4 (June 2009). *Anticipating ocean acidification's economic consequences for commercial fisheries*.
[35] National Marine Fisheries Service. *Fisheries of the United States 2006*. 2007

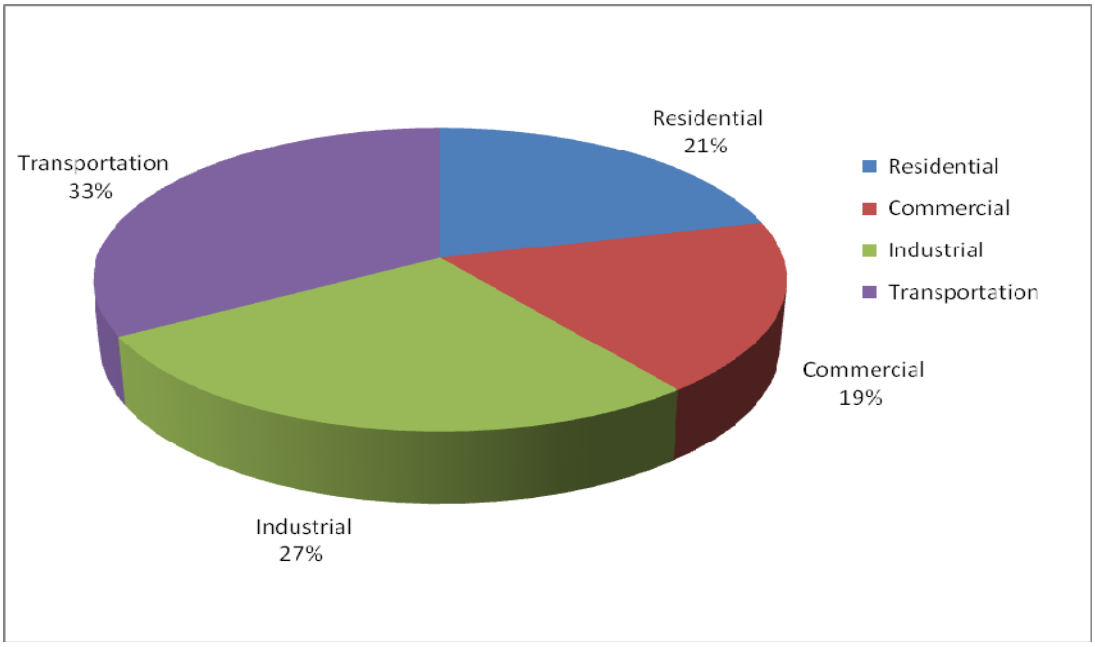
c. Role of Transportation in Climate Change

i. National Transportation Trends and GHG Emissions

In 2008, transportation activities in the U.S. accounted for 33 percent of GHG emissions. Virtually all of the energy consumed in the transportation sector comes from petroleum products. Nearly 59 percent of the emissions resulted from gasoline consumption for personal vehicle use. The remaining emissions came from other transportation activities, including the combustion of diesel fuel in heavy-duty vehicles and jet fuel in aircraft.[36]

Nationally, emissions from transportation activities are second only to emissions from the industrial (27 percent) sector (see Figure 4). Other contributions include those from residential (21 percent) and commercial (19 percent) sectors. Depending on local conditions, such as average auto use and temperature, emissions from transportation activities can account for as much as 40 percent of an area's GHG emissions. Transportation is also the fastest-growing source of GHGs in the U.S., accounting for 44 percent of the net increase in total U.S. emissions since 1990. As such, transportation is an integral component of any comprehensive emissions reduction strategy.

1-Figure 4: 2008 U.S. Greenhouse Gas Emissions by Sector



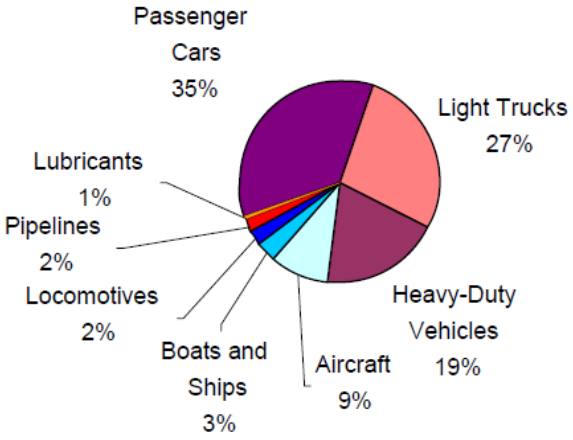
Source: US EPA Inventory of Greenhouse Gas Emissions and Sinks, US EPA 2008

Transportation sources of GHG emissions include: cars and light trucks, heavy trucks and buses, non-road recreational vehicles (such as dirt bikes and snowmobiles), farm and construction machines, lawn and garden equipment, marine engines, aircraft, and locomotives. Emissions from an individual car are generally low, relative to the smokestack image many people associate with air pollution. But in numerous cities

[36] *US EPA Inventory of Greenhouse Gas Emissions and Sinks, US EPA 2008, found at http://www.eia.gov/environment/*

across the country, the personal automobile is the single greatest polluter (Figure 5), as emissions from millions of vehicles on the road add up. Driving a private car is probably a typical citizen's most "polluting" daily activity.

1-Figure 5: 2003 Transportation Greenhouse Gas Emissions, by Source



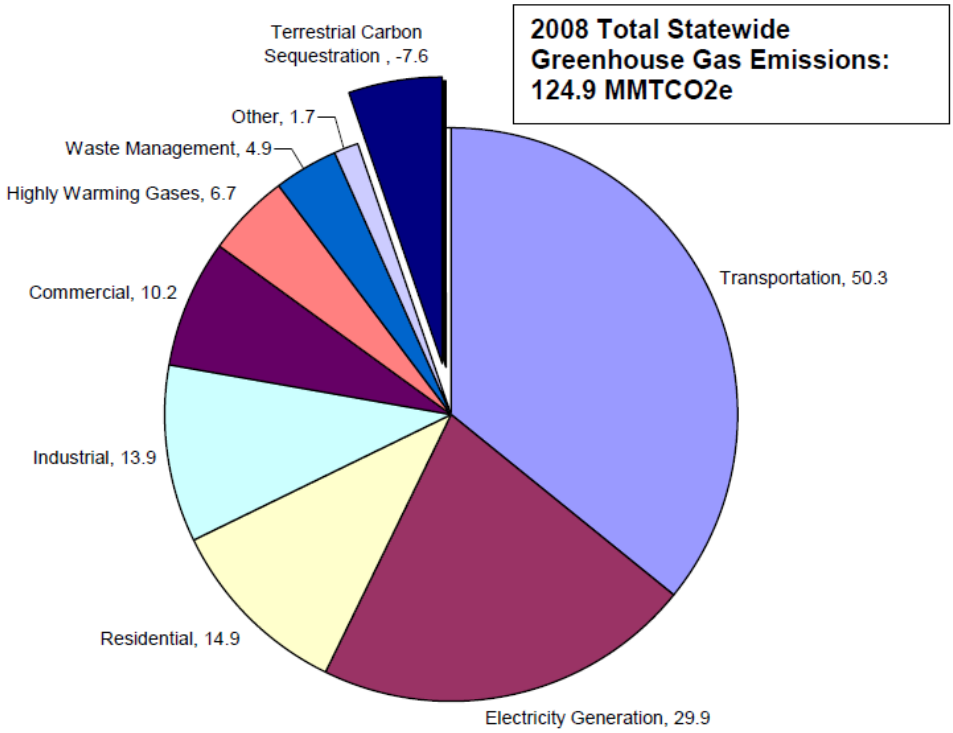
Source: U.S. Environmental Protection Agency, 2005. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2003.* Washington, DC, Table 2-9.

Nationwide GHG emissions from light-duty vehicles (passenger cars and light-duty trucks which include Sport Utility Vehicles or SUVs) grew 19 percent from 1990 to 2003. The overall rise can be broadly explained by a 34 percent increase in light-duty vehicle miles traveled (VMT) over the period, which outweighed a small improvement in fuel economy in the light-duty vehicle class. However, it is worth noting that the improvement in vehicle energy efficiency was due primarily to the replacement of less fuel-efficient vehicles from the 1970s and early-1980s. Since 1988, the average fuel economy of new light-duty vehicles sold has declined as a result of increasing percentage of light-duty truck in the vehicle class. In 2002, sales of new light-duty trucks overtook passenger cars. As one primary result, GHG emissions from light-duty trucks increased by 51 percent from 1990 to 2003, compared with a two percent increase from passenger cars.

ii. New Jersey's Transportation Trends

Estimated emissions from New Jersey's on-road gasoline vehicles, on-road diesel vehicles, aviation, marine vessels, and railroad and other transportation sources totaled approximately 50 million metric tons (MMT) of CO_2e in 2008. Combined, these six subcategories of transportation contributed approximately 40 percent of New Jersey's gross GHG emissions in 2008 (See Figure 6). As such, transportation represents the largest sector of New Jersey's GHG emissions, with on-road gasoline consumption representing the vast majority of those emissions.

1-Figure 6: GHG Emissions by Sector, New Jersey, 2008 Millions of Metric Tons CO_2e

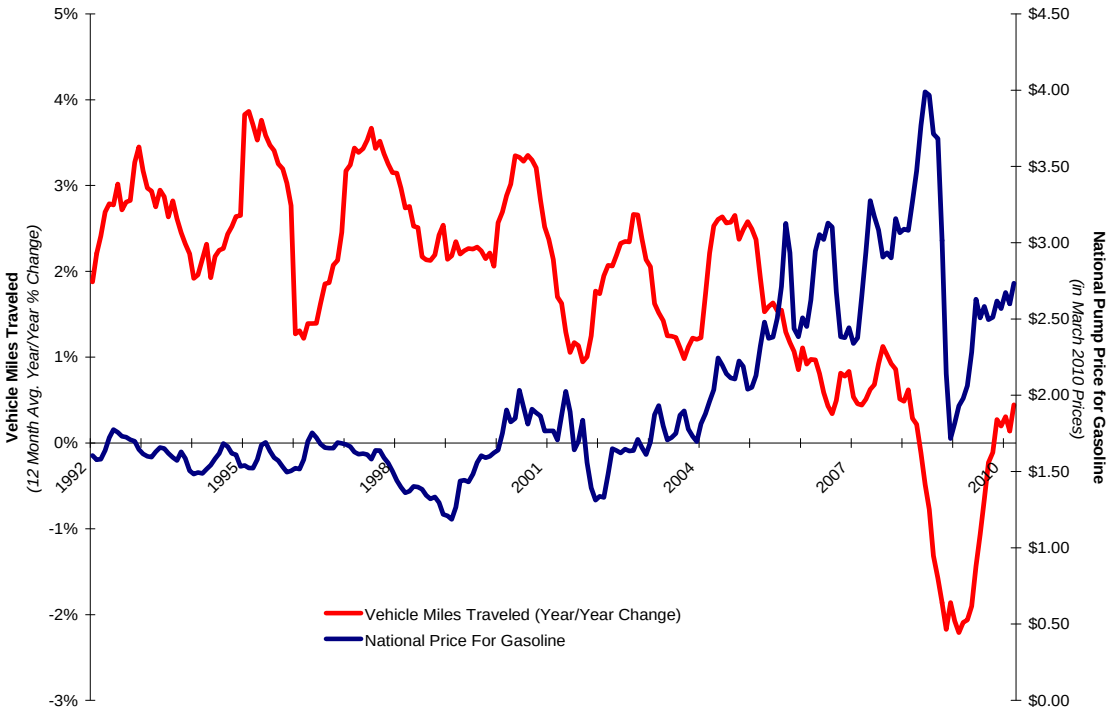


Source: Statewide Greenhouse Gas Emission Inventory for 2008, Office of Climate and Energy, May 2011

In New Jersey, like the nation, transportation is also the fastest growing sector in terms of GHG growth. This is due to both: 1) the annual increase in the number of miles driven (otherwise known as vehicle miles traveled or VMT) each year by New Jersey motorists, and 2) the fact that the fuel efficiency gains from cars over time have been negated by the increased use of light trucks (e.g., sport utility vehicles). The U.S. Bureau of Transportation Statistics data shows the percentage of registered light vehicles (sport utility vehicles) in New Jersey increased by 8% from 2000 to 2008. This trend boosts the amount of emissions for transportation due to less efficient vehicles being used. Even though total VMT in New Jersey from 2007 to 2008 declined by approximately 3 percent, it appears that this decrease occurred in part because of a 26 percent spike in gasoline prices during the same period. If historic trends hold true, VMT declines associated with spikes in gasoline prices tend to reverse themselves once gasoline prices drop.[37] Figure 7 illustrates the relationship between gasoline prices and changes in VMT nationally and shows that with incentives (in this case the price of fuel), American drivers will reduce VMT.

[37] *Meeting New Jersey's 2020 Greenhouse Gas Limit: New Jersey's Global Warming Response Act Recommendations Report, December 2009*

1-Figure 7 Gasoline Prices and Vehicle Miles Traveled



Source: Bureau of Transportation Statistics, Energy Information Agency

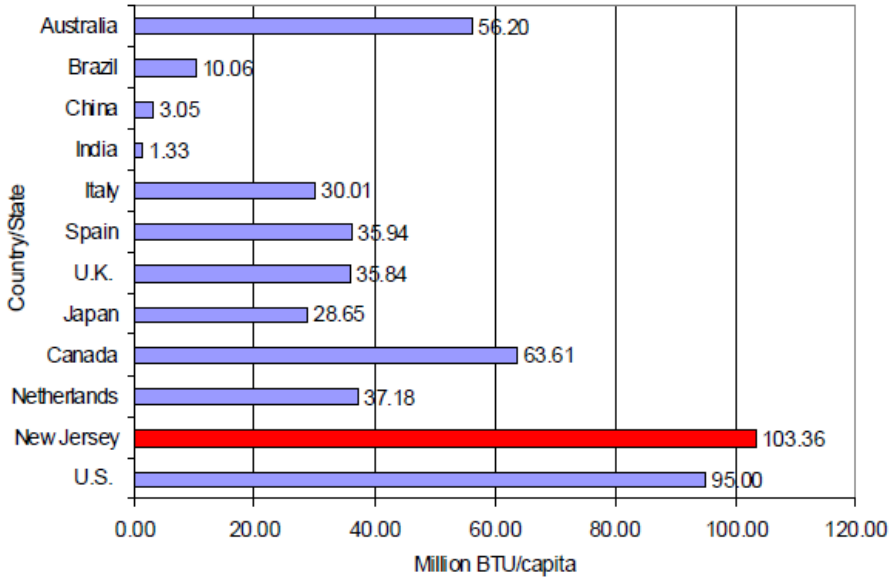
The total contribution of the transportation sector to GHG emissions is a product of several factors, including the vehicles themselves, the overall level of travel activity, the technologies used to power that activity, and the infrastructure used to support that activity. Since there is a cause and effect link between land development and VMT (e.g., people living in the suburbs and commuting greater distances to work and other activities), land use is directly and synergistically linked to the transportation sector of New Jersey's GHG inventory. As such, recommendations intending to address transportation-related emissions must focus on each of these factors:

- The promotion of more fuel efficient vehicles, more efficient driving practices, and proper vehicle maintenance;
- Reducing the number of miles traveled in automobiles by offering safe and reliable alternative transportation options, and reduce reliance on private automobiles;
- Increasing the use of lower carbon fuels (natural gas, electric, biofuels);

- Roadway infrastructure improvements to encourage bicycling and walking; and
- Land use planning to shrink the distance between destinations and thus promote bicycling, walking and public transportation.

As compared to other states in the U.S., New Jersey ranks 17th in per capita transportation petroleum usage and 20th in per capita total transportation energy usage (Figure 8). Compared to other countries, New Jersey's per capita energy use in the transportation sector is high.

1-Figure 8: Per Capita Petroleum Consumption in Transportation Sector, 2004



Source: U.S. DOE, EIA, and U.S. Census

Equally as important, in terms of climate change, is the number of vehicle miles accumulated in New Jersey per the number of individuals in each vehicle. Private automobiles remain the most commonly used mode of travel for people living in the United States, and this is true for New Jersey residents as well. According to data from the U.S. Census Bureau's 2000 Journey to Work Data, most New Jersey workers (71.8 percent) drive alone to work. While this rate is lower than that of most U.S. workers, including those workers living in Pennsylvania and Connecticut, it is higher than that of workers living in New York State. Slightly over 10 percent of New Jersey workers take public transportation to work, while 9.2 percent carpool, 3.2 percent walk to work and 3.3 percent work at home.

New Jersey operates one of the largest public transit agencies in the country (New Jersey Transit), providing regional rail service and bus service throughout the state. Other providers operating transit service in New Jersey include the Port Authority of New York and New Jersey and the Port Authority Transit Corporation of Pennsylvania. While this system is impressive, its geographic focus, which is on the central core of the state from New York to Philadelphia, can be improved and expanded. This is evident from statistics from the 2000 Census, which show that while 70.6 percent of New Jersey residents

working in Manhattan, and 24 percent of those who worked in Philadelphia took public transportation to work, only 5 percent of people who lived and worked in New Jersey used transit to get to work. In Monmouth County, 75.7 percent of workers drove alone, 9.2 percent carpooled and 8.9 percent used public transportation to get to work at the time of the 2000 Census.

These commuting statistics are complemented by recent research, conducted by New Jersey Future, which indicates that "in 1980, two out of three employed New Jersey residents (65.3 percent) drove to work alone; by 2000, it was three out of four (75.1 percent)." The New Jersey Future report indicates that the number of New Jersey residents carpooling to work decreased from 18.6 percent in 1980 to 10.9 percent in 2000.

In summary, New Jersey residents consume significant amounts of petroleum due to their reliance on cars as their preferred mode of transportation. Addressing New Jersey's reliance on carbon-intensive fuels, private automobiles, and VMT will need to be a top priority in order for the state to reach its statewide 2050 GHG goal.

d. Potential Actions to Reduce Transportation-Related GHG emissions

Given that transportation is one of the largest of all contributing sectors of anthropogenic GHG emissions, federal and state governments have created a variety of programs to assist in reducing transportation-related GHG emissions. The strategies can be grouped by the following objectives:

1. Reduce vehicle miles traveled;
2. Increase vehicle fuel efficiency; and
3. Reduce carbon content of fuels.

While there are hundreds of potential emissions reduction measures associated with the transportation sector, each one falls into one of these three main categories (Table 3).

1-Table 3: Strategies to Reduce Greenhouse Gas Emissions from Transportation

Main Categories	Examples
Reduce Vehicle Miles Traveled	Carpooling
	Reduce Distance Between Destinations
	Increased Transit Usage
	Walking/Biking
	Transportation Demand Management Strategies[38]
Increase Fuel Efficiency	"Smooth Operator" Campaigns[39]
	Alternative Fuel Vehicles
Reduce Carbon Content of Fuels	Conversion to biodiesel and ethanol
	Alternative fuel vehicles

On July 6, 2007, Governor Jon S. Corzine signed the *New Jersey Global Warming Response Act* (GWRA), which calls for reducing GHG emissions to 1990 levels by 2020, and to 80 percent below 2006 levels by 2050. The *Draft Global Warming Response Act Recommendation Report* (December 2008), provides an outline of actions to be taken towards achieving these goals, including actions in the transportation and planning sectors. Table 4 lists the New Jersey's draft recommendations for reducing transportation-related GHG.

These measures in addition to other state and local efforts can be prioritized, tracked, and monitored by directly linking them to the estimated GHG emission reductions that will be gained through the action. Utilizing emissions reductions estimates to identify and implement energy conservation measures enables a more financially and administratively efficient approach to attaining the overall statewide 2050 GHG goal.

[38] *Transportation demand management strategies include: leverage public and private funds to increase the use of ridesharing and other commuting options; improving pedestrian-oriented design elements, requiring users of parking to pay the costs directly, as opposed to sharing the costs indirectly with others; including and improving public transportation infrastructure; subsidizing transit costs for employees or residents; bicycle-friendly facilities and environments; providing active transportation (AT) facilities including bike lanes and multi-use trails; flex-time work schedules with employers to reduce congestion at peak times, congestion pricing tolls during peak hours; road space rationing by restricting travel based on license plate number, at certain times and places.*

[39] *"Smooth Operator" programs administered by Virginia, Maryland, and the District of Columbia train local government fleet managers. They promote good driving techniques that can reduce bad driving habits such as jackrabbit starts, heavy braking, etc that can increase fuel use by 5-10 percent.*

1-Table 4: 2020 New Jersey Climate-Specific Supporting Transportation Recommendations

1. Determine needs for implementing infrastructure alternatives to conventional motor vehicle fuels (i.e., gasoline and diesel) in New Jersey.
2. Implement transportation-related initiatives and demonstration projects.
3. Develop and implement a Low Carbon Fuel Standard[40] LCFS through a multi-state effort.
4. Establish a carbon footprint standard for transportation projects
5. Employ efforts for effectively implementing the State Development and Redevelopment Plan (SDRP).
6. The NJDOT and the NJDEP will work cooperatively with all three Metropolitan Planning Organizations (MPOs) to ensure that they incorporate growth management and GHG reduction goals into their plans and programs.
7. The State will work in partnership with local and regional entities to conduct an infrastructure capacity assessment of the municipalities that are served by, and feed, the Port Authority Transit Corporation (PATCO) rail and bus lines, and whose residents commute to Atlantic City, Camden and Philadelphia.
8. Explore fuel-efficient vehicle incentive programs.

Source: Meeting New Jersey's 2020 Greenhouse Gas Limit: New Jersey's Global Warming Response Act Recommendations Report, December 2009

e. Summary

The impacts of climate change on Monmouth County can have a wide variety of impacts on residents, businesses, and visitors.

The increases in risks attributable to climate change and associated sea level rise can have a dramatic impact on homeowners, businesses, and future development along the shore. Combined with the rise in sea levels, the harsher and more frequent storms, higher storm surge, and more volatile weather changes will put Monmouth County's infrastructure under strain and increase delays and costs. Increases in the ocean's CO_2 levels, which will lead to acidification, will harm Jersey's coastal wildlife and endanger its fisheries.

In addition to risks along the shore, inland areas will be impacted by changes in its biological systems. Challenges to the agricultural sector, a main component of western Monmouth County's appeal and economy, will become more daunting as climate changes affect crops and agricultural pests. Health risks to residents will also increase as smog, and diseases spread by pests become more prevalent. All of these factors impact the core of Monmouth County's appeal as a place to live, work, and play.

Without action to reduce anthropogenic GHG emissions, New Jersey and Monmouth County could face increasing economic hardship. Armed with the knowledge of the causes of climate change and mitigation strategies which will help reverse the trend,

[40] *A low-carbon fuel standard (LCFS) is a rule enacted to reduce carbon intensity in transportation fuels as compared to conventional petroleum fuels, such as gasoline and diesel. The most common low-carbon fuels are alternative fuels and cleaner fossil fuels, such as natural gas (CNG and LPG). The main purpose of a low-carbon fuel standard is to decrease carbon dioxide emissions associated to fuel-powered vehicles considering the entire life cycle.*

Monmouth County is progressively addressing its contribution to GHG emissions and climate change.

2. GHG Inventory Protocols

A variety of greenhouse gas (GHG) emissions standards, guidance, protocols, and reporting mechanisms are available for use by various types of entities and organizations, ranging from national governments and federal agencies to businesses to local governments. Examples of popular guidance and protocol documents include 1) the World Resources Institute/World Business Council on Sustainable Development GHG Protocol: Corporate Accounting and Reporting Standard, International Organization for Standards (ISO) 14064, 2) NJDEP Guidance for GHG Emissions for 2010, and 3) the ICLEI International Emissions Analysis Protocol (IEAP). Each of these protocols was reviewed for applicability to the Monmouth County operations GHG emissions inventory (see Appendix A). Based on a review of available guidance documents, ICLEI's Local Government Operations (LGO) Protocol is the only comprehensive local government-specific GHG emissions protocol in the United States. As such, the study team recommended that Monmouth County use the LGO Protocol for its inventory of county facilities.

A description of the LGO Protocol and its associated software calculation tool is provided below.

a. The ICLEI International Local Government GHG Emissions Analysis Protocol (IEAP) and Local Government Operations Protocol (LGO)

Founded in 1990, ICLEI – Local Governments for Sustainability is an association of city and county governments dedicated to improving global environmental conditions through cumulative local action. Through its campaigns, ICLEI generates political awareness of key environmental issues, provides technical assistance and training to build capacity in local governments to address these issues and evaluates their progress toward sustainable development.

ICLEI created the International Local Government GHG Emissions Analysis Protocol (IEAP) to provide an easily implemented set of guidelines to assist local governments in quantifying the greenhouse gas emissions from both their internal operations and from the whole communities with their geopolitical boundaries. By developing common conventions and a standardized approach, ICLEI seeks to make it easier for local governments to achieve tangible reductions in GHG emissions. The standardized approach described in this protocol facilitates comparisons between local governments and the aggregation and reporting of results being achieved by the action of diverse communities.

While the IEAP has been developed for use by local governments, other parties needing to compile sub-national inventories will find it useful. The protocol has been designed to provide both guidance and establish a standard for local government GHG management

programs. At this stage of the Protocol's development, it is intended that local governments will self-identify compliance with IEAP. An accreditation process and associated recognition may be established by ICLEI in the future, for those parties seeking more formal acknowledgment that their greenhouse management is compliant with the International Local Government GHG Emissions and Analysis Protocol.

Users of this protocol, for inventory compilation and reporting purposes, are requested to state that the information presented complies with the requirements of the IEAP. The term "shall" is used in the chapters containing standards to clarify what is required to prepare and report a GHG inventory in accordance with the International Local Government GHG Emissions Analysis Protocol. This is intended to improve the consistency with which the standard is applied and the resulting information that is publicly reported.

A review of available guidance documents reveals that ICLEI's Local Government Operations Protocol (LGOP) is a comprehensive local government-specific greenhouse gas emissions protocol used in the United States. The LGO Protocol is a supplement to the IEAP and was developed by ICLEI USA, The Climate Registry, the California Climate Action Registry, and the California Air Resources Board in 2008 for U.S. local governments.

The LGOP is a program-neutral GHG protocol that is designed to allow local governments in the United States to quantify and report GHG emissions resulting from their operations. It provides specific calculation methodologies and emissions factors to use in estimating emissions. The LGO Protocol is the most comprehensive and widely-used protocol in the United States for the quantification of GHG emissions from government operations.

The main body of the text of the LGOP (Parts 1 – 4) is "program-neutral," meaning it outlines the appropriate actions for conducting a GHG inventory without specifying a particular, singular approach, and contains guidance on measuring emissions from buildings, vehicle fleets, wastewater, solid waste, and other sources.

A typical emissions calculation appears as:

{activity data * emissions factor = quantity of carbon dioxide equivalent}

1. For buildings, emissions are determined based on direct fuel used (such as fuel oil and natural gas) for heating and cooling, as well as indirect emissions from electricity consumption.

2. For vehicles, the transit fleet, and employee commute, emissions are calculated based on total quantity of fuel used and/or vehicle miles traveled.

3. Wastewater treatment is not a sector all local governments have. If present, wastewater treatment emissions are estimated based on treatment technologies and quantity of water treated.

4. Solid waste emissions are based on either waste disposed of by a local government or waste deposited in a local government-owned landfill. For waste disposed of, the calculation is based on tonnage, for landfills, methods depend on methane controls present at the landfill site.

Based on a review of available guidance documents, ICLEI's Local Government Operations Protocol is the only comprehensive local government-specific greenhouse gas emissions protocol in the United States. The LGO Protocol guides participants through emissions calculation methodologies and reporting guidance applicable to all U.S. local governments. In addition, the LGO Protocol is a well accepted and established means of producing a GHG inventory of a local government that can be recognized by other governing bodies. As such, the study team recommends that Monmouth County use the LGO Protocol for its inventory of County facilities.

b. Clean Air and Climate Protection 2009 Software (CACP)

In conjunction with the LGO Protocol for the Monmouth County Government operations, the study teams recommended using the CACP 2009 Software to document and calculate the GHG emissions from county operations. CACP 2009 was developed specifically to support emissions inventories based on the principles and methods of the ICLEI LGO Protocol. It serves as a one-stop emissions management tool that calculates and tracks emissions and reductions of GHG and criteria air pollutants associated with electricity consumption, fuel use, waste disposal and other processes.

ICLEI has provided local governments in the United States with software for the quantification of GHG since the mid-1990s. CACP 2009 was developed specifically to support emissions inventories based on the principles and methods of the LGO Protocol. At present, 600 ICLEI members in the United States use CACP 2009 to develop their government operations and community inventories, set reduction targets, and develop climate action plans.

CACP 2009 provides the following:

- Create emissions inventories for the community as a whole or for the government's internal operations.
- Quantify the effect of existing and proposed emissions reduction measures.
- Predict future emissions levels.
- Set reduction targets and track progress towards meeting those goals.

As Monmouth County is already using CACP 2009 to complete the facilities portion of its operations inventory, it should also use CACP 2009 for the remainder of its operations inventory to allow Monmouth County to calculate their total GHG emissions for benchmarking and tracking purposes.

3. Monmouth County Employee Commuter GHG Emissions

This section provides an audit of Monmouth County's transportation-related GHG emissions from employee commutes. The employee commute GHG emissions were estimated based on a commuter survey that provided information on commute mode, distance traveled to work, vehicle type, etc.

A menu of potential policies that could be implemented to reduce transportation-related GHG emissions from employee commutes is provided. From this larger list of policy options, specific recommended policies that would be the most feasible to implement in the near-term are identified. Monmouth County does not control the means by which its employees get to work, but can influence a greater number of employees to select non-single occupancy vehicle (SOV) options through various incentive and education programs. By reviewing, recommending, and initiating changes within its own organization, Monmouth County can directly reduce its own transportation borne GHG emissions and provide example for the municipalities within the county by "leading by example".

a. Commuter Survey Results and Recommendations

To better understand existing Monmouth County employee commuting patterns and their willingness to use alternative modes of transportation to commute to work, the study team analyzed a commuter survey compiled by the Monmouth County Planning Board.

A link to a web-based commuter survey was distributed by email to all Monmouth County employees in August 2010. The primary purpose of the commuter survey was to gather information necessary to estimate the greenhouse gas emissions associated with Monmouth County employee commuting. In addition, the survey included questions designed to gauge the potential for alternatives to driving alone to meet the commuting needs of Monmouth County employees in various locations. A full list of questions and more information on the survey methodology is presented in Appendix C.

i. Survey Results

A total of 1,337 people completed at least a portion of the commuter survey, representing an overall response rate of 38 percent of Monmouth County's approximately 3,500 employees. Of these responses, 1,285 provided sufficient information (e.g. distance traveled to work) to be useable for the purpose of estimating employee greenhouse gas emissions. Some respondents did not report a distance traveled to work, but reported their home and work locations.

With two exceptions, all survey respondents reported that their home was located in New Jersey. One employee lived in New York (Queens County) and one employee did not provide home location information. Table 1 summarizes the home county of the survey respondents. Approximately 82 percent of respondents lived in Monmouth County.

Ocean and Middlesex Counties were the home location of 14 and two percent of respondents, respectively.

3-Table 1: Employee Home Counties

County	Count	Percent
Monmouth	1,093	81.8%
Ocean	183	13.7%
Middlesex	30	2.2%
Mercer	9	0.7%
Union	6	0.4%
Burlington	5	0.4%
Hudson	3	0.2%
Morris	2	0.1%
Essex	1	0.1%
Gloucester	1	0.1%
Queens (New York)	1	0.1%
Somerset	1	0.1%
Warren	1	0.1%
No Response	1	0.1%
Total	**1,337**	**100.0%**

Table 2 summarizes the home municipality of the survey respondents. Freehold (including the borough and township) was the home location for more than 14 percent of respondents. A total of 120 different home municipalities were reported, illustrating the large geographic spread of Monmouth County's employees.

3-Table 2: Employee Home Municipalities

Municipality	Count	Percent
Freehold	193	14.4%
Howell	137	10.2%
Neptune	82	6.1%
Middletown	57	4.3%
Jackson	56	4.2%
Wall	52	3.9%
Manalapan	46	3.4%
Brick	41	3.1%
Tinton Falls	31	2.3%
Ocean	30	2.2%
Long Branch	28	2.1%
Marlboro	21	1.6%
Toms River	21	1.6%
Hazlet	19	1.4%
Lakewood	19	1.4%
Matawan	19	1.4%
Union Beach	19	1.4%
Other	451	33.7%
No Response	15	1.1%
Total	**1,337**	**100.0%**

Table 3 summarizes the top Departments/Offices of the survey respondents. The highest number of respondents reported they worked for the Monmouth County Park System, Department of Human Services, and the Prosecutor's Office.

3-Table 3: Monmouth County Employee Work Departments/Offices

Department/Office	Count	Percent
Parks	154	11.5%
Prosecutor's Office	149	11.1%
Human Services	125	9.3%
Highway	58	4.3%
Library	52	3.9%
Sheriff's Office	50	3.7%
Geraldine L. Thompson Care Center	48	3.6%
County Clerk	37	2.8%
Health	32	2.4%
Information Technology	30	2.2%
Buildings & Grounds	26	1.9%
Engineering	22	1.6%
Public Works	18	1.3%
Shade Tree Commission	15	1.1%
Community Development	14	1.0%
Purchasing	14	1.0%
Other[41]	285	21.3%
No Response	208	15.6%
Total	**1,337**	**100.0%**

Table 4 summarizes the top work locations of the survey respondents. Downtown Freehold and the Kozloski Road complex in Freehold Township were the two largest work locations, with 21 percent and 17 percent of respondents commuting to these locations, respectively.

Table 5 summarizes the one-way daily commute distance of the survey respondents. Approximately 84 percent of respondents lived within 20 miles of their work location, with 21 percent living within five miles. Forty-eight respondents (3.6 percent) indicated that live within one mile of their work place. Only 17 respondents (1.3 percent) indicated that they lived over 40 miles from their work location. The average (mean) one-way commute distance (for those that responded to this question) was 13.2 miles.

As shown in Table 6, the Sport Utility Vehicle (SUV) / Pickup and Mid-size auto were the most common vehicle types used by Monmouth County employees. Seventeen respondents (1.3 percent) indicated that they do not drive to work. The overwhelming majority of employee vehicles have conventional gasoline engines (97.5 percent). Diesel and hybrid engines represent 1.6 and 0.9 percent of employee vehicles, respectively.

[41] The Planning Board is included in the other category

3-Table 4: Employee Work Locations

Location	Count	Percent
Downtown Freehold	284	21.2%
Kozloski Road complex	223	16.7%
Prosecutor's Office (Jerseyville Avenue, Freehold)[42]	108	8.1%
Park System Headquarters	91	6.8%
300 Halls Mill Road	81	6.1%
250 Center Street	76	5.7%
County Library HQ	54	4.0%
Geraldine L. Thompson Center	52	3.9%
Board of Health	30	2.2%
Dutch Lane Road	22	1.6%
Correctional Institute	19	1.4%
Fire Academy	16	1.2%
Ocean Township Office 2405 Route 66	15	1.1%
Other	209	15.6%
No Response	57	4.3%
Total	**1,337**	**100.0%**

3-Table 5: Employee Commute Distance

Miles from Work	Count	Percent
0-5	280	20.9%
6-10	263	19.7%
11-15	317	23.7%
16-20	263	19.7%
21-25	86	6.4%
26-30	30	2.2%
31-35	18	1.3%
36-40	11	0.8%
41-45	9	0.7%
46-50	5	0.4%
51-75	2	0.1%
76-100	1	0.1%
No Response	52	3.9%
Total	**1,337**	**100.0%**

[42] Includes members of the Prosecutor's Inspection Unit.

3-Table 6: Employee Commute Vehicle Type

Vehicle Type	Count	Percent
SUV / Pickup /Minivans[43]	493	36.9%
Mid-size auto	414	31.0%
Compact	205	15.3%
Full-size auto	130	9.7%
Heavy Truck	5	0.4%
Motorcycle	1	0.1%
I don't drive	17	1.3%
No Response	72	5.4%
Total	**1,337**	**100.0%**

Table 7 summarizes weekly employee mileage on personal vehicles used for work, excluding the miles traveled for the commute to work. The high rate of no response to this survey question (30.8 percent) likely indicates that some respondents who do not use their personal vehicle for work skipped this question rather than entering zero miles traveled. Therefore, it can be concluded that approximately 70 percent of respondents do not use their personal vehicles for work. Of those respondents who do use their vehicle for work, most do not travel more than 20 miles per week. A small number of respondents use their personal vehicles extensively for work. The mean number of miles traveled per week was 52.1 (excluding those who did not use their personal vehicle for work from the calculation).

3-Table7: Employee Use of Personal Vehicle for Work (excluding Commute)

Miles Traveled Per Week for Work	Count	Percent
0	535	40.0%
1-10	130	9.7%
11-20	83	6.2%
21-30	43	3.2%
31-50	46	3.4%
51-75	18	1.3%
76-100	24	1.8%
101-200	28	2.1%
201-300	8	0.6%
301-400	5	0.4%
401-500	5	0.4%
No Response	412	30.8%
Total	**1,337**	**100.0%**

Table 8 summarizes the response to the survey question on commute mode. Over 90 percent of respondents typically drive alone to work. Carpooling was the most prevalent

[43] SUVs, Light Trucks, and Minivans all use a light truck chassis and are therefore grouped together.

alternative to driving alone and was practiced by 36 respondents. Ten respondents indicated that they walked or bicycled to work while only two respondents used public transit as their primary commute mode. Note that the survey question asked how respondents "most often" travel to work. Therefore, employees that occasionally use transit, bike or walk are not accounted for in the results presented in Table 8.

3-Table 8: Employee Commute Mode

Primary Commute Mode	Count	Percent
Drive alone	1,229	91.9%
Carpool with one other person	36	2.7%
Walk	8	0.6%
Dropped Off	5	0.4%
Bicycle	2	0.1%
Carpool with two or more other people	2	0.1%
County Transport Car	2	0.1%
Public transit (bus, train, etc)	2	0.1%
No Response	51	3.8%
Total	**1,337**	**100.0%**

As shown in Table 9, the most often cited reason for the choosing their current commute mode was the lack of another viable option. Convenience and the need for a car at work were also important factors in deciding commute mode. Relative to these reasons, cost was not an important factor to most respondents.

3-Table 9: Reasons for Choosing Current Commute Mode

Reason	Number of Responses Citing Reason
No Other Viable Option	794
Cost	69
Need/Want Car Available at Work	414
Convenience	358
Other Reasons (open ended)	75 Total • Vehicle Needed for After Work Activities (e.g. shopping, picking up children etc.) - 12 • Commute Using Assigned County-Vehicle/ On-Call 24-7 for Emergency Response - 21 • Work Schedule - 6

Table 10 summarizes the response to the survey question on policies that could encourage the use of alternative transportation for commuting. The policy receiving the most responses was carpool incentives such as gas cards and preferred parking (328

respondents). Over 200 respondents indicated that emergency ride home options, improved transit service and better information on commute options could influence them to use alternative transportation instead of driving alone. Other policies to encourage alternative transportation suggested by respondents included a four-day work week, showers at work and allowance for telecommuting. One respondent suggested that employees be assigned to the office location closest to their home. Approximately 100 respondents indicated that they were not interested in alternative transportation, regardless of the commuter benefits offered.

3-Table 10: Policies that Could Encourage the Use of Alternative Transportation for Commuting

Policy	Number of Responses Citing Policy
Vanpool/carpool incentives such as gas cards, preferred parking	328
Ability to pay for transit tickets with pre-tax money	50
Emergency Ride home option	211
Improved transit options	233
Improved walking and bicycling routes / conditions	104
Better information about my commute options	204
Discounted Transit Tickets	84
Other (open ended)	220 Total • Four-day Work Week or flexible time- 19 • Ability to Work from Home- 8 • No Policies Would Change Decision to Drive Alone- 103 • Not Applicable or vehicle required for work - 28

ii. Summary of Employee Commute Greenhouse Gas Emissions

ICLEI's Clean Air Climate Protection (CACP) software was used to calculate the GHG emissions associated with employee commutes and use of personal vehicles for work. Since the commuter survey did not gather information on vehicle model year, emissions were calculated using the alternative methodology which assumes a default vehicle age distribution. Annual vehicle miles were entered by vehicle type and the CACP default fuel efficiency coefficients were used to determine fuel consumption and greenhouse gas emissions.

Employee commute annual vehicle miles traveled were calculated using the survey data and assuming employees commute to work five days per week. It was also assumed that employees do not commute on 10 holidays, 10 vacation days and 10 sick days per year. Therefore, a total of 230 working days were assumed (5 days per week multiplied by 52 weeks per year, less 30 days for holidays, vacation and sick time). The analysis also assumes that the employee does not use their personal vehicle for business travel.

Based on the survey results, slightly less than three percent of employees carpool to their place of employment with one other person. Since the number of respondents (two) carpooling with two or more other people was so low, a carpool vehicle occupancy of two was assumed.

Due to the low number of respondents that reported using transit as their primary commute mode (two), transit commute emissions were not calculated (treated as walking/bicycling commutes).

Table 11 summarizes the percentages of vehicles by fuel type and vehicle type that were used to compute the vehicle miles travelled inputs into CACP. The same vehicle fleet characteristics were assumed for the single occupancy and car pool populations. Also, the same mean one-way trip distance (13.2 miles) was assumed for single-occupancy vehicles and carpool vehicles, and across all fuel type and vehicle type combinations.

3-Table 11: Survey Respondents Vehicles by Fuel Type and Vehicle Type

Fuel Type	**Vehicle Type**			
	Heavy-Duty	**Light Trucks**	**Passenger Cars**	**Total**
Gasoline (98.4 percent of all vehicles)*	4	478	746	**1,228**
	0.3%	38.9%	60.7%	**100.0%**
Diesel (1.6 percent of all vehicles)	1	15	3	**19**
	5.3%	78.9%	15.8%	**100.0%**

* Includes hybrid vehicles

The use of employee's personal vehicles for work outside of commuting were not included in the GHG emissions estimate due to the high rate of no response to the applicable survey question on this issue. In addition, it is believed that some respondents may have incorrectly included their commute distance in responding to the survey question on non-commute use of personal vehicles for work, artificially increasing the average distance traveled.

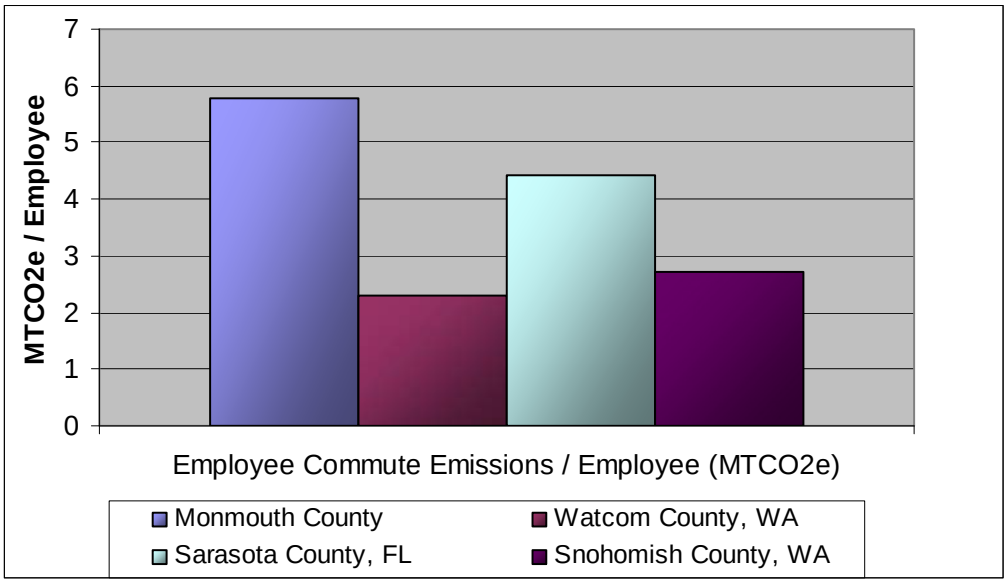
Table 12 provides the results of the employee commute greenhouse gas inventory generated by CACP based on the annual vehicle miles traveled estimates. Employee commute CO_2e emissions in Monmouth County total 12,363 tons per year. To put this number in perspective, total direct emissions from on-road mobile sources in Monmouth County in 2009 were forecast to be 2.624 million metric tons according to NJTPA's regional inventory. The employee commute emissions from Monmouth County government operations are about 0.5 percent of the on-road mobile source emissions in Monmouth County.

3-Table 12: Employee Commute Greenhouse Gas Inventory

	CO_2 (tons)	N_2O(lbs)	CH_4 (lbs)	Equivalent CO_2 (tons)
Gasoline	11,891	1,578	1,329	12,149
Diesel	213	1	1	213
Total	12,104	1,579	1,330	12,363

Monmouth County has higher employee commute GHG emissions per employee than other comparable counties[44] with a similar workforce size. As shown in Figure 1, Monmouth County's per-employee emissions are nearly twice of some of the other counties in the comparison. This is likely due to the spread-out pattern of development in Monmouth County.

3-Figure 1 County Employee GHG Emissions Per Employee



Source: ICLEI

[44] Comparable counties were chosen using counties with similar demographics and county employee counts.

b. Recommended Policies for Reducing Employee Commute Emissions

This section describes the recommended employee commute GHG emissions reduction policies that appear the most feasible to implement in the near-term. The recommended policies include programs for vanpools, carpools, emergency ride home services, preferred parking, financial incentives to encourage the use of transit, and options for increasing the walking/biking commute mode share. Additional policies for reducing employee commute emissions that were considered in developing the list of recommended polices, but were not considered practicable at this time, are described in Appendix D.

The ICLEI Climate and Air Pollution Planning Assistance – CAPPA V1.5® model was used to estimate the reduction in greenhouse gases for a number of the recommendations identified below. For each recommendation, a range of employees who may enroll in specific programs is presented to demonstrate the effect each program could have on reducing GHG emissions as well as other pollutants. The emissions reduction estimates were prepared based on the number of possible staff who may elect to enroll in the program as determined by employee preferences identified in the August 2010 survey or simply as a share of total employees.

i. Employer Trip Reduction Plans (ETR)

A strategic starting point for employee SOV reductions is an Employer Trip Reduction Plan. The 1990 Clean Air Act Amendments (CAAA) provided the legal basis to place the burden to change commuting behavior on employers. The U.S. EPA has mandated that non-attainment areas reduce vehicular emissions through Employee Commute Options/Employer Trip Reduction (ECO/ETR) programs. A number of states resisted such requirements, at which time the EPA removed the mandate but requested that employers make "a good faith effort" to meet higher vehicle occupancy targets. As a result, the state of New Jersey modified its program and proceeded with more flexible objectives and goals specific to the region.[45]

As an area of non-attainment, in addition to the abovementioned options, the following recommendations are set forth to Monmouth County for inclusion in an ETR plan for submission to the state. The plan should be designed to demonstrate how Monmouth County is attempting to reduce their employee contribution to SOV use during peak-commuting periods. The following identifies policies which may help reduce SOV trips and decrease congestion during peak-hour commuting times. Those elements identified below should be reviewed and discussed among county officials to determine the best way to implement the programs. They should be considered now as well as in the future should the county elect to make changes to the ETR program. It is understood that not all of the recommendations being proposed will be used by the county, but they are presented in the following sections for future consideration.

[45] http://www.entrepreneur.com/tradejournals/article/116186587_1.html

ii. Ridesharing Programs

Ridesharing is defined as one or more people using one or a combination of the following transportation modes to get to their place of employment: carpool, vanpool, bus, train, and/or shuttle. The employment of such practices can cut commuting costs in half and also reduce harmful GHG emissions. Additionally, ridesharing can reduce the burden some employees may feel or experience from their commute, build stronger relationships between and among employees, reduce individual travel costs, and serve as an added perk for existing or potential employees.

Currently in Monmouth County, few county employees share a ride to their place of employment. However, many workers live in a small handful of municipalities making ridesharing a realistic goal. The identification and implementation of ridesharing programs based on an employee's place of residence and willingness to participate in such programs as identified in the August 2010 employee survey is not only feasible but also has the potential to be a great success. Programs can be implemented incrementally based on the success of the program. Specific components may need modification or elimination based on employee satisfaction and feedback.

Meadowlink Commuter Services, a public-private partnership, is an agency designed specifically to help companies and agencies identify state and federal financial programs and incentives, customize solutions, and administrate selected programs to improve and enhance commuting options for employees. The following recommendations are either programs offered through the use of Meadowlink Commuter Services or other initiatives designed to increase ridesharing and reduce SOV trips to work. It is anticipated that some or all of these initiatives would be implemented under the ridesharing program to maximize the potential to reduce SOV trips.

The following sections describe ridesharing programs and ancillary programs meant to enhance the benefits and mitigate problems with ridesharing programs. Discussions with Meadowlink concerning Monmouth County employee ridesharing programs brought up key considerations for a ridesharing program's success. Some of the factors discussed included financial incentives for ridesharing participants and additional financial incentives for the driver/coordinator. Meadowlink identified the "value of time savings" as being a major hurtle, since many commuters who live within 20 miles of their offices would not see a benefit to a ridesharing program unless the total cost of their commute was drastically reduced.

iii. Vanpool Sponsorship Program

Vanpools are generally a more formal arrangement of transport and for a larger number of people than carpooling. The cost savings for people traveling more than 20 miles one-way from home to work can be offset by the time involved for multiple pick-ups and drop-offs. The vanpool driver, who is often a co-worker, generally rides for free since they have assumed the responsibility of the safety and timeliness of the group. There are three types of vanpools:

- Third Party Vanpools – Vehicles are owned and operated by a vendor, who covers maintenance, insurance and administration of the vanpool. The vendor is paid a monthly fee by users to cover the vanpool's lease and operating costs.

- Employer-sponsored Vanpools – This is the most cost effective means by which to arrange vanpooling options. The county could purchase or lease the vans and arrange for maintenance, insurance and administration. Low fares may also promote participation in program. This alternative would result in an increase in the number of vehicles in the county fleet and would have a cost impact to the county. This could only be implemented if such a program and policy were to be approved.

- Owner-operated vanpools – These vanpools are owner-operated by one or more members of the vanpool. The owner arranges for maintenance, insurance, and billing and is reimbursed by the passengers.

There are numerous benefits that can be realized with the implementation of vanpooling and supporting policies. The use of vanpools reduces individual fuel costs, GHG emissions, and other commuting fees such as tolls. Secondly, vanpool passengers can enjoy a more leisurely ride to work rather than dealing with the stress of driving. Vanpooling can also build stronger relationships among co-workers and therefore increase office morale. The assurance that the van will pick participants up at a specific time each day helps reduce absenteeism and late arrival.

The NJ TRANSIT Vanpool Sponsorship Program offers financial incentives for vanpooling in areas where public transportation is not available or feasible. NJ TRANSIT will provide $175 per month to newly forming or existing vanpool groups who meet eligibility requirements. Such programs are arranged with local vanpool providers and local Transportation Management Associations (TMAs). The TMA for Monmouth County is Meadowlink. The New Jersey Department of Transportation (NJDOT) website allows potential participants to calculate cost savings should they commute by van rather than SOV.

The study team recommends that vanpooling options be fully considered in the implementation of ridesharing options. Approximately 24.5 percent of Monmouth County employees indicated that they would participate in ridesharing options if vanpooling incentives, along with preferred parking, were implemented.

Additionally, the study team recommends designing protocols and policies to be followed by participants. This would include notifying the driver if a ride on a specific day(s) is not needed. Monmouth County officials should work with NJ TRANSIT, Meadowlink TMA and supervisory staff, and/or a task force comprised of agency staff, to identify pricing and other appropriate protocols. County officials should review ridership on a quarterly basis to identify successes and challenges of the program. This periodic review will help identify adjustments to the program should they be necessary. The county could establish goals for participation and offer additional incentives to participants. The implementation of such policies could greatly reduce SOV trips to county offices.

iv. Carpooling Programs

Rideshare matching assistance can be provided or sponsored by Monmouth County and the Meadowlink TMA. The county could provide a list of names and municipalities in which people live who are interesting in carpooling with co-workers. The sharing of this information could allow employees to form their own carpools. Another option would be for county officials to designate groups. It may be more appropriate to allow workers to form their own carpools, and the county could offer assistance in finding additional people should there still be space in the vehicle. Meadowlink has an on-line service for matching potential riders (see ezride.org). Lastly, NJDOT has a toll-free ridesharing hotline to help organize carpools for people with compatible schedules. Incentives such as preferred parking, the Emergency Ride Home (ERH) program, and flex hours to form carpools may encourage participation in such a program. Carpooling becomes increasingly attractive to people who commute 10 or more miles each way. It is recommended that Monmouth County work with Meadowlink to implement such a program.

Table 13 illustrates the total number of county employees for which carpooling and vanpooling options are offered. The reduction in GHG emissions is based on rates provided by the Victoria Transport Policy Institute (VTPI). Based on a 5 percent to 15 percent participation rate of Monmouth County employees, VMT would be reduced 240,275 to 720,825 annually. This is based on an average 13.2 mile one-way commute as identified through results of the August 2010 employee survey. Approximately 12,196 to 36,590 of gasoline would be saved for an estimated cost of between $38,880 and $190,650 annually.[46]

3-Table 13: Employees Offered Ridesharing Options and Emissions Reductions

Car- and Van-pooling	CO_2e (metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM_{10} (lbs)
175	44	14	1	3158	331	7
350	88[47]	28	2	6316	663	14
525	132	42	3	9474	993	20

Source: Climate and Air Pollution Planning Assistant – CAPPA V1.5, ICLEI, Local Governments for Sustainability.

v. Emergency Ride Home (ERH) Programs

In the event of illness, a family emergency, or late work hours, Meadowlink provides an emergency ride home. The program is a free incentive benefit for those employees

[46] An average gas price for the Central Atlantic region – which includes New Jersey – was used to determine annual gasoline savings. The average was calculated using the 2008 rate of $3.271 per gallon of gasoline. Estimated 13.2 miles average one-way commute was used based on findings from the August 2010 Monmouth County employee survey. An average fuel economy per vehicle of 19.7 miles per gallon was applied.

[47] 88 CO_2eq is equivalent to the annual greenhouse gas emissions from 15.7 passenger vehicles

enrolled in Meadowlink's car and van pool service, or those using public transportation. Should someone require such services, a taxi or sedan ride home will be provided if the reason for the requested ride is appropriate. The implementation of such a program would be beneficial to all county employees; however, it may be the most attractive to workers with young children, elderly parents, or a sick relative since without the program they may not feel comfortable exploring other transportation options. Approximately 16.5 percent or 211 county employees said the implementation of such a program would be influential in their consideration to participate in ridesharing programs.

County officials can also design their own ERH program should the county not elect to solicit assistance from Meadowlink. Similar to those services provided by Meadowlink, an approved list, which includes the reasons for needing such services, should be shared with all employees. The program can be financed in a number of different ways. First, Monmouth County could contract with a local taxi or rental car company that would bill the county on a monthly basis for services rendered. Other ways this program can be financed include the provision of fare money from petty cash, employee reimbursement, or even a co-worker driving someone home in the event of an emergency. A form should be disturbed that employees can complete after the ERH has been taken. This will help ensure that people are using the service appropriately.

The implementation of this program requires administrative support from employers and, depending on the frequency of use, is generally cost effective. A maximum dollar amount can be established prior to program implementation to help control costs.

In order to ensure the success of this program, the county should allocate funds for this program during each fiscal year. Depending on which program the county selects (Meadowlink or a county-imitated program), funding will either be included with other services or will need to be set aside to finance this program. During the budget planning process, expenses for this program from the previous year should be reviewed. These expenses, coupled with any change in the number of those participating in the ridesharing program, should be considered when funding is allocated, if not included with another program.

Prior to the onset of this initiative, Monmouth County should review internal protocols to accommodate this program. Additionally, a detailed plan for the county department or administrative staff who would be handling this program should be in place prior to the program initiation. It may be appropriate to supply training for county staff involved in administering the program. This will help ensure that those responsible for the program's success are knowledgeable of the initiative and informed on how best to deal with specific situations.

A list of county staff to be contacted in the event of an emergency should be distributed to all county employees. A pamphlet should also be prepared and distributed to county employees identifying those emergencies for which a ride would be provided. This would help workers determine if ridesharing options would be appropriate for them if being able to get a ride in the event of an emergency is a determining factor.

vi. Customized Parking Management

Customized parking management includes programs that provide preferred parking to employees who travel to their place of work by carpool or vanpool. Incentives included as part of this may include parking spaces closer to the building entrance. Reserved parking spaces that are set reserved for car/vanpoolers may encourage employees to join a car/vanpool. Approximately 24.5 percent or 328 Monmouth County employees indicated that carpool and vanpool incentives – such as preferred parking – would likely influence their decision on commuting patterns.

Another option for parking management is to provide "preferred" parking for certain types of vehicles. The preferred parking spaces would be closer to the entrances of the offices or in places that have a more preferable section of a parking lot. The parking spaces would be reserved for employees using hybrid or small fuel efficient vehicles. This would give an incentive to employees to purchase and commute with smaller more fuel efficient vehicles in order to have a more convenient parking spot. The implementation of this strategy could result in some dissatisfaction among current employees who may have spaces close to their work locations as a result of length of employment with the county. The county would need to do a county-wide public information campaign about the reasons for any changes.

The implementation of customized parking management strategies is relatively easy and cost effective. An ample number of parking spaces should be allocated to ensure that all employees who wish to participate and benefit from the program would be able to do so. It would be necessary for county officials to review the success of the program after one year to determine if changes are necessary. Any information prepared and distributed to employees should fully identify program components. Benefits that employees may enjoy from being part of a ridesharing program should be fully advertized in order for the initiative to reach its maximum effectiveness.

vii. Financial Incentives

There are numerous financial incentive programs that can be implemented by Monmouth County that would benefit both employees and the county overall. Such programs are generally designed to encourage transit use and ridesharing. The study team recommends exploring the feasibility of implementing programs listed below for Monmouth County employees to reduce SOV trips. These incentives would need to be offered in tandem with other ridesharing and parking options. Union contracts may have to be considered before instituting any of these programs. The August 2010 employee survey found that 6.3 percent of county employees indicated that discounted transit tickets would influence their decision regarding their commute. The study team also recommends that county officials, or a consultant, design an informational pamphlet on transit options in and around the area, since 15.3 percent of county employees indicated that better information on commuting options may influence their decision to use transit rather than another

mode of transportation. Financial incentives and environmental benefits of non-SOV trips should be included in this information.

- NJ TRANSIT BusinessPass[48] – Enrollment in this program allows participants to save up to $1,000 per year using the NJ TRANSIT pass that offers Internal Revenue Service (IRS) approved pre-tax savings of up to $230 per month on commuting costs.[49] Such a program is offered through employers and allows participants to save on monthly bus, rail, and light rail passes by deducting a portion of the cost from pre-tax salaries. Monthly passes are discounted up to 30 percent as compared with single rides. One-way passes can also be purchased in bulk for those employees who may use transit occasionally, but not daily. The more employees enrolled in the program, the more an employer saves.

- TransitChek – This is an IRS-approved program that under federal law allows employees to set aside up to $460 per month/$5,520 per year of an employee's salary before taxes (pretax) to pay for their commute. Coverage includes $230 per month/$2,760 per year for transit and eligible vanpooling expenses and $230 per month/$2,760 per year for parking. Employers also benefit from the reduction in taxable payroll. This program, which is the largest in the United States, is available for people in New Jersey, New York, and Connecticut. The program is generally set up to be taken directly out of a participants paycheck and delivered monthly either to their place of employment or residence. The TransitChek website provides an interactive tool for potential participants to calculate both their cost savings and reduction in greenhouse gas emissions should they travel by transit rather than SOV. Unlike the NJ TRANSIT Pass, the TransitChek can be used by any participating mass transit provider.

- Meadowlink's AdVANtage Program – This program pays the cost of empty seats in newly formed vanpools for the first three months. This program allows new Van Pools to "ramp up" as new riders learn about the program. Meadowlink also helps obtain funding from the New Jersey Transit Vanpool Sponsorship Program.

- Fare Subsidies – The county could explore the possibility of offering fare subsidies to employees who participate in ridesharing options. Such subsidies would increase the discount enjoyed by county employees who elect to participate in ridesharing and/or preferred parking programs. The cost to the county to implement such subsidies would be greater, yet it may be necessary to help achieve county objectives of reducing SOV trips and GHG emissions. However, it is not anticipated that such a cost would be significant if subsidies range from $5-$15 per month per employee.

[48] http://www.NJ TRANSIT.com/tm/tm_servlet.srv?hdnPageAction=BusPassTo

[49] This program works much like a flexible spending plan. The program will appear that way to employees but this benefit is different on the payroll side. Pre-tax transit is under IRS code, Section 132(f), Qualified Transportation Fringe. It is not part of Section 125.

The VTPI estimates that financial incentives increase enrollment in ridesharing and transit by 10-30 percent.

viii. Mass Transit

The study team has reviewed the locations of major Monmouth County work places and found that several were within 250 feet of a NJ TRANSIT bus stop. Two NJ TRANSIT bus lines – numbers 833 and 836 – run through downtown Freehold. Due to the low usage of mass transit by Monmouth County employees, the possible reasons may be lack of knowledge about the systems, the routes proximity to ones point of origin (residence), limited service and the additional time typically required to use transit compared to SOV travel. Slightly more than 200 county employees indicated that they would like more information about commuting options available to them. Another 233 indicated that they would like to see improved transit options.

One potential solution is the use of "Smart Transit" systems which are becoming more common as commuters and transit systems have increased access to technology and portable devices. These systems leverage smart phone and GPS technology that has become cost effective over the past decade. For example, NJ TRANSIT already has a free e-mail alert service that tells riders about delays, route changes, and other changes that may affect their commute. Riders receive text alerts via phone texting and e-mail (received via smart phone) so they can adjust their commuting schedule even when they are not in the office or in front of a computer.

More advanced systems merge asset based GPS devices installed on buses with smart phones and other applications to give riders the most up to date position of their bus. For riders without smart phones, transit systems have installed "Smart Bus Stops" which tell riders when the next bus will be at the stop. Such improvements will greatly enhance the attractiveness of NJ TRANSIT services by reducing the amount of time a rider would need to wait for a bus and remove any uncertainty about the bus's arrival time.

Although these improvements would dramatically enhance service for all riders, the impact on Monmouth County employees is unknown since the exact origin point (i.e., residence or other location) is needed in order to gauge the potential for using the bus system. Although the study team has reviewed the disembarking point, office location and boarding point cannot be determined accurately.

ix. Conclusions of Motorized Commuting Options

Nearly 84 percent of employees surveyed live within 20 miles of their office. For this reason, ridesharing programs the county would need to be promoted and direct financial incentives would need to be provided in order for the ridesharing programs to be successful.

Aside from providing some of the support programs such as preferred parking, financial incentives, and emergency rides home, the county can promote the use of ridesharing by actively seeking out willing drivers and potential passengers. This can be done by looking

for clusters of employee residences along a route, solicit those employees, and advertise the routes to potential drivers. In addition, the county can use social media and other forms of communication to facilitate employee participation in these programs.

c. Overview of Non-motorized Commuting Options

The following section provides an overview of ways for making non-motorized transportation options more attractive to county employees. The implementation of some of these recommendations would require coordinating with other state agencies such as NJDOT and NJ TRANSIT.

i. Commuting by Bicycle

Commuting by bicycle has increased as roadways have been improved to support both vehicular and non-vehicular movements. Linear paths have been completed to support connectivity between locations, gas prices have increased, and environmental concerns among the general public have lead some to explore alternative modes of transportation for both work and non-work related trips. Bicycle trips are particularly appropriate to reduce the number of vehicular trips under five miles: approximately 20.9 percent of Monmouth County employees live within this distance from their place of employment.

The implementation of bicycle parking facilities combined with other amenities such as showers, clothing lockers, and bicycle racks on NJ TRANSIT buses and vehicles used for vanpooling for those traveling from further distances may increase bicycle use among Monmouth County employees. Currently very few Monmouth County employees travel to work by bicycle, yet 7.7 percent indicated that they would bicycle (or walk) should roadway conditions be improved. It is understood that Monmouth County is not solely responsible for roadway improvements. However, it is recommended that county officials work with NJDOT to determine if bicycle lanes or other enhancements could be implemented at the time roadways are repaired. Some improvements can be relatively low cost, yet can considerably change ones perception of user safety on the roadway and therefore increase usage. The implementation of such improvements would be in accordance with the 2009 NJDOT Complete Streets policy, which is designed to ensure that both planners and engineers design, construct, and maintain state- or federally-funded roadways to provide safe access for pedestrians, bicyclists, and transit users of all ages and abilities. Monmouth County has also adopted a Complete Streets Policy requiring all users to be considered at the time of roadway improvements or new construction.

The installation of bicycle parking is a relatively easy way to increase bicycle commuting to work. Often times employees may not feel comfortable leaving their bicycle unlocked or unattended for an extended period of time. Additionally, the installation of showers and lockers may also increase bicycle use among county employees. Lockers for personal storage are a relatively cheap and easy way to increase ridership. Showers – while more costly to install and possibly challenging in terms of space – would also

likely increase bicycle trips. In addition, classes on how to bike in traffic should also be sponsored by the county for its employees. The NJ Bike and Walk Coalition provides a "Traffic Skills 101" bicycling class that teaches riders the proper way to navigate traffic and avoid accidents.

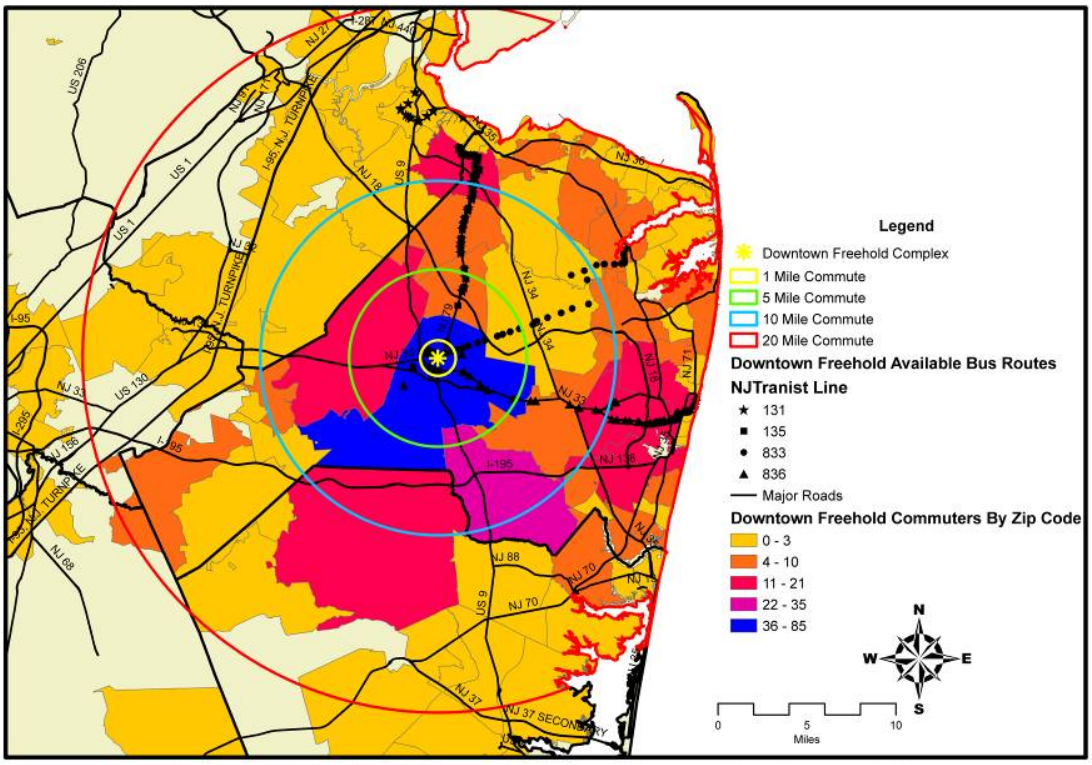
Lastly, some workers who live further away may be more inclined to bicycle part of the way to work should lockers and showers be available. Some may be interested in riding to a location where a vanpool could pick them up or to a convenient NJ TRANSIT stop. Bicycle racks could be placed on vans used for vanpooling. County officials could also work with NJ TRANSIT to determine the feasibility of installing more bike racks on buses with routes through Monmouth County. There would be county costs associated with the installation of additional bike racks. It is recommended that Monmouth County officials explore the abovementioned options in terms of budget and feasibility. It may be appropriate to discuss with county employees who have expressed interest in bicycling to work exactly what improvements would need to be made and/or amenities would encourage them to ride to work.

Bicycles are permitted at all times on buses with bike racks on the front or with underfloor luggage compartments on a first-come, first-served basis. Currently half of the NJ TRANSIT bus fleet is "bike friendly."[50] The study team has reviewed the potential for bus ridership and found several of the major employment centers for the county had NJ TRANSIT bus stops within 250 feet of their property. Figures 2a and 2c illustrate the potential for three of the county's major employment centers: Downtown Freehold, the Kozloski Road Complexes, and the Parks Headquarters.

[50] http://www.NJ TRANSIT.com/rg/rg_servlet.srv?hdnPageAction=BikeProgramTo

3-Figure 2a

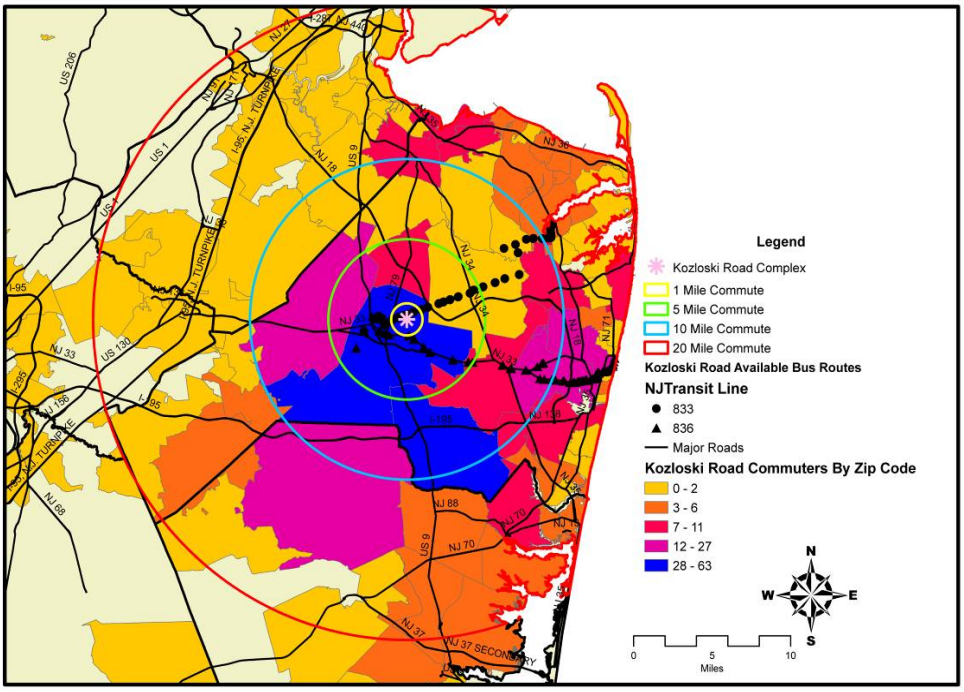
Downtown Freehold Employees Surveyed



Potential Bike with Bus Ridership

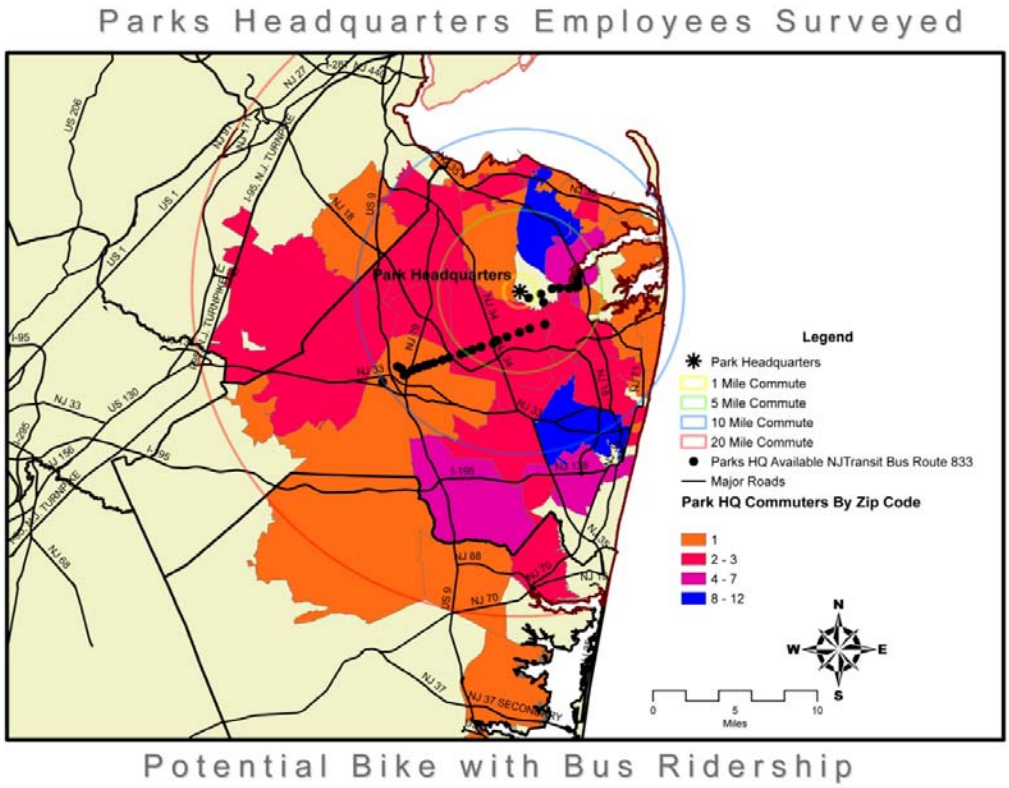
3-Figure 2b

Kozloski Road Employees Surveyed



Potential Bike with Bus Ridership

3-Figure 2c



Source: Monmouth County Commuter Survey 2010, NJ TRANSIT

Table 14 presents a summary of the environmental benefits that would be experienced should bicycle commuting increase. The number of employees presented in the table is based on the number of people who indicated that they would be interested in riding to work if roadway improvements and other amenities were available. Vehicular mileage would be reduced by 23,000 to 115,000 miles annual if between 20 and 100 Monmouth County employees bicycle to their place of employment. This would save between 1,168 and 5,838 gallons of gasoline annually.

3-Table 14: Monmouth County Employees Bicycling to Work and Greenhouse Gas Reduction[51]

Employees Bicycling	CO_2e(metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM_{10} (lbs)
20	11	3	0	789	82	2
60	33	10	1	2,368	248	5
100	55	17	1	3,946	414	8

Source: Climate and Air Pollution Planning Assistant – CAPPA V1.5, ICLEI, Local Governments for Sustainability.

Table 15 illustrates the environmental benefits that would be experienced should a small percentage of Monmouth County employees elect to both bicycle and use transit to get to

[51] An average gas price for the Central Atlantic region – which includes New Jersey – was used to determine annual gasoline savings. The average was calculated using the 2008 rate of $3.271 and the 2008 rate of $2.365. The average bike trip was calculated at 5 miles.

their place of employment. The study team understands that the combination of these alternative transportation modes would not likely be highly popular among county employees, but this information is presented for informational and reference purposes. The reduction in vehicle miles traveled would range from 68,080 to 340,400, and users would save between 3,456 and 17,279 gallons of gasoline annually.

3-Table 15: Monmouth County Employees Bicycling and Using Transit to Work Associated Reductions

Employees Bicycling and Using Transit	CO_2e (metric tons)	NOx (lbs)[52]	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM_{10} (lbs)
20	21	-25	-168	2,324	244	-6
60	62	-75	-503	6,972	731	-17
100	104	-125	-839	11,621	1,218	-28

Source: Climate and Air Pollution Planning Assistant – CAPPA V1.5, ICLEI, Local Governments for Sustainability.

ii. Pedestrian Commuting

Similar to bicycling, but to a lesser scale because of time and proximity, walking to work has increased as roadways have been improved to support both vehicular and non-vehicular movements, linear paths have been completed to support connectivity between locations, gas prices have increased, and environmental concerns among the general public have lead some to explore alternative modes of transportation for both work and non-work related trips.

Currently, less than one percent (or eight) of the Monmouth County employees that responded to the survey walk to work as their primary commute mode. However, an additional 104 employees indicated that they would consider walking (or bicycling) to work should routes and conditions be improved. According to survey results, approximately 150 employees commute three miles or less to work one way.[53] It is recommended that the county work with NJDOT to achieve objectives outlined in the 2009 Complete Streets policy on state roads, and work to implement the Monmouth County Complete Streets Policy on county roads. This would include improvements such as dedicated bike/pedestrian paths, sidewalk improvements and safe street crossings. If such improvements are made, those who live closer to their place of employment may walk from home and those living further away could walk to and/or from transit stops. The county should also promote its Henry Hudson Trail that could potentially bring both bikers and pedestrians from as far north as Aberdeen to Route 537 in Freehold, just ½ mile from Downtown Freehold and 1.5 miles to the Kozloski Road Districts. To reduce trip length, and therefore times, the county should create a pathway extending to Harrison Road to the parking lot of the Kozloski Complexes. The county should promote walking groups for its employees either during lunch hour or after work. This helps link the workplace with positive exercise habits and may foster employees to walk to work.

[52] The negative (or increase) impact on GHG reductions is caused by the use of a fossil fuel burning transit vehicle.
[53] Not scaled to total employee population.

Table 16 illustrates the environmental benefits that would be associated with an increase in the number of Monmouth County employees walking to work. The weekly trips assume an increase of between 20 and 60 people walking to work five times a week. Trips are estimated to be approximately one mile each way. The reduction in annual vehicle miles travels would range from 10,400 to 31,200 and gasoline savings would amount to between 528 and 1,584 gallons, totaling between approximately $1,488 and $4,463 in cost savings.

3-Table 16: Reduced Trips to Work and Associated Reductions

Weekly Trips Switching from Car to Walking	CO_2e (metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM_{10} (lbs)
200	5	2	0	357	37	1
400	10	3	0	714	75	2
600	15	5	0	1,071	112	2

Source: Climate and Air Pollution Planning Assistant – CAPPA V1.5, ICLEI, Local Governments for Sustainability.

In addition to the reduction in GHG emissions, the county should promote the health benefits of daily walking and biking as it pertains to weight loss, heart disease prevention, and other related illnesses caused by a lack of exercise. In addition, worker productivity can actually increase due to a small amount of exercise. University of Bristol researchers found that employees who enjoyed a workout before going to work – or exercised during lunch breaks – were better equipped to handle daily challenges. It also found that people's general mood improved on days that they exercised.

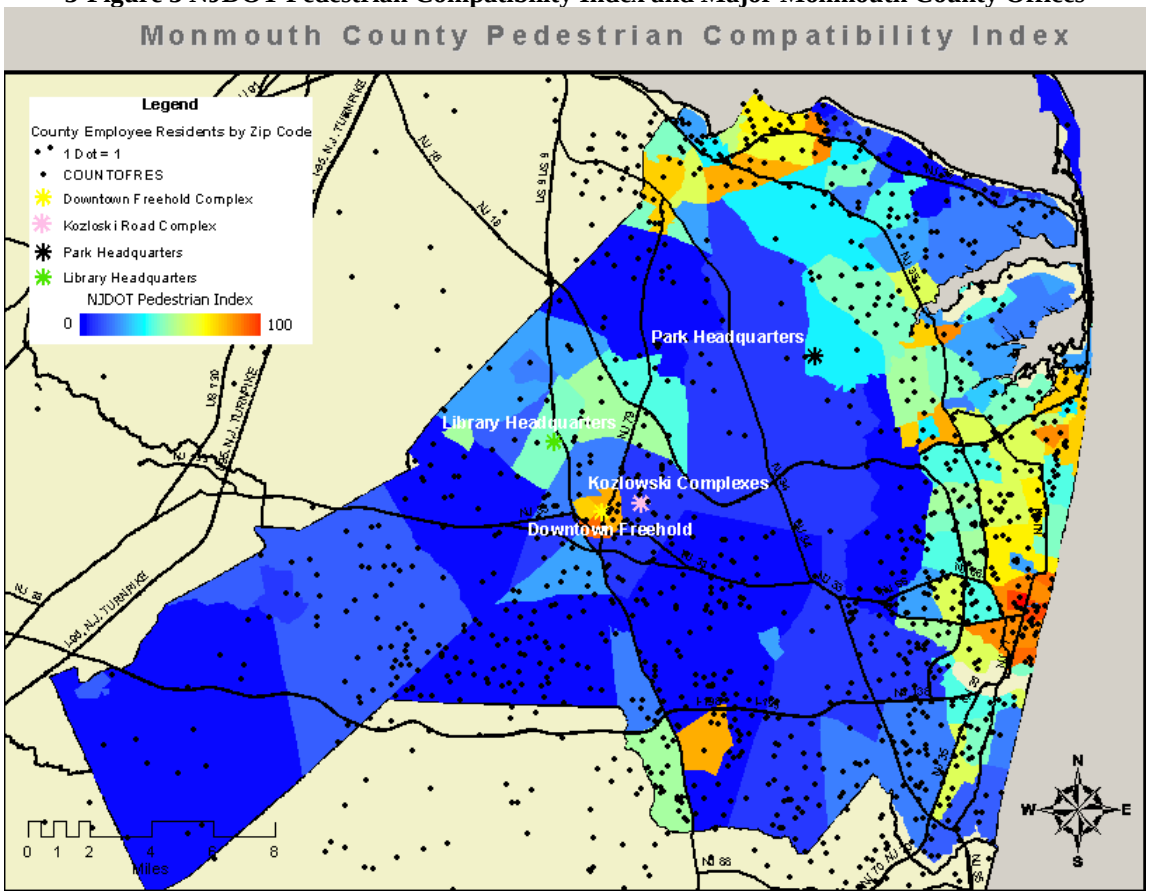
The key findings of the research include:

- Seventy two percent reported improvements in time management on exercise days compared to non-exercise days.
- Seventy nine percent said mental and interpersonal performance was better on days they exercised.
- Seventy four percent said they managed their workload better.

The county should actively look for ways to bring greenways, trails, and other non-motorized pathways to their offices.

Although walking and biking are the most ideal way to reduce GHG emissions, the challenges facing employees wanting to walk to work can be daunting. Many of the major Monmouth County Offices are in areas with high pedestrian compatibility, but they are also surrounded by large sections of incompatible area. Figure 3 illustrates the major Monmouth County office locations, surveyed employee residences by zip code, and their relationship to pedestrian friendly areas as defined by the NJDOT.

3-Figure 3 NJDOT Pedestrian Compatibility Index and Major Monmouth County Offices



Source: NJDOT, Louis Berger Group

d. Commuter Reduction Strategy Conclusions

Any strategy undertaken by Monmouth County to reduce employee SOV trips should be viewed as an investment in the environment, the workforce, and the county's leadership in reducing GHG emissions. Similar to other investments, the most efficient and rewarding option or combination of options should be selected. Table 17 provides a summary of benefits, costs, and negative aspects associated with implementing a variety of different programs designed to reduce SOV trips.

A key component for successfully presenting SOV and GHG reduction strategies to municipalities in Monmouth County is the ability of the county to lead by example. Although the data on the various strategies only captures the potential of the county, it is anticipated that additional capture can occur if the county is successful in aiding municipalities in implementing their own commuter GHG reduction policies.

Another aspect of GHG employee reduction planning is tracking the county's successes and failures in reducing SOV trips. After the ETR is implemented, a portion of the effort should be devoted to measuring the plan's success and to identify, correct, or eliminate plans that do not meet expectations or employee approval. Knowing what works, and

what does not can lead to more understanding of what can ultimately work for municipalities as well as the county in the long run.

The study team recommends the preparation and distribution of a pamphlet that discusses the added benefits of some of the recommended strategies, including cost savings, reduction in travel time and GHG emissions, and potential weight loss and health benefits, among others. It may be that many employees are unaware of the added benefits of such options and/or are timid to indicate that they would like the opportunity to see if this is an arrangement that would work for them. In addition to a pamphlet, social networking sites and support groups should be promoted to assist employees in engaging their peers and learn from each other on alternative commute options. These sites can include the best walking routes to work, carpooling groups, updates of mass transit information, maps of local pedestrian and bike amenities, and a forum for discussing alternative commuting issues.

Monmouth County should prioritize the improvement of bicycling facilities to increase the number of employees who bike to work. The reason focusing on bicycle facilities is that it captures a larger pool of potential employees and can also serve as pedestrian-related facilities.

The county should also provide additional financial incentives to employees for using mass transit. Although the county can provide a variety of plans to incentivize employees, the most common such as Transit Checks and other pre-tax plans may be a good start. The county can then gauge participation in these programs and improve or expand them if needed.

3-Table 17: Summary of Program Benefits

Measure	Potential CO_2 Savings (metric tons)	Potential Cost Impact	Implementing Agency	Pros	Cons
Bicycle Facility Improvements (with and without transit connections)	11-104	Can be relatively low cost. Some enhancements can be made in tandem with roadway improvements.	Monmouth County, NJ TRANSIT, and/or NJDOT	• Can be done in tandem with other improvements. • Health benefits. • Enhancements to bicycle facilities would improve employee physical safety.	• Need to coordinate with other agencies. • Some components may not be feasible to implement given physical space limitations in office buildings.
Increased Walking	5-15	Can be relatively low cost. Some enhancements can be made in	Monmouth County and NJDOT	• Can be done in tandem with other improvements.	• Need to coordinate with other agencies.

		tandem with roadway improvements.		• Health benefits. • Enhancements to sidewalks would improve employee physical safety.	
Financial Incentives	N/A	Employees receive pre-tax transit options. Some cost but lower than it would be if not provided by the employer. Some cost to the county may be associated with implementing financial incentives to get employees to participate in these programs.	Monmouth County	• The more people enrolled in programs, the more money the county saves. • Relatively easy to implement.	• May be challenging to get employees to enroll.

4. Monmouth County Vehicle Fleet Emissions (2009)

This section provides an audit of the Monmouth County fleet operations and recommendations for reducing GHG emissions from fleet operations. The GHG emissions from Monmouth County's vehicle fleet were estimated based on fuel consumption data from fleet management databases maintained by the Public Works and Parks Departments. This section also provides an overview of existing initiatives the county has undertaken to reduce their fleet's GHG emissions. The baseline audit of 2009 transportation-related emissions is important as a benchmark against which the success of future GHG reduction initiatives can be measured.

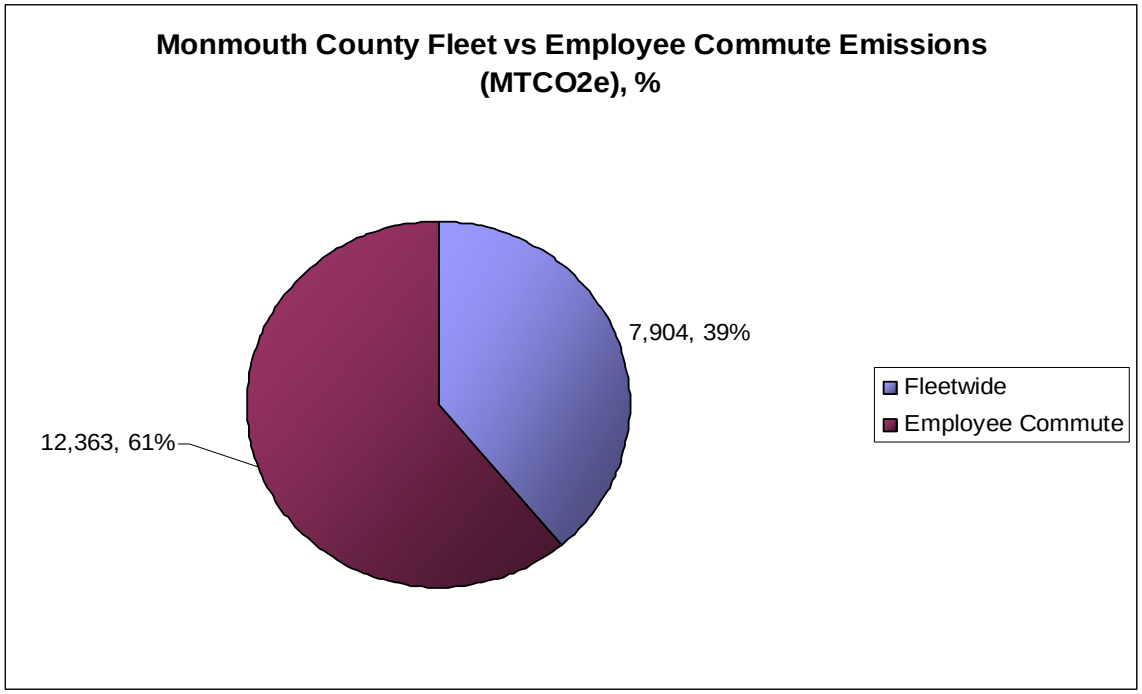
a. Fleet GHG Emissions

This section summarizes the results of the inventory of Monmouth County's vehicle and equipment fleet emissions. The methods and conversions used to calculate the emissions are presented in Appendix A. The fleet information, such as vehicle types, models, fuel

consumption and other data was provided by the Monmouth County Public Work and Parks Departments.

For the calendar year January-December 2009, Monmouth County fleet and vehicle related emissions totaled 7,904 metric tons of CO_2e. The employee commute emissions discussed in Section 3 totaled 12,363 tons of CO_2e. Figure 1 illustrates the comparison between emissions from county operations and employee commute.

4-Figure 1 Total Monmouth County Government Emissions by Source Per Year



In order to gain a sense of the relative size of emissions in each category, Table 1 displays information on the number of other familiar sources that would produce an equivalent amount of greenhouse gas emissions.

4-Table 1 Emissions Equivalency Factors Per Year

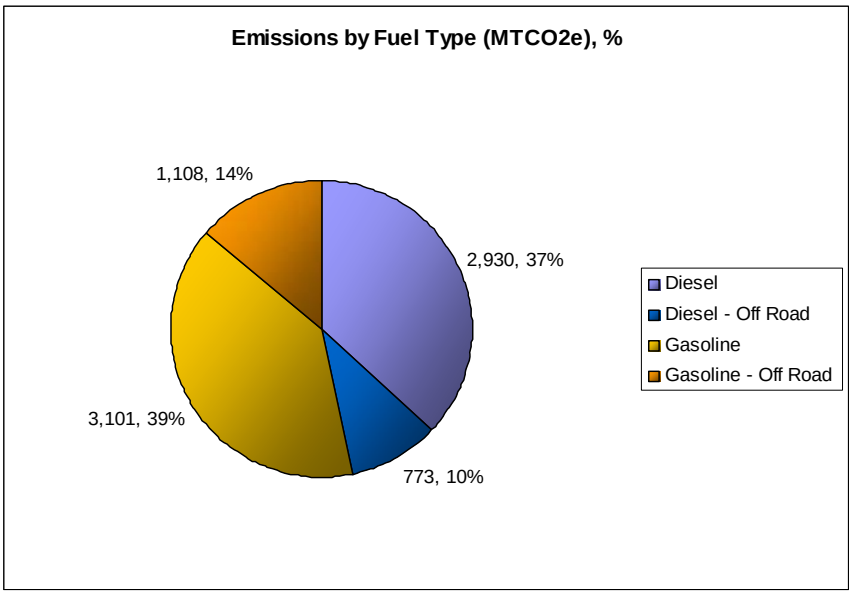
		Equivalent to[54]			
	Total Emissions ($MTCO_2e$)	**Railcars of Coal**	**Number of Average US Households Annual Energy Use**	**Number of Coal Fired Power Plants Annual Emissions**	**Tons of Landfilled Waste**
County Fleet	7,904	37.4	610	0.002	2,414
Employee Commute	12,363	64.6	1,052	0.003	4,163

[54] USEPA. Greenhouse Gas Equivalencies Calculator. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results . Accessed 1/11/11.

i. Emissions by Fuel Type

There are four different source fuel types used by Monmouth County for various operations accounted for in this inventory. Both on-road and off-road uses of gasoline and diesel fuel are accounted for. On-road uses include typical fuel consumption for passenger cars and other vehicles used on public roadways. Off-road uses include heavy equipment, such as tractors that consume fuel, but do not record mileage data, as well as small equipment, like gas-powered grounds keeping equipment (e.g. mowers). Figure 2 illustrates the contribution of each of these fuel types to the county fleet emissions.

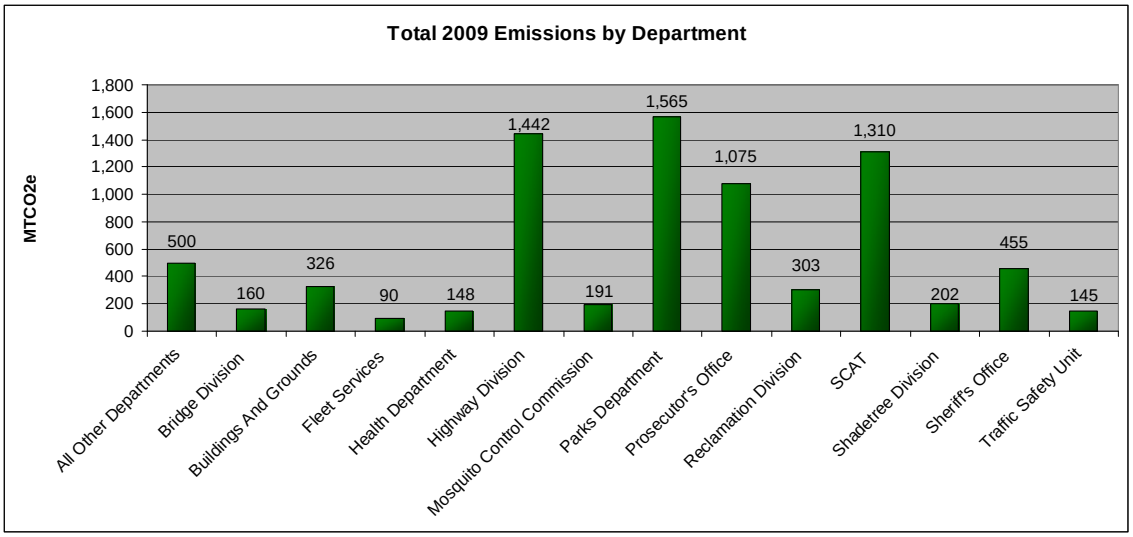
4-Figure 2



ii. Emissions by Department

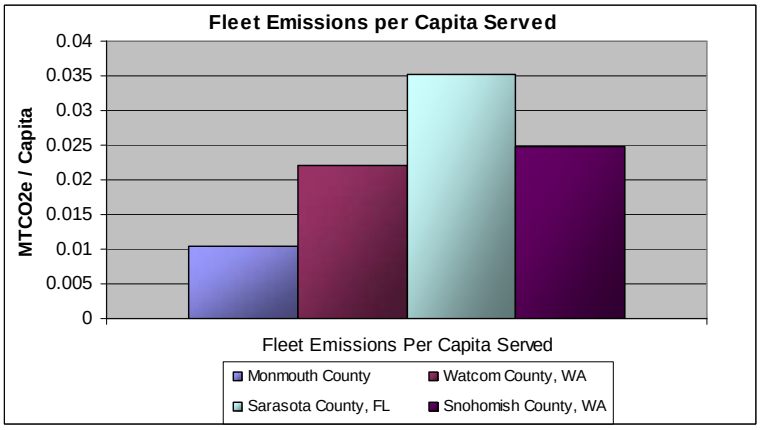
When organized by department, as shown in Figure 3, some expected trends are evident. The Parks Department produced the highest amount of emissions – 1,565 tons of CO_2e. Following the Parks Department are the Highway Department, Special Citizens Area Transportation (SCAT), and Prosecutor's Office; each of which require significant travel to perform their duties. The category called "all other departments" in Figure 4 includes departments with low numbers of vehicles and small emissions contributions. This category includes the Library, Fire Marshall's Office, John L. Montgomery Home, Social Services Department, Extension Services, Geraldine Thompson Medical Home, Information Services, and others.

4-Figure 3 Total 2009 Emissions by Department



Although the emissions calculations for the fleet show areas where there is room for improvement, the impacts of initiatives enacted prior to this inventory have already shown significant results. On a comparative basis, Monmouth County's fleet emissions are low relative to its peers, as illustrated in Figure 4.

4-Figure 4 Monmouth County Fleet Emissions per Capita Served[55]



Source: ICLEI

b. Existing Fleet Programs and Fleet Strategies for GHG Reduction

Monmouth County Public Works and Engineering Department (MCPW&E) has made great strides in becoming more fuel efficient and environmentally responsible. The MCPW&E has instituted a variety of efficiency initiatives, including the following:

- tracking vehicle and equipment fleet and fuel consumption;
- using vehicles more efficiently or not at all;

[55] Comparable counties were chosen using counties with similar demographics and county employee counts.

- using more efficient, lower polluting alternative fuels and engines; and
- reducing idling.

Most of the MCPW&E initiatives have been implemented prior to the 2009 baseline emissions inventory and therefore are reflected in the overall emissions for the county's operations in this study. The true amount of GHG reductions generated by these initiatives cannot be analyzed in this study, but should be recognized when the county evaluates its fleet in comparison to other county fleets.

In addition to the strategies that directly impact their fleet's emissions, the county also plays a role in reducing municipal emissions by partnering with municipalities and offering services such as street cleaning and fuel facilities. In some cases municipal and privately contracted service vehicles are older and generally less efficient than county vehicles.

Another important aspect of the county's progressive fleet management is the ability of the county to lead by example. By becoming the leader in fleet GHG emissions reduction the county has the ability and credibility to engage various stakeholders and municipalities more effectively. Municipalities can also save time and money by learning from the county's efforts with what works and what does not for their fleet management in local market conditions.

i. Tracking of Fleet Inventory and Fuels

In 2008 the MCPW&E installed and activated a fleet inventory and fuel tracking system to measure fuel consumption for all of the 1,000 vehicles and equipment in its fleet. The system measures the fuel that is pumped in a vehicle using a bar code system that is linked to the pump mechanism. The total fuel consumption and mileage/hours of the vehicle is tracked through the management system.

The system allows for a more accurate fuel consumption rate for the various fleet vehicles by make, model, year, and department. This information can be used to gauge the overall efficiency of a vehicle or model's performance over time. Table 2 presents the statistics derived from the county's fleet management system for the Ford Crown Victoria (Police Interceptor) which comprises almost 10 percent of the county's total fleet of on-road vehicles. The table shows that the county's overall miles per gallon is close to the average for the vehicle, 16 miles per gallon,[56] when city and highway miles per gallon are combine. The data also shows which departments are above or below the fleet average. Based on this information, idling, vehicle usage, and other policies can be adjusted or enforced by departments.

4-Table 2 Crown Victoria PP Vehicles Mileage Statistics by Department

Department	Miles Per Gallon	Difference from Fleet Average	Number of Vehicles

[56] Average miles per gallon was taken from www.fueleconomy.gov using the average year for the overall model fleet.

Buildings and Grounds	13.19	-2.69	1
Fire Marshal's Office	16.71	0.83	2
Mosquito Commission	13.88	-2.00	1
Police Academy	13.74	-2.14	4
Prosecutors Office	16.56	0.67	48
Sheriff Department	15.19	-0.69	38
Youth Detention	16.45	0.56	1
Total Fleet	15.88		95

In addition, the fleet management system can spread the use of vehicles from departments that use the vehicles heavily, to other departments that use the vehicle sparingly. This will help prolong the life of the vehicle as well as assist in maintaining the vehicle to sustain maximum efficiency. This rotation would be dependent on operational requirements.

ii. Reduced Use Strategies

The most obvious and accepted initiative for making any vehicle more efficient is to boost its mileage per gallon ratio through reducing idling time. The county has put into place an idling policy that employees using county vehicles must follow. The county's idling policy states:

> *Monmouth County Employees shall not allow or permit the unnecessary operation of the engine of a motor vehicle or piece of equipment while stopped for a foreseeable period of time, unless required due to safety and operational concerns.*

The county cites several reasons for the policy, including the cost of the fuel used, wear on the engine, and the public perception of government waste, health hazards, and environmental degradation.

Other Monmouth County strategies for emissions reduction focus on more efficient road maintenance practices that have already been put into place and have been well documented in other areas around the country. Two major initiatives focus on seasonal maintenance issues, including reducing summer lawn cutting activities and winter snow removal.

Reduced mowing strategies have been adopted by a variety of state transportation agencies looking to reduce the cost of maintaining large swaths of grass along right of ways of roads. Delaware, Kentucky, New Hampshire, Virginia and Pennsylvania are among the states that have enacted reduced mowing strategies recently. Following this concept, the county has instituted a policy of planting wild flowers, or other natural species, in selected areas along roadways to return to their natural growth habitats and reduces areas of grass to mow. This strategy reduces wear of mowers, cuts GHG emissions, saves on labor costs, and in turn provides more labor hours to be used on more urgent public works projects.

Although the idea of reduced mowing may seems simple, according to the US EPA a typical push mower emits as much hourly pollution as 11 cars, with a riding mower emitting as much as 34 cars. This is due to lower emissions standards for small engines. In 2009, the county's large scale mowers/tractors clocked a little over 18,300 hours, the equivalent of 622,000 car hour emissions. A reduction of 10 percent, 1,800 hours, of hourly mowing time would be like removing 62,000 car hours. In addition, lawn care is often completed in the hot summer months where high temperatures can amplify the impact of engine emissions on the formation of smog.

During the winter months, the county must maintain their roads by removing ice and snow. For anti-icing, the county uses a mixture of magnesium chloride and water which is applied to the roadway before a storm or before ice and snow has a chance to accumulate. When the roadway is treated with magnesium chloride, oftentimes while it is still dry, the chemical is stored in the pores of the roadway. Magnesium chloride prevents water and snow from freezing as quickly by lowering the freezing point to above 20 degrees F. Magnesium chloride also prevents the formation of a strong bond between the ice and the pavement surface. This makes the snow removal process much easier for maintenance crews which results in fewer trips to remove the snow and ice. In addition, less salt has to be used so salt transport trips are reduced as well. The county assumes a 1/3 reduction in snow removal trips each time it snows, which thereby reduces fuel and labor costs as well as GHG emissions.

iii. Use of Alternative Fuels and More Efficient Engines

The county has been investing in the use of bio-diesel fuel and bio-diesel engines to reduce GHG emissions and reduce the cost associated with engine maintenance. Bio-diesel is a renewable fuel derived from vegetable oil or animal fats that can be added to petroleum diesel as a blend or used on its own. In the United States, most bio-diesel is made from soybeans. Bio-diesel is also made from canola oils and from waste stream sources including used cooking oils or animal fats.

Although bio-diesel's lifecycle emissions impact depends on the source and fuel blend, bio-diesel can offer distinct environmental advantages over petroleum diesel fuel (See Table 3).

4-Table 3 Comparison of CO_2 Emissions by Fuel Source

Fuel Type	CO_2 Emissions (lbs. per Gallon)
Bio-diesel	5.84
Ethanol	14.6
Gasoline	24.3
Petro-diesel	26.55

Source: U.S. Department of Energy

Since diesel engines are inherently more efficient than gasoline fueled engines, the fuel savings can be substantial. In addition, diesel engines have less maintenance and can last nearly 40 percent longer between preventative maintenance intervals. The cost savings over the life of the diesel vehicle is estimated to be $4,000 versus its gasoline fuels counterpart, although there is some additional cost in using bio-diesel fuel.

The MCPW&E is also reviewing the use of hybrid vehicles for certain types of jobs. The county currently has hybrid vehicles in its fleet that it uses for administrative fleet service duties. It is the intention of the MCPW&E to review and evaluate the county's hybrid vehicle presence in the future. Tables 4 and 5 present the annual costs of depreciation and fuel for both conventional and hybrid vehicles. The total savings of the hybrid vehicle is approximately $700 to $1000 depending on the price of gasoline. Recent gas price spikes of $4.00 per gallon amplify the cost effectiveness of the hybrid vehicles. While there are savings, the cost of purchasing a hybrid vehicle can be $5-8,000 greater that a comparable gas vehicle. The county would be more likely to purchase more hybrid vehicles if there were grant programs to cover the difference in cost. In addition, the costs of long-term maintenance is unknown at this time but may be a cost factor that would have to be considered.

4-Tables 4 and 5 Toyota Prius versus Conventional Dodge Avenger Costs

Toyota Prius		**Dodge Avenger**	
Annual Depreciation	$ 3,070	Annual Depreciation	$ 3,023
Miles Per Gallon	45	Miles Per Gallon	23
Fuel @ $2.50	$ 667	Fuel @ $2.50	$ 1,304
Fuel @ $3.50	$ 933	Fuel @ $3.50	$ 1,826
Total Annual Costs		Total Annual Costs	
Total @ $2.50	$ 3,737	Total @ $2.50	$ 4,374
Total @ $3.50	$ 4,003	Total @ $3.50	$ 4,896

Source: Middlesex County of Department of Transportation, Louis Berger Group: updated gas pricing

c. Recommendations for Reducing Monmouth County Fleet Emissions

Data used for the Monmouth County fleet GHG inventory were analyzed to identify and calculate the emissions reduction from a set of potential measures that the county could employ to reduce GHG emissions. The data set was detailed enough to enable an analysis that targeted specific vehicle use cases for the fleets used by each department. This highly detailed data set also allowed consideration of the feasibility of each type of measure based on vehicle type and the ways that the various fleets may be affected by implementation of each measure. For example, Sheriff's Department cruisers have specific performance requirements that make switching to hybrid technologies or smaller engines unfeasible with current technology. Therefore, these vehicles were excluded from the analysis for the hybrid conversion measure. Similarly, fuel use associated with heavy

equipment such as tractors, dump trucks, street sweepers, and other vehicles with specific use cases, were excluded from the analysis.

In some cases, implementation of one measure may overlap with the implementation of one or more other measures. To eliminate double counting of fuel or emissions reductions, an order of evaluation method was applied across the measures, which accounts for structural or technology changes to vehicles first. Then, if measures that affect the distances traveled or the way a vehicle is operated are calculated, the improved higher efficiency of vehicles that were affected by technology are incorporated in the calculation to determine how much fuel consumption is reduced.

It should be noted that all calculations for fleet-based reductions were based on annual mileage and fuel use data that was supplied for the GHG inventory, which is not always 100 percent accurate in gauging the achieved fuel economies of the vehicles in the fleet. For example unrecorded fuel purchases at commercial gas stations can result in fuel economies higher than what is currently achieved. Conversely, fuel attributed to a vehicle that was actually consumed by a piece of equipment that travels with the vehicle (e.g. a lawnmower that is being carried in a truck) can result in a fuel economy that is lower than the actual fuel economy for that vehicle. Monmouth County currently uses bar codes for each vehicle and piece of equipment, so fuel estimates should be fairly accurate. However, these data do provide representative figures that allow a reasonably accurate depiction of the potential for reductions.

i. Data Collection

The tracking of fuel consumption and mileage by vehicle conducted by MCPW&E should be continued to allow for improvements in performance over time to be tracked. The Parks Department should consider adopting the tracking system used by MCPW&E to provide information on which vehicles in the Parks Department fleet are using the most fuel and prioritize these vehicles for future replacement or other emissions reduction strategies. More detailed record keeping of how fuel is consumed and for which uses would allow for improved management of emissions from this department. Additionally, more information on fuel usage would allow for the development of emissions reductions measures without compromising the level of service provided at Parks Department facilities.

ii. Vehicle Technology Options

Eventually, advances in vehicle technology and fuel efficiency will allow Monmouth County vehicles to perform many of the tasks that they complete now using less fuel. However, current vehicle technology options are somewhat limited and do not allow for a full transition to a high-efficiency vehicle fleet. For the most part, suitable replacements for current county vehicles only exist within the passenger car and some small SUV vehicle types, while heavy vehicle types are assumed to continue burning fossil fuels for the foreseeable future. Hybrid vehicles are significantly more expensive to purchase than conventional gas vehicles. This would have to be factored into any decision to increase the use of hybrids. Improving the overall fleet fuel economy requires a phased-in

approach, which will be an on-going process as vehicles are replaced. Over the course of the next 20 years, vehicle technology will continue to improve and availability of new technology, such as electric vehicles, will increase.

iii. High Efficiency Vehicle Replacement

After examining the inventory of county vehicles in the 2009 inventory, potential candidate replacement vehicles were selected based on the first model year in which a vehicle substitute for a high efficiency vehicle exists. This list was further refined by looking at the department that controls the vehicle to eliminate those cases where a particular type of vehicle is required to move equipment or perform another specific function that may require a vehicle type where no high-efficiency alternative exists. This excluded vehicles such as dump trucks, heavy equipment, buses, etc. Next, the remaining vehicles were sorted by age, since it is unlikely that the county would replace any vehicles before they reach the end of their useful lives or make a significant amount of new purchases within a single year. After determining that no standard vehicle was older than 15 years, this age was selected as the target replacement age for vehicles.

Once the final candidate vehicles were selected for each analysis year, the actual efficiency in miles per gallon (MPG) was calculated using actual odometer and fuel consumption data provided by the county. Next, a higher fuel efficiency value was assigned to each vehicle that was selected for the replacement. Projected fuel economy calculations were obtained from the "baseline scenario" in the VISION model from Argonne National Labs.[57] A projected volume of fuel consumed was calculated using the new high-efficiency MPG rating and the number of miles traveled by the vehicle in a year, according to the inventory data. This assumes that the mileage for each vehicle in 2009 is representative of the amount of driving that would occur in 2015. The projected amount of fuel consumption is then subtracted from the fuel that would have been consumed by the vehicle traveling that distance at its current MPG rate to calculate reduced fuel consumption. Emissions reductions were then calculated from the volume of fuel saved as illustrated in Table 6.

4-Table 6 Annual Emissions Reductions from Hybrid and Electric Vehicle Purchases

Year	Fuel Reduced (gal)	CO_2 (metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM_{10} (lbs)
2015	11,450	101	34	2	7,740	812	17
2020	24,709	217	74	5	16,704	1,752	36
2030	29,796	262	89	6	20,143	2,112	43

Table 6 also provides the long-term potential of this measure once all candidate vehicles are replaced. Before additional hybrid or electric vehicles are added to the fleet, a cost/benefit analysis would have to be done to justify the additional cost of the purchase and potential maintenance of the hybrid vehicles. Total emissions reduced in 2020 and

[57] Argonne National Labs, Transportation Technology R&D Center, VISION Model. http://www.transportation.anl.gov/modeling_simulation/VISION/

2030 are cumulative and include the emissions reductions achieved by replacement purchases from the previous years. It should be noted that the age structure of the Monmouth County fleet and the criteria of 15 years of age for replacing a vehicle results in a large number of replacements between 2009 and 2015 and relatively few in the 2015-2020 and 2020-2030 periods. Therefore, a relatively small additional benefit occurs between 2020 and 2030, which is due to the fewer number of vehicle replacements within that timeframe. For this analysis it was assumed that the proportion of electric passenger cars purchased in each period would also increase over time due to wider availability and lower costs as the market for these vehicles grows, and that there are no suitable electric light truck alternatives at this time. In order for hybrid or electric vehicles to be economically feasible at this time, grant funding, or other subsidy would probably be necessary to achieve the assumed levels in Table 7. Table 7 contains a summary of the inputs used in this analysis. Note also that the increase in the proportion of electric vehicles results in increase electricity use by the county. This has an effect on total emissions from the buildings sector of county operations, but it is relatively minor.

4-Table 7: Input Parameters for Hybrid and Electric Vehicle Purchases

Year	Passenger Cars Replaced	Light Trucks Replaced	% Hybrid Passenger Cars	% Electric Passenger Cars	Passenger Car Hybrid Fuel Economy (MPG)	Passenger Car Electric Fuel Economy (MPGGe)	Light Truck Hybrid Fuel Economy (MPG)	Increased Electricity Use (kWh)
2015	53	21	90%	10%	46	95	24	33
2020	36	6	50%	50%	50	107	39	26
2030	4	11	0%	100%	53	109	40	13

iv. Vehicle Idling Reduction Enforcement

Many jurisdictions across the nation, including Monmouth County, have anti-idle policies in place to conserve fuel and lower fleet maintenance costs. Law enforcement vehicles are usually exempt from these policies as their vehicles contain mission critical communications and other equipment that relies on power produced by a running engine. Recent advances in power storage technology allow law enforcement vehicles to be outfitted with power supplies that do not require the vehicle to remain running to power the equipment used in the field. There will still be instances where this is not practical or desirable, however.

This emissions reduction measure includes the installation of alternate power supplies in law enforcement vehicles. Although these devices take up some space in the trunk or cargo space of a vehicle, they have been successfully deployed in departments across the nation without reported loss of critical amounts of cargo space or reduced vehicle performance.[58]

[58] Evans. *Energy Xtreme Idle-Reduction Technology*. Police Fleet Manager. Sept-Oct 2010. (http://www.energyxtreme.net/main/images/news_images/energy%20xtreme%20pfm%20feature%2044-46.pdf)

To model this measure, Sheriff's Department cruisers and small SUVs were selected from the total list of county vehicles. Then, the achieved fuel economy was calculated for each vehicle based on its annual mileage and corresponding fuel consumption. Then this fuel economy figure was increased by 18 percent to reflect the fuel economy reported by departments in other cities[4] who have used the power storage technology. A new total fuel consumption estimate was calculated by using the higher fuel economy, but retaining the same annual miles traveled for each vehicle, as was reported in the inventory data. Emissions reductions are calculated by taking the difference in total fuel consumption between the original Sheriff's Department fleet (as indicated in the inventory) and the proposed emissions savings that would result if these vehicles were not idling. The results are presented in Table 8.

4-Table 8: Emissions Reductions from Law Enforcement Idle Reduction

Number of Vehicles retrofitted	Fuel Reduced (gal)	CO_2 (metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM_{10} (lbs)
69	6,518	57	19	1	4,406	462	9

v. Vehicle Use Reductions

Using the most efficient vehicles is one way to reduce fuel consumption and emissions, and another strategy is to reduce the amount of vehicle use and to use vehicles in the most efficient way. The following reduction strategies are intended to limit vehicle use, when possible, and to make vehicle use more efficient.

vi. Route Optimization

For many local governments, the services they provide through "fixed routes," such as garbage collection and fixed route transit, are usually already configured to minimize total driving needed to service each address. Monmouth County does not operate these types of services. Routes that are traditionally more difficult to manage, which Monmouth County does operate, are for unpredictable, on demand services, such as inspections or public works maintenance jobs. Utilizing GIS-based routing and navigation equipment substantially reduces driving distances for "on demand" services and employees can be empowered to plan driving routes quickly in response to each day's work load, which may increase worker efficiency and productivity. By 2012, all county vehicles will have GPS technology to make routing efficiency possible.

For this measure, county vehicle data was examined to find vehicles that were likely used for some kind of response purpose, such as a social service or inspection. This resulted in vehicle selections from the Health Department, Social Services, Human Services, Information Services, The Planning Board, Weights and Measures, Office of Aging, The Mosquito Commission, The Shadetree Commission and Special Citizens Area Transportation (SCAT). The SCAT buses appear to be uniquely suited for this measure due to the nature of the "on demand" service that SCAT provides, and therefore the majority of the reductions achievable from this measure are from the SCAT service.

This measure recommends subscription to a GIS-based routing optimization service such as ArcLogistics, developed by Environmental Systems Research Institute, Inc. (ESRI).[59] In an online calculator for the benefits of its product, ESRI applies an approximate 20 percent reduction in the overall mileage traveled for vehicles utilizing the program.[60] For this measure the total mileage for each of the vehicles selected was reduced by 20 percent. The fuel savings associated with this mileage reduction was calculated using each vehicle's 2009 fuel economy. In those cases where the same vehicle was also considered previously for replacement with a hybrid model, the hybrid fuel economy was used. The cost of the subscription would have to be factored into the decision to use this technology. Results of this measure are summarized in Table 9.

[59] ESRI ArcLogistics. Accessed 12-20-2010. http://www.esri.com/software/arclogistics/index.html
[60] ESRI. ArcLogistics Cost and Carbon Footprint Reduction Estimates. Accessed 12-20-2010. http://roi.esri.com/costsavings2009/index.cfm

4-Table 9: Emissions Reductions from Route Optimization

Department	Number of Vehicles Analyzed	Mileage Reduction	Gasoline Reduced	Diesel Reduced	CO_2 Reduced (MT)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM_{10} (lbs)
Office of Aging	3	1,143	85	N/A	0.75	0.25	0.02	57.54	6.03	0.12
Extension Services	4	6,167	337	N/A	2.95	1.01	0.07	227.50	23.86	0.49
Health Department	19	19,389	759	N/A	6.66	2.27	0.15	512.77	53.78	1.10
Human Services	5	3,208	109	N/A	0.96	0.33	0.02	73.76	7.74	0.16
Information Services	9	5,767	310	N/A	2.72	0.92	0.06	209.28	21.95	0.45
Mosquito Commission	28	43,963	2,971	149	27.60	14.19	1.31	19.31	2.17	0.10
Planning Board	6	4,481	151	N/A	1.33	0.45	0.03	102.20	10.72	0.22
Safety Office	1	160	7	N/A	0.06	0.02	0.00	4.50	0.47	0.01
SCAT	61	211,202	132	23,265	238.69	833.65	115.24	1,150.74	351.91	114.21
Shadetree Commission	12	19,420	1,216	551	16.30	3.63	0.24	821.81	86.19	1.77
Social Services	15	18,451	983	N/A	8.64	2.94	0.19	664.86	69.73	1.43
Weights and Measures	11	15,321	804	N/A	7.06	2.40	0.16	543.57	57.01	1.17
Total	**174**	**348,671**	**7,863**	**23,964**	**314**	**862**	**117**	**4,388**	**692**	**121**

The overall cost savings of the route optimization can be substantial. With the gasoline price between $3.00 to $4.00 dollars the overall savings on gasoline purchases alone would save the county between $23,600 and $31,500. In addition, the cost savings on diesel fuel can be just as substantial, saving the county $71,892 annually.[61]

[61] Uses a $3.00 a gallon diesel fuel estimate.

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vii. Efficient Driver Education

Once the county improves vehicle performance and reduces the overall amount of driving, the benefits of improving how the vehicles are operated can be modeled. In-use fuel economy can be increased by obeying the speed limit, avoiding sudden starts and stops and generally reducing aggressive driving behavior. It is estimated that fuel economy can be improved up to 33 percent through changes in driver behavior alone.[62]

Almost every standard vehicle in the fleet was included in this measure, although heavy equipment was not included because the fuel consumption for these types of vehicles is less dependent on mileage. Law enforcement and other emergency vehicles were also excluded because drivers of these vehicles are often required to drive aggressively. For the remaining vehicles, potential fuel reductions were calculated by improving their achieved fuel economy by 15 percent over the annual miles each vehicle was driven. This is a conservative estimate of the savings potential since actual performance will depend on the degree to which employees change their habits. For vehicles that were assumed to have been replaced by a high efficiency model, the high efficiency fuel economy was also improved. For vehicles that had miles reduced from a route optimization, annual miles reflected this change as well. Again because this is a voluntary measure that requires the participation of employees, total savings were reduced to 60 percent of the theoretical potential to account for lack of uptake among county employees. An employee education and training program could potentially increase the efficacy of this measure. Results are summarized in Table 10.

4-Table 10: Emissions Reductions from Efficient Driver Education

Fuel Type	Fuel Reduced (gal)	CO_2 (metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM_{10} (lbs)
Gasoline	18,120	159	54	4	12,250	1,285	12
Diesel	8,494	87	304	42	388	125	42

Maintaining the effectiveness of driver education over the long term requires consistent reinforcement of the message of saving fuel and reducing costs for the county. Performance can be increased through informal competitions between departments for the most improvement or other incentives.

[62]EcoDriving USA. EcoDriving Practices. Accessed 12-20-2010. http://www.ecodrivingusa.com/#/ecodriving-practices/

d. Summary of Fleet Emissions Reduction Strategies

The measures suggested here for Monmouth County represent a significant opportunity for emissions reductions of 717 metric tons of CO_2 annually in the near term. Over time as fleet fuel economy improves with vehicle replacement, an additional 39 metric tons can be reduced annually by the year 2020.

Reducing fuel use also reduces county expenditures. Using figures from the Energy Information Administration of the United States Department of Energy for the November 2010 average gasoline ($3.04/gal) and diesel ($2.54/gal) costs for Mid-Atlantic states, cost savings were also estimated along with emissions reductions.[63] It is likely that fuel costs will increase over time and subsequently, these potential savings are expected to increase. Table 11 provides a summary of all fuel consumption and emissions reductions.

4-Table 11: Emissions Reduction Summary for Monmouth County Fleet Vehicles

Measure Type	Fuel Reduced (Gallons)	Fuel Type	Cost Savings	CO_2 Reduced (MT)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM_{10} (lbs)
Cruiser Idle Reduction	6,518	Unleaded	$20,010	57	19	1	4,406	462	9
Driver Education	8,494	Diesel	$28,541	87	304	42	388	125	42
Driver Education	18,120	Unleaded	$55,629	159	54	4	12,250	1,285	26
High Efficiency Vehicles (2015)	11,450	Unleaded	$35,150	101	34	2	7,740	812	17
Route Optimization	23,964	Diesel	$78,667	245	858	119	1,093	353	117
Route Optimization	7,863	Unleaded	$20,407	69	23	2	5,316	557	11
		Total	$243,990	717[64]	1,294	169	31,193	3,594	223

The county should focus primarily on providing efficient drivers education for all of its employees who use, or could use, a fleet vehicle, and make it voluntary for those who do not. This program would consist of a short driver's education course summarizing key concepts and practices for efficient driving. Although the analysis in Table 11 provides estimates of cost savings and GHG emissions reduced, the new driving techniques may be passed on or learned by others not employed by the county such as husbands, children, and so on.

The second priority would be to set in place route optimization technology. It is advised that the county start out with a pilot program if possible. However, the initial capital costs may be more efficient with economies of scale. The third priority for the county should be to purchase the equipment necessary to reduce law enforcement vehicle idling. Unlike route optimization this would need to be conducted on an individual vehicle by vehicle basis.

[63] EIA Gasoline and Diesel Fuel Update. Accessed 12-20-2010. http://www.eia.doe.gov/oog/info/gdu/gasdiesel.asp

[64] Equivalent to CO^2 emissions from 9 tanker trucks' worth of gasoline

It is assumed that the county will naturally begin to acquire high efficiency vehicles as these technologies become more mainstream and their costs become more economical.

5. Countywide Greenhouse Gas Emissions

a. Introduction

The previous sections described the potential impacts of climate change on Monmouth County, identified the connection between transportation-related GHG emissions and climate change, and estimated the GHG emissions associated with county government operations and county government employee commuting.

Sections 5.b through 5.d provide an estimate of total countywide transportation sector GHG emissions, including government-related emissions as well as the emissions created by Monmouth County residents, businesses and visitors. The estimates are broken down to the municipal-level and use data from a study done by the North Jersey Transportation Planning Authority (NJTPA). The impacts of seasonal traffic patterns and emissions in Monmouth County are addressed in the municipal-level inventory of on-road mobile sources. Section 5.d splits out GHG emissions for non-road mobile sources in Monmouth County such as trains, commercial marine vehicles, off-road vehicles, and airports.

b. Inventory of Transportation-Related Greenhouse Gas Emissions

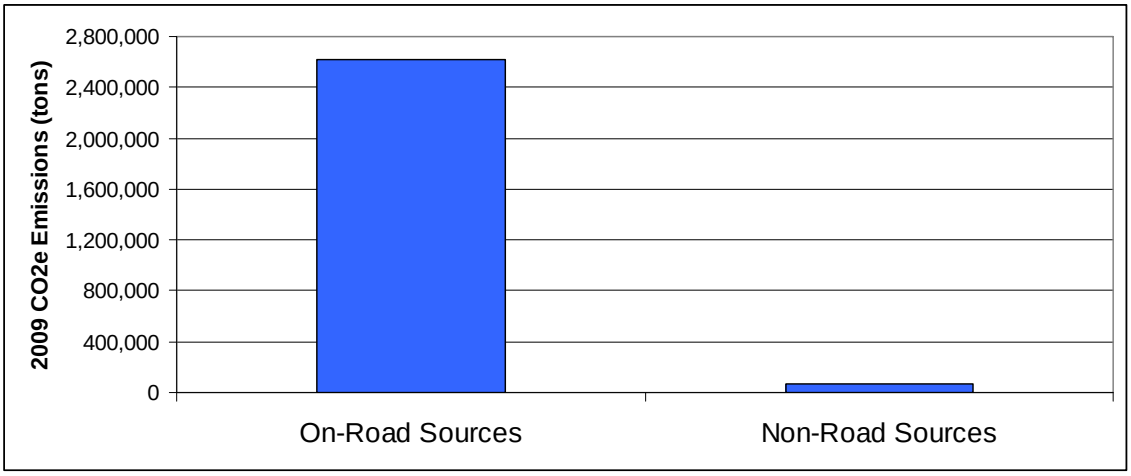
A significant amount of data for this section was supplied by the North Jersey Transportation Planning Authority's (NJTPA) Regional Greenhouse Gas Emissions Inventory and Forecast study. NJTPA's study estimated GHG emissions from mobile sources throughout the NJTPA's thirteen county region, which includes Monmouth County. The base year for the NJTPA's GHG estimates was 2006, with forecasts of emissions extending out to 2050. To remain consistent with the 2009 analysis year used for Monmouth County's operational inventory (Sections 4 and 5), this section of the study will utilize the NJTPA's GHG emissions forecast for 2009. The countywide GHG Inventory takes into account all mobile emissions sources that are both private and public in Monmouth County, and includes the emissions associated with county fleet operations and employee commutes. By using the NJTPA 2009 GHG emissions estimates, the county can compare the transportation-related GHG emissions within their control to the total countywide GHG emissions.

The NJTPA study had two separate methods of calculating and reporting GHG emissions -- the consumption-based method and the direct method. Direct emissions were defined as occurring at the source of emissions (e.g. at the tailpipe). Using the example of on-road mobile sources, direct emissions were computed for individual highway links and allocated to the municipality in which the link was located. Unlike the direct emissions, consumption-based emissions were calculated for each origin-to-destination trip in the region, and then allocated to the origins and destinations which produced and attracted those trips. This report focuses on the direct emissions occurring within Monmouth County for consistency with the inventory framework used for county operations and employee commutes (Sections 3 and 4). Future analysis could consider the consumption-

based emissions approach in order to analyze the impact of GHG emissions associated with trips originating or destined within Monmouth County.

A review of the data generated by the NJTPA study shows that on-road mobile sources (cars, trucks, buses, motorcycles etc.), are the dominant source of GHG emissions in Monmouth County. Figure 1 illustrates the difference between the on-road and non-road source emissions in Monmouth County. The ratio of on-road to non-road emissions is 36:1, meaning that for every 36 tons of CO_2e emitted from on-road sources, only one ton is emitted from non-road sources. For this reason, the analysis of GHG emissions reduction measures through alternative transportation improvements (Section 5.e) and transportation and land use planning (Section 5.g) is focused on strategies that reduce on-road vehicle emissions.

5-Figure 1 Comparison of Monmouth County 2009 On-Road and Non-Road Mobile Source Emissions



Source: NJTPA Regional Greenhouse Gas Emissions Inventory and Forecast

c. On-Road Mobile Sources

The on-road transportation sector includes motor vehicles that typically travel on public roads, such as passenger cars and trucks, motorcycles, commercial trucks, heavy-duty vehicles, and buses. These vehicles may be fueled by gasoline, diesel, or other alternative fuels. Although CO_2 is the main GHG emitted from this sector, methane (CH_4) and nitrous oxide (N_2O) are emitted as well.

i. Municipal-Level On-Road GHG Emissions

The NJTPA's on-road inventory of direct emissions was conducted for a base year of 2006 and a series of forecast years through 2050. The vehicle miles traveled and other vehicle operations inputs (e.g., speed) were determined using NJTPA's North Jersey Regional Transportation Model – Enhanced (NJRTM-E). Emissions of CO_2, CH_4, and N_2O were calculated using EPA's Motor Vehicle Emission Simulator (MOVES) model. The resulting GHG forecast for 2009 is summarized in Table 1.

Refer to Appendix E for information on the minor adjustments made to the NJTPA annual VMT and emissions data for Monmouth County.

5-Table 1 NJTPA Monmouth County Municipal-Level On-Road GHG Direct Emissions Forecast for 2009

	VMT*	CO_2 (Tons per year)	N_20 (Tons per year)	CH_4 (Tons per year)	CO_2e (Tons per year)
Aberdeen	221,358,421	87,669	1.17	1.62	88,064
Allenhurst	6,073,929	2,620	0.04	0.06	2,634
Allentown	8,280,836	3,881	0.06	0.10	3,904
Asbury Park	32,016,007	14,951	0.26	0.37	15,038
Atlantic Highlands	12,846,543	5,894	0.10	0.14	5,927
Avon-by-the-Sea	7,220,921	3,270	0.05	0.08	3,289
Belmar	18,102,086	8,846	0.16	0.23	8,899
Bradley Beach	4,827,650	2,260	0.04	0.06	2,273
Brielle	41,436,793	19,164	0.32	0.46	19,274
Colts Neck	241,861,293	95,264	1.20	1.66	95,671
Deal	14,241,300	5,932	0.09	0.13	5,963
Eatontown	183,598,629	82,168	1.35	1.92	82,625
Englishtown	7,569,693	3,702	0.06	0.10	3,724
Fair Haven	20,511,000	9,306	0.16	0.22	9,359
Farmingdale	3,611,207	1,758	0.03	0.05	1,768
Freehold Twp	398,880,164	180,214	2.88	4.06	181,191
Freehold Boro	42,953,614	22,504	0.41	0.62	22,643
Hazlet	168,243,464	73,140	1.15	1.61	73,530
Highlands	7,257,164	3,300	0.05	0.08	3,319
Holmdel	431,040,779	161,836	2.09	2.84	162,542
Howell	500,547,086	216,975	3.28	4.56	218,087
Interlaken	1,413,086	672	0.01	0.02	676
Keansburg	7,453,164	3,724	0.07	0.09	3,747
Keyport	46,740,514	20,261	0.31	0.47	20,367
Little Silver	22,731,964	10,801	0.18	0.27	10,864
Loch Arbour	3,361,743	1,492	0.02	0.04	1,500
Long Branch	96,327,864	45,452	0.78	1.12	45,717
Manalapan	142,546,343	68,412	1.18	1.67	68,812
Manasquan	25,854,157	11,705	0.19	0.27	11,770
Marlboro	256,507,143	109,431	1.52	2.10	109,947
Matawan	26,246,850	11,638	0.18	0.26	11,700

	VMT*	CO_2 (Tons per year)	N_20 (Tons per year)	CH_4 (Tons per year)	CO_2e (Tons per year)
Middletown	604,621,586	241,923	3.45	4.81	243,094
Millstone	193,569,150	76,455	1.08	1.51	76,822
Monmouth Beach	12,546,593	5,842	0.10	0.14	5,876
Neptune	192,986,200	82,483	1.26	1.82	82,913
Neptune City	38,744,493	17,761	0.30	0.42	17,861
Ocean	183,657,179	77,386	1.16	1.67	77,781
Oceanport	27,154,843	12,877	0.22	0.32	12,952
Red Bank	73,589,129	43,855	0.88	1.27	44,155
Roosevelt	4,288,686	1,933	0.03	0.05	1,944
Rumson	30,957,000	13,348	0.21	0.31	13,421
Sea Bright	29,481,464	12,135	0.19	0.26	12,198
Sea Girt	3,544,864	1,687	0.03	0.04	1,697
Shrewsbury	58,855,450	25,915	0.41	0.57	26,054
South Belmar	950,250	518	0.01	0.02	522
Spring Lake	4,592,550	2,192	0.04	0.05	2,205
Spring Lake Heights	31,528,579	13,753	0.22	0.31	13,829
Tinton Falls	644,392,579	230,617	2.71	3.71	231,535
Union Beach	15,089,464	6,966	0.12	0.16	7,005
Upper Freehold	280,644,614	106,354	1.40	1.95	106,829
Wall	810,429,114	325,362	4.49	6.26	326,886
West Long Branch	50,853,264	23,664	0.40	0.57	23,800
Total	**6,294,138,457**	**2,611,270**	**38.08**	**53.51**	**2,624,200**

*2009 VMT not reported directly in NJTPA analysis. Calculated based on linear interpolation from the reported values for 2006 and 2020.

Table 2 shows the 2009 VMT estimates in relation to population. For Monmouth County as whole, VMT per capita was 9,772, which is close to the national average of 9,551.65 At the municipal level, VMT per capita varies substantially, with the dense communities along the coast generally having lower VMT per capita than the more rural areas in western Monmouth County. The highest VMT per capita in Monmouth County occurred in Upper Freehold where 40,809 annual vehicle miles were traveled per person, over four times the average for Monmouth County. It is important to note that the VMT data reflects all travel within the municipal boundaries, not just trips generated by the residents of a particular municipality. In the case of Upper Freehold, the VMT per capita result is influenced by through traffic on I-195 combined with the low population of this

[65] Based on FHWA Traffic Volumes Trends data for 2009 and the U.S. Census 2009 population estimate for the United States.

area. Despite the effects of regional traffic, the data still shows some important patterns. Oceanport, a municipality without any major regional roadways, has VMT per capita almost of that of the county average. Oceanport's relatively low VMT per capita is likely due to the dense pattern of development that reduces vehicle travel and proximity to transit service.

5-Table 2 2009 VMT Per Capita

	2009 VMT	2009 Population*	VMT per Capita
Aberdeen	221,358,421	18,371	12,049
Allenhurst	6,073,929	697	8,714
Allentown	8,280,836	1,840	4,500
Asbury Park	32,016,007	16,564	1,933
Atlantic Highlands	12,846,543	4,594	2,796
Avon-by-the-Sea	7,220,921	2,239	3,225
Belmar	18,102,086	5,897	3,070
Bradley Beach	4,827,650	4,994	967
Brielle	41,436,793	4,895	8,465
Colts Neck	241,861,293	10,065	24,030
Deal	14,241,300	1,047	13,602
Eatontown	183,598,629	14,310	12,830
Englishtown	7,569,693	1,916	3,951
Fair Haven	20,511,000	5,949	3,448
Farmingdale	3,611,207	1,572	2,297
Freehold Twp	398,880,164	34,589	11,532
Freehold Boro	42,953,614	11,432	3,757
Hazlet	168,243,464	20,942	8,034
Highlands	7,257,164	5,251	1,382
Holmdel	431,040,779	16,852	25,578
Howell	500,547,086	51,551	9,710
Interlaken	1,413,086	876	1,613
Keansburg	7,453,164	10,536	707
Keyport	46,740,514	7,482	6,247
Little Silver	22,731,964	6,141	3,702
Loch Arbour	3,361,743	273	12,314
Long Branch	96,327,864	32,989	2,920
Manalapan	142,546,343	39,390	3,619
Manasquan	25,854,157	6,273	4,121
Marlboro	256,507,143	40,546	6,326
Matawan	26,246,850	9,101	2,884

	2009 VMT	2009 Population*	VMT per Capita
Middletown	604,621,586	66,603	9,078
Millstone	193,569,150	10,223	18,935
Monmouth Beach	12,546,593	3,571	3,513
Neptune	192,986,200	28,349	6,808
Neptune City	38,744,493	5,100	7,597
Ocean	183,657,179	28,204	6,512
Oceanport	27,154,843	5,730	4,739
Red Bank	73,589,129	11,914	6,177
Roosevelt	4,288,686	904	4,744
Rumson	30,957,000	7,309	4,235
Sea Bright	29,481,464	1,808	16,306
Sea Girt	3,544,864	2,098	1,690
Shrewsbury	58,855,450	4,837	12,168
South Belmar	950,250	1,778	534
Spring Lake	4,592,550	3,542	1,297
Spring Lake Heights	31,528,579	5,142	6,132
Tinton Falls	644,392,579	19,772	32,591
Union Beach	15,089,464	6,612	2,282
Upper Freehold	280,644,614	6,877	40,809
Wall	810,429,114	26,142	31,001
West Long Branch	50,853,264	8,416	6,042
Total	**6,294,138,457**	644,105	9,772

* Source for 2009 population estimates: New Jersey Department of Labor and Workforce Development

ii. On-Road Seasonality Impacts

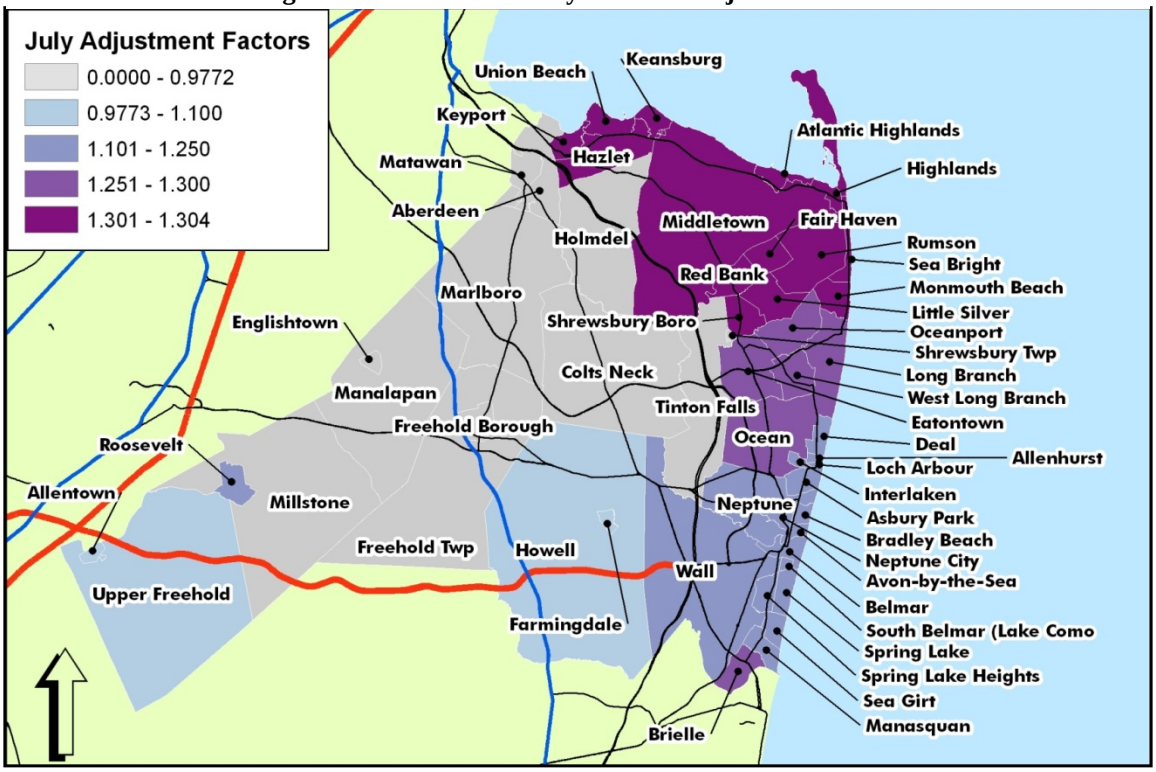
There is no doubt that Monmouth County's traffic greatly increases as the temperature rises and the beaches beckon tourists from the more populated New York and Northern New Jersey areas. The usual routes taken by tourists to the Monmouth shore almost always originate from the Garden State Parkway and branch out onto the most direct beach bound highway routes. Seasonal exits from the Garden State Parkway in Monmouth County that lead to major roadways destined for the coast swell dramatically during the peak summer months. This causes major traffic congestion which in turn reduces travel speeds and increases vehicle GHG emission rates.

Seasonal variations in traffic volumes are computed from annual average traffic volume projections using seasonal adjustment factors. The NJTPA's transportation modeling and post-processing procedures take into account seasonal variations in traffic volumes at the county level. In other words, the same seasonal adjustment factors are applied to all municipalities in Monmouth County to determine monthly traffic volumes. While this approach is appropriate for regional modeling purposes, a refined methodology was

developed for this study. The methodology involved gathering the available traffic count data for Monmouth County and developing municipal-level seasonal adjustment factors for various types of roadways (e.g. freeways, arterials and local streets). The traffic data showed that the shore communities had pronounced seasonal pattern to VMT (high in the summer, low in the winter), while other municipalities farther inland had much less variation month to month. In some of the shore communities, July VMT is nearly 50% greater than December VMT, indicating a highly seasonal VMT distribution. The July seasonal adjustment factors are represented in Figure 2. A July seasonal adjustment factor of 1.3 means that average daily traffic volumes in July are 30% higher than average annual daily traffic volumes.

Using information from the analysis of seasonal traffic patterns, an estimate of monthly municipal-level GHG emissions was developed. The analysis remains consistent with the NJTPA 2009 forecast for total annual direct emissions at a municipal level. This was accomplished by using the NJTPA direct emissions forecast for each municipality as a "control total" and adjusting the monthly allocation of GHG emissions to municipalities in proportion to the revised assessment of monthly VMT by municipality. Additional detailed information on the methodology and results is provided in Appendix E.

5-Figure 2 Monmouth County Seasonal Adjustment Factors



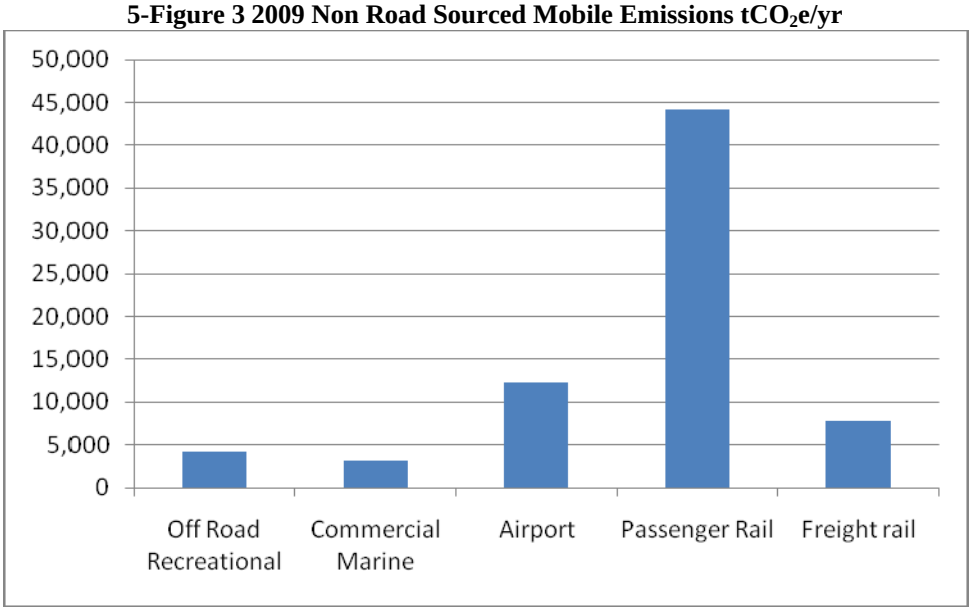
d. Non-Road Mobile Sources

Transportation related non-road emissions include the following: railway transportation; air transportation; off-road transportation; and marine transportation. The NJTPA study

provides the specific methodologies for deriving the GHG emissions for each of the non-road inventories summarized in this portion of the report.

Figure 3 shows that passenger rail has the highest emissions relative to the other non-road sources in Monmouth County. While passenger rail and freight rail do result in emissions, they generally contribute to a net reduction in total emissions because they reduce trips that would otherwise be made by autos or trucks and are more efficient than on-road vehicles on a passenger-mile and ton-mile basis. For instance, the GHG emissions from the NJ TRANSIT passenger rail line are equivalent to the annual GHG emissions of 8,650 autos. This is in contrast to the fact that the rail system transports over 11,000 passengers on an average weekday. That is a reduction of 2,350 autos and their potential GHG emissions.

5-Figure 3 2009 Non Road Sourced Mobile Emissions tCO_2e/yr



Source: NJTPA Regional Greenhouse Gas Emissions Inventory and Forecast

i. Rail

Monmouth County has one commuter rail line and multiple freight lines. Although the county's rail system also includes a military freight line and a small rail line in Allaire State park, they are not included in the study.

Passenger Rail

The rail emissions in Monmouth County covered in this report include both freight and passenger rail lines. To calculate the GHG emissions created by passenger trains in Monmouth County, the NJTPA created a measurement of rail track within the municipalities using Geographic Information System (GIS) software. Based on the length of track, a portion of the total rail GHG emissions is apportioned to that section of track.

Monmouth County has one passenger rail system known as the North Jersey Coast Line operated and maintained by NJ TRANSIT. Although the passenger line is counted as one route, the operations are actually two separate lines. One line ends in Long Branch and is powered by electrical systems. The other line (the Waterfront Connection) begins in Long Brach and ends in Bay Head, Ocean County. This line runs exclusively on diesel fuel south of Long Branch[66], however, during weekdays there are 5 round trip diesel trains run directly from Bay Head to Hoboken Terminal. This allows riders on the non-electrified part of the line to access Newark Penn Station and Hoboken Terminal on a one-seat ride. Table 3 presents the rail generated GHG emissions by municipality.

5-Table 3 2006 Rail Miles Traveled[67], Fuel Consumption, and 2009 Direct CO_2 Emissions by Municipality

	Annual Miles Traveled		MWh	MMBTU	2009 Emissions tCO_2^e/yr	
	Electrical Rail Line	Diesel Rail Line	2006 Electric Consumption	2006 Diesel Consumption	Electrical Rail Line[68]	Diesel Rail Line
Aberdeen	42,757	36,768	2,591	3,091	-	229
Matawan*	15,857	2,866	1,118	1,479	5,732	3,293
Hazlet*	35,456	6,782	2,499	3,500	1,743	1,300
Holmdel	40,976	7,837	2,888	4,045		299
Middletown*	101,331	19,382	7,141	10,002	3,146	2,600
Red Bank*	26,531	5,075	1,870	2,619	2,933	1,929
Little Silver*	39,724	7,598	2,799	3,921	2,303	1,658
Oceanport	32,483	6,213	2,289	3,206		237
Long Branch*	34,053	38,404	2,400	19,819	1,213	5,663
Ocean	-	10,900	-	5,625	-	416
Deal	-	16,648	-	8,591	-	635
Allenhurst**	-	6,866	-	3,544	-	583
Loch Arbour	-	1,148	-	593	-	44
Interlaken	-	3,196	-	1,650	-	122
Asbury Park**	-	17,712	-	9,141	-	1,553
Neptune Township	-	5,982	-	3,087	-	228
Bradley Beach**	-	12,807	-	6,609	-	929
Avon-by-the-Sea	-	14,576	-	7,523	-	556
Belmar**	-	11,410	-	5,889	-	982
Wall	-	10,332	-	5,332	-	394
Spring Lake**	-	27,511	-	14,198	-	1,462
Sea Girt	-	12,308	-	6,352	-	470

[66] All service south of Long Branch is diesel, generally utilizing Alstom PL42AC, F40PH-2CAT, or GP40PH-2B locomotives.

[67] Although 2006 miles are listed, a comparison of NJ TRANSIT service in Monmouth County showed little difference in the Coast Line's services for 2006 to 2009, therefore the miles traveled will be similar. Calculations are made using annualized weekday services only.

[68] Electrical GHG emissions are sourced only at station stops with electrical capabilities.

	Annual Miles Traveled		MWh	MMBTU	2009 Emissions tCO_2^e/yr	
	Electrical Rail Line	Diesel Rail Line	2006 Electric Consumption	2006 Diesel Consumption	Electrical Rail Line[68]	Diesel Rail Line
Manasquan**	-	16,720	-	8,629	-	1,057
Brielle	-	10,813	-	5,580	-	413

* All Jersey Coast Line Station Stops **Waterfront Connection Stops (Stops south of Long Branch and exclusively diesel)
Source: NJTPA Regional Greenhouse Gas Emissions Inventory and Forecast Study, 2010

According to the NJTPA's analysis, the total GHG emissions for the North Jersey Coast Line within Monmouth County (including the Waterfront Connection which is the section of track below Long Branch Station) are 44,123 tons of CO_2e annually. NJ TRANSIT estimates that there are 9,820 electric and 1,512 diesel trains per year from Aberdeen to Long Branch and an additional 6,181 trains that run south of Long Branch that run on all diesel.

Freight Rail

According to the Monmouth County Office of Economic Development, two freight carriers, CSX Transportation and Norfolk Southern connect rail freight users in Monmouth County to the North American railway network, in a shared service territory. Most routes are jointly owned by these two railroad companies, and provide shippers with an opportunity for competitive cost-effective railway transportation. The physical delivery of shipments in Monmouth County is handled by Conrail, which is jointly owned by CSX and Norfolk Southern, and serves as their local agent.

The NJTPA methodology for calculating rail freight emissions relies on miles and tonnage of cargo to create an average freight rail traffic density, or ton-miles per mile. The GHG emissions for the county freight lines were then estimated using a national average energy factor per ton-mile transported of 302 BTU/ton-mile. Table 4 presents the GHG emission estimates from the NJTPA study.

5-Table 4 2009 Monmouth County Freight Rail Direct GHG Estimates

Ton Miles	MMBTU	Emissions tCO_2e/yr
345	104370	7,718

Although this may seem to be a high amount of CO_2e emissions, on a per ton mile basis rail is significantly more efficient. According to analysis conducted by Oregon's Department of Transportation, trucks emit 310 CO_2e per ton mile while rail only emits 27 CO_2e per ton mile, nearly a 91% drop in emissions.[69]

ii. Aviation

[69] http://www.oregon.gov/ODOT/TD/FREIGHT/docs/FreightPlan100710/FreightClimate.pdf?ga=t

Monmouth County only has one executive airport with significant enough traffic to be measured. The Monmouth (Allaire) Executive Airport on Route 34 is privately owned and has 213 airplanes based at the facility.[70] Of the 213 planes, 84% are single engine, 9% are multi-engine, 4% are jet aircraft and 3% are helicopters. The data used to calculate the GHG emissions for the Monmouth Executive Airport is the EPA's 2008 National Emissions Inventory (NEI) landing-takeoff (LTO) data. Table 5 shows the emission factors for the majority of the aircraft found at the airport.[71]

5-Table 5 Emission Factors used for Various NEI LTO Categories

NEI Category	CO_2 Emissions (kg/LTO)	Representative Aircraft
General Aviation, Piston	0.23436	Beech King Air
General Aviation, Turbine	1.08623	Cessna
Air Taxi, Piston	0.23436	Beech King Air
Air Taxi, Turbine	1.08623	Cessna

Using the emission factors from Table 5, annual growth rates for LTOs in the NJTPA's report show that the Monmouth Executive Airport accounts for 2.9% of the region's landings and takeoffs and 12,000 tons of CO_2e emissions for 2009.

5-Table 6 2009 Direct Emissions from Monmouth Executive Airport

Landings and Takeoffs (LTOs)	2009 CO_2e Emissions (tons)
28,445	12,290

The NJTPA report also analyzed the GHG emissions created from the ground support vehicles at Allaire Airport (see Table 7). The overall fuel consumption and GHG impact of ground support at Allaire Airport is minimal to the county's overall emissions.

5-Table 7 Airport Ground Support Equipment

Fuel	2009 Fuel Consumption (gal/yr)	2009 Emissions (tCO_2e/yr)
Gasoline	13.6	0.11
LPG	15.5	0.09
Diesel	550.8	5.56

iii. Commercial Marine Vehicles

Emissions associated with commercial marine vessels (CMVs) in the NJTPA study cover all the major marine emissions categories, including ocean going vessels (OGVs), harbor

[70] FAA Master Record for BLM (Allaire Airport)
[71] The source of the airport GHG emissions estimates is Section 2.2.3 of the NJTPA's Regional Greenhouse Gas Emissions Inventory and Forecast Study.

boats, towboats, dredging boats, ferry boats, excursion vessels and government boats. Small, privately owned vessels are not included in the commercial category. Only emissions occurring within the three-mile demarcation line of the shore are included in this analysis. This is consistent with the boundary used for the ozone non-attainment area State Implementation Plan (SIP) emission inventory and the PANYNJ GHG inventory. Emissions come from fuel combusted in these vessels, both in the main engines for propulsion and in the secondary engines for electrical power and other onboard services.

Over the past two decades, modes of transportation within the county have been diversified by expanding ferry services to New York City and recently Jersey City.[72] Two major services, Sea Streak and NY Waterway, depart Monmouth County from the northern bayshore communities of Belford, Highlands, the Atlantic Highlands, and a seasonal stop at Sandy Hook.

Table 8 shows 3,200 tons of CO_2e were emitted by CMVs within Monmouth County in 2009.

5-Table 8 Direct CO_2 emission from Monmouth County CMVs

Type of CMV	2009 CO_2e/yr Emissions
Harbor boats	60
Dredging Boats	12
Ferry/Excursion	3,000
Govt Boats	131
Total	3,203

iv. Recreational Off-Road Vehicles[73]

Table 9 summarizes the GHG emissions off-road recreational vehicles based on the NJTPA study. The emissions estimates were generated using EPA's NONROAD2008 model.

[72] NY Waterway to offer Monmouth County-to-Jersey City ferry service, Jersey Journal, February 13, 2011
[73] Other non-road mobile source emissions such as construction vehicles, agricultural vehicles, and movable generators are not available currently in the NJTPA report. However, The NJTPA report states that emissions from these sources are relatively small.

5-Table 9 Off-Road Recreational Mobile Emissions

Type of Vehicle	Fuel and Engine Type	2009 Fuel Consumption (gal/yr)	2009 Emissions (tCO_2e/yr)
Motorcycles: Off-road	Gasoline, 2-Stroke	46,382	398
All Terrain Vehicles	Gasoline, 2-Stroke	48,422	416
Specialty Vehicles/Carts	Gasoline, 2-Stroke	12,395	106
Motorcycles: Off-road	Gasoline, 4-Stroke	13,561	116
All Terrain Vehicles	Gasoline, 4-Stroke	138,426	1,188
Golf Carts	Gasoline, 4-Stroke	200,093	1,718
Specialty Vehicles/Carts	Gasoline, 4-Stroke	12,599	108
Specialty Vehicles/Carts	LPG	1,220	7
Specialty Vehicles/Carts	Diesel	11,885	119
Total		484,983	4,176

e. Conclusion of Countywide GHG Inventory

Even though many think of their daily commutes and other trips as trivial to the overall emissions picture, when they are tallied together, Monmouth County's transportation sector generates a sizable amount of GHG emissions. Monmouth County's total direct transportation GHG emissions are 2.7 million CO_2e annually, 97% of which is generated by on road vehicles. To put that number into perspective, it equates to the CO_2 emissions of 6.2 million barrels of oil annually, or 302 million gallons of gasoline. To mitigate these effects, each resident would need to plant 107 trees and tend them for ten years to soak up the carbon emissions generated.

Although not all of the GHG emissions can be directly linked to every resident in the county, and some are attributable to visitors to Monmouth County, every resident in Monmouth County has the opportunity to make an impact on GHG emissions reductions.

6. Inventory of Alternative Transportation Infrastructure and Recommendations for Reducing Greenhouse Gas Emissions

a. Introduction and Methodology

The previous section provided the basis for the county's total transportation GHG emissions for 2009. This section provides a set of recommendations to assist in reducing transportation-related GHG emissions. The recommendations are based on a review of a variety of data sources including Environmental Impact Statements (EISs), academic studies, NJ TRANSIT reports, or other sources such as statistical analysis provided by the NJTPA, NJ TRANSIT, or NJDOT to assess the use, condition, and possible enhancement of alternative transportation infrastructure in Monmouth County to reduce GHG emissions.

For proposed infrastructure investments that are still in the planning stages, the estimated cost of infrastructure upgrades and investments was taken from a reputable source such as a publicly available Environmental Impact Statement or a comparable project report. In the case of infrastructure improvements that do not have such sources of information, alternative cost estimates were generated and documented for transparency. GHG emissions reductions were generated using ICLEI's *Clean Air Pollution Planning Assistant version 1.3* (CAPPA1.3®) tool as a base for comparison and understanding the impacts of each strategy.

All of the estimates are annual assessments that do not account for prolonged use of the investment. Therefore each cost to GHG emissions estimate is for the initial capital outlay, and its GHG impact for that year based on the current assumptions. In cases where the investment will go beyond one year, a dollar to pounds of CO_2e for the decade was estimated to show long term return on investment in terms of GHG reductions that would occur based on an extended current performance.

It should be pointed out that many of the recommended projects are still not fully defined in terms of their scope or scale. In some cases, such as the MOM rail line, underlying assumptions about ridership have changed due to the cancelation of the ARC project. This report makes no attempt to reevaluate the existing estimates and therefore the data presented should be used for preliminary comparative estimates only.

b. Highway Congestion Reduction Strategies

i. Existing Conditions

Although Monmouth County does not have jurisdiction over the Garden State Parkway (GSP), there is no doubt it is one of the most travelled roadways in the county. Any impact on VMT reduction that can occur on the GSP would reduce overall GHG

emissions for the county significantly. This is compounded if those VMT reductions occur during critical peak times when congestion is at its highest. Three options the county can recommend to the New Jersey Turnpike Authority to reduce GHG emissions on the GSP include: time of day pricing (congestion pricing), High Occupancy Tolls or (HOT) lanes, and High Occupancy Vehicle (HOV) lanes. With the recent cuts in transportation funding, these options are being reassessed within the state. However, the state does not currently support HOT or HOV lanes on the GSP.[74] While these may be options in the future, they are not discussed in this report due to the fact that they are very unlikely to be considered in a time frame that would be relevant to this study. This leaves time of day pricing, or congestion pricing, as the most agreeable option.

Time of day pricing is one strategy that highway authorities have used for travel demand management (TDM). The concept of using market incentives such as reduced priced tolls at off-peak hours relies heavily on traveler behavior. To assess the behavioral reactions of New Jersey motorists, the New Jersey Turnpike Authority, the owners of the GSP, initiated a time of day pricing initiative in September of 2000. The impacts of the initiative were studied by NJDOT and documented in a report published in 2005.[75] The study included a survey and micro-simulation model to estimate the impacts of the initiative on behavior and traffic flows with a subsection on GHG emissions. The survey found that respondents who indicated that they changed their travel behavior because of the time of day pricing program, accounted for 7.0 percent of individuals and 6.6 percent of car trips once weighted by trip frequency. The main reasons for not changing travel behavior include "no flexibility" (40.2 percent) and "my choice, I go when I want to go" (32.3 percent). The micro-simulation analyses showed that between 2000 and 2001, at the time of the pricing initiative, there was a reduction in emission levels as high as 10.7 percent. However, after 2001 a slight increase in emissions was observed due to the increasing demand, an expected outcome given the relationship among the demand, delays and emissions.

By charging users of the GSP during peak travel times a premium toll price, and offering users an off-peak price a discount, the initiation of this type of program has the ability alter the GSP user's behavior by "peak spreading". This means that some users will choose to not travel at peak time, but rather slightly before or after the peak times. This will save the user on toll charges and diminish congestion by reducing the number of autos on the road during peak periods. The use of seasonal time of day tolling is also an option. This initiative would be like any other time of day tolling program with the exception that increased tolling rates would take effect at peak time on summer weekends only.

[74] http://www.nj.com/news/index.ssf/2011/03/shaving_time_off_for_nj_commut.html

[75] Evaluation Study of New Jersey Turnpike Authority's Time of Day Pricing Initiative, NJDOT, May 31, 2005

ii. ***Recommendations***

To provide more congestion relief on highways and major corridors the county could advocate for market oriented solutions. To reduce congestion along one of its most used roadways, the GSP, the county could support the use of time of day pricing if and when it may be considered by the Turnpike. This can have the impact of "smoothing out" traffic to reduce congestion often caused by commuters using the facility all at the same time.

The implementation of time of day pricing on the GSP or tolls just within the Monmouth County would be a politically sensitive issue, even though the implementation cost of a time of day pricing initiative is low[76] (electronic tolling has the ability to change the price of the tolls at a minimal cost). These types of changes have typically taken place when the overall toll prices change.[77]

iii. ***Estimated Cost and Emissions Reduction Benefit***

Expansion of the congestion pricing initiative on the GSP has the potential to result in overall reductions in GHG emissions, especially in the short-term. This type of measure is not being considered by the state agencies at this time, but is a strategy that has been used in other places and has the potential to reduce congestion and related GHG emissions. A more thorough analysis of the cost/benefit ratio is included in Appendix E. Key considerations in estimating the benefits and costs of this initiative are as follows.

- Changes in average speed due to congestion
- Alternative routes chosen during peak traffic
- The cost of time for a commuter to travel during peak times versus off-peak times
- The sensitivity of peak hour commuters to a rise in toll pricing

Although the magnitude of the benefits is unclear, this strategy can be implemented at no net cost to county or state agencies and is likely to produce a net gain in revenue to NJTA overall. A recent study of traffic and revenue on the GSP conducted on behalf of the State of New Jersey (NJ Dept. of Treasury, 2008) indicated that traffic on the GSP is relatively inelastic to price changes. Overall price elasticity on the GSP was approximately -0.15 (for each 10 percent increase in price a 1.5 percent decrease in traffic can be expected). When factoring in the price elasticity response, a 15 percent increase during peak periods (similar in magnitude to that evaluated by NJDOT for a 10% savings in emissions) in toll prices can be expected to result in an overall net gain in revenue of 12 percent.

[76] A time of day toll increase or change would need a public relations campaign to make the users of the GSP aware if the price change.

[77] Time of day pricing has been instituted twice at all of the Port Authority river crossing facilities. Both times the price adjustments occurred when the whole system's pricing was being changed. This reduces the cost of public relations and educational campaigns to inform the public. The 2008 time of day pricing adjustment is only valid for E-ZPass users.

The extent of GHG emissions reductions from this strategy would depend on the pricing levels considered and would require detailed modeling to fully analyze the effects on GSP and other roadways. Because the effectiveness of this strategy is based on facility and area-specific factors which include one-way tolling on the GSP, we recommend that the county request a detailed simulation study before supporting implementation.

c. Bus Rapid Transit

i. *Existing Conditions*

Along with making SOV traffic more efficient through market force means, buses can also become more efficient through infrastructure investment. Currently NJ TRANSIT is expanding the use of highway shoulders for bus operations along Route 9. Buses are allowed to travel in the shoulder on a section of US 9 in Old Bridge Township (Middlesex County) all of the time, however their speed cannot exceed 35 MPH. Signage and bus stop pullouts protect buses and motorists where this special lane separation occurs. NJ Transit plans to expand this operation farther south into Monmouth County in the future. While this is not a true BRT in that there are not dedicated bus-only lanes, this type of investment will have a positive impact on Route 9 traffic congestion since the Route 9 corridor has a significant amount of commuter bus traffic. In addition, the increase speed of the buses may persuade more drivers to take advantage of the bus services, further compounding congestion relief.

ii. *Recommendations*

In addition to the changes in commuter bus service, the Route 9 corridor's local bus service can be made more efficient if made into a regional Bus Rapid Transit (BRT). BRT provides a faster, more efficient service than an ordinary bus line through the use of additional lanes used only by the bus service. Some think of it as "light rail on wheels". The typical BRT system is a bus system that has a dedicated lane which decreases their headways since no traffic can stop them or slow them down. The systems often have fewer stops then traditional local service, but very often the stops promote transit oriented development and higher densities similar to rail stops. Much like subways or light rail systems, the tickets are bought in advanced of getting on the bus to reduce waiting time at the stop. While there could be substantial reductions in GHG emissions with a true BRT on Route 9, it may prove practically difficult given the constrained rights of way. At this time, shoulder widening is the appropriate action for Monmouth County to advocate for at this time. The discussion of BRT is included in this document because it is an emerging strategy that can render significant benefits to congestion reduction and GHG emissions.

Although BRT systems have been extensively used outside of the United States, a growing number of BRT systems have recently been constructed over the past decade in more comparable areas in the US. Some examples are:

Newark's Go Bus- Go Bus, which is not truly a BRT, service operates during weekday morning and evening peak hours, with buses departing Irvington Bus Terminal every 15 minutes from 6:30 a.m. to 8:30 a.m., and Newark Penn Station every 15 minutes from 4:05 p.m. to 6:05 p.m. NJ Transit and the City of Newark have designated the center lane of Raymond Blvd as a priority bus lane during evening peak hours (3:30 – 6:30) in an effort to facilitate mobility and safety in the Newark Penn Station area. In addition to the dedicated lane, the system also has specialized signalization, and pedestrian improvements around the station will ease congestion, protect transit riders en route to and from the station, and keep buses running on schedule.

Cleveland Ohio's Healthline- A seven-mile system that takes a 100-passenger bus 35 minutes to travel from beginning to end. The system has 58 stops along the route and has boasted of $4 billion in new development along the corridor. The system cost $200 million to upgrade the local bus service to BRT.

Albany and Schenectady New York's BusPlus – The system extends for 17 miles and has 18 stops (down from the 90 used by the local bus service). The system was designed for both commuters and shoppers along the corridor. Albany has also changed their zoning and land use strategies to focus on transit oriented development in order to capitalize on the BRT investment.

In addition, a BRT along Route 1 in New Jersey has been studied extensively and continues to be under consideration for future funding.

Advocate for Improvements along Route 9 Corridor

The current bus system shoulder expansion is two to three years away from construction. This project would encompass enhancements to the shoulders to allow bus traffic and bus queue jumps to speed alighting of passengers. Analysis provided by NJ TRANSIT for the air quality improvements that can come from this project are described in the section below:

The proposed bus-only lane along the shoulder of Route 9 offers significant air quality savings. Potentially, approximately 27,500 miles of daily private auto VMT can be removed from the region with no additional transit service.

Modeling and Analysis Assumptions:

- *Forecasting year is 2015*
- *Bus travel time savings estimated at 5.2 minutes per trip*
- *1,200 additional daily bus trips created (as per model)*
    - *700 diverted from automobile*
        - *Approximately 27,500 auto VMT reduction*
    - *500 diverted from rail*
    - *Approximately 75% of diversions to bus are trans-Hudson*
- *Automobile average model year is 2012*

- *Trip Distribution (for all day, work, and non-work) for air quality modeling purposes:*

	AM	*Midday*	*PM Peak*	*Night*
VMT Distribution	*40%*	*20%*	*38%*	*2%*

Although this is not a full BRT, this improvement can be significant in terms of congestion reduction, single auto trip diversion, time savings, vehicle miles traveled, and therefore GHG emissions. Using CAPPA emissions factors, the CO_2e emissions reduction annually is approximately 20 thousand metric tons.

iii. *Estimated Cost and Emissions Reduction Benefit*

Although a Route 9 BRT study has yet to begin, and the data needed to estimate the GHG emissions reductions from a new BRT system on Route 9 are not available, comparative projects exist to provide some form of understanding on the impact of a hypothetical new system. The closest comparable project to the Route 9 BRT system in Monmouth County is the proposed Route 1 BRT between Trenton and South Brunswick. The project could result in a reduction of up to 368,000 VMTs annually by 2025 along the corridor depending on the alternative chosen. The preferred alternative shows 30,100 regional riders using the system annually.[78] Table 10a and 10b.1 present the potential cost saving and GHG reductions from a potential Route 9 BRT project.

Table 10b.2 presents many of the same assumptions as in Table 10b.1 but with a higher leverage factor which reflects an increase in the amount of transit oriented development around the system. The higher factor takes into account the county's effort to enact zoning and land use to promote denser residential areas and commercial spaces around stations. In other words, transit facilitates and encourages denser mixed-use development. This type of development results in shorter average trip lengths and allows more walking and bicycling than less dense forms of development.

[78] NJ TRANSIT, Central New Jersey Route 1 BRT Alternatives Analysis Study February 2006

5-Table 10a Estimation of Costs Savings and GHG emissions reduction due to BRT

30,100	Number of New Daily Transit Passengers[79]
$3.50	Price of Gasoline ($ per gallon)
50.0	Passengers per Vehicle[80]
2.7	Leverage Factor[81]
9.8	Average Trip Length (mi)
19.7	Average Passenger Fuel Economy
69,874,000	Annual Transit Passenger Miles
188,659,800	Annual Vehicle Mile Reduction
9,576,640	Annual Gasoline Savings (gallons)
442,675	Increased Diesel Use (gallons)

Source: The Louis Berger Group, ICLEI's CAPPA1.3

5-Table 10b.1 Estimated GHG Emissions[82] and Criteria Pollutant Reductions from BRT With a National Average Leverage Factor of 2.7

CO_2e (metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM10 (lbs)
40,852	-1,551	-1,260	3,216,812	332,956	4,795

Source: The Louis Berger Group, ICLEI's CAPPA1.3

5-Table 10b.2 Estimated GHG Emissions and Criteria Pollutant Reductions from BRT With a Higher Leverage Factor of 4.0

CO_2e (metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM10 (lbs)
62,553	5,336	-810	4,775,371	496,407	8,148

Source: The Louis Berger Group, ICLEI's CAPPA1.3

After a ten year period, the GHG reduction return for a BRT system would be 1.5 pounds of CO_2e per dollar. If zoning and land use around the BRT stations support TOD, the

[79] This translates to a 11,100 reduction in person trips by autos or 35% auto diversion

[80] American Public Transportation Association reports 9.4 passengers per vehicle for regular buses. However BRT typically has higher ridership levels. The more passengers per vehicle, the less energy per passenger. Sources: http://www.apta.com/research/stats/energy/efficiency.cfm Transportation and Land Use Coalition. www.transcoalition.org/reports/revolutionizing_transit.pdf

[81] 2.7 vehicle miles reduced/transit passenger mile. This is because transit encourages of dense neighborhoods, reducing trip length and shifting trips to walking and bicycle modes. Source: Holtzclaw. Does A Mile In A Car Equal A Mile On A Train? Exploring Public Transit's Effectiveness In Reducing Driving. http://www.sierraclub.org/sprawl/articles/reducedriving.asp.

[82] Assumes future emissions rates of ½ current rates

project would have a much larger leverage factor and increase the return on investment by 64%.

While there could be substantial reductions in GHG emissions reduction with the BRT, it may be practically difficult on Route 9 given the constrained right-of-way. At this time, shoulder widening is a step in the right direction, but would not derive the same benefits of a full BRT.

d. Park and Ride Lots

Park and ride lots are an extension of the transportation system that allow drivers to either transfer to another mode of transportation, or share rides. If lots are reaching or surpassing capacity, they can put a strain on demand for mode changing and ride sharing. According to NJDOT's park and ride inventory, Monmouth County has 49 park and rides. Of those 49, 13 are used by rail passengers. The others are used by either ride sharers (carpooling or van pooling) or bus riders. This section reviews the total NJDOT and NJ TRANSIT rail station park and ride inventory and provides recommendations based on the data gathered.

i. *Existing Conditions*

Rail Related Park and Rides

Table 11 presents the available parking spots and the average used spots on a normal weekday along the North Jersey Coast Line. A review of all of the parking facilities used by rail passengers shows that some rail stations have higher capacity utilization than others. However, the stations that often have only a few parking spots to offer are limited in their lot size and ability to expand due to their proximity to existing developments. Although this may seem to be an impairment to providing rail service, a closer review of rail ridership per station cross referenced with the available parking provides some explanation.

5-Table 11 NJ TRANSIT Parking Lot Capacity Utilization

Station	Capacity	Used	Capacity Utilization
Aberdeen-Matawan	2,150	1,508	70%
Hazlet	589	434	74%
Middletown	1,688	1,110	66%
Red Bank	812	623	77%
Little Silver	548	446	81%
Long Branch	331	248	75%
Elberon	222	74	33%
Allenhurst	95	74	78%
Asbury Park	65	38	58%
Bradley Beach	73	70	96%
Belmar	217	96	44%

Spring Lake	188	80	43%
Manasquan	127	102	80%
greater than or equal to 75% capacity			

Source: NJ TRANSIT 2010 Parking Guide Rail

Although the availability of parking can be an attraction to rail usage, the data suggests that some stations have a higher capacity to draw riders from other modes of transportation. Table 12a provides the available parking for each station and their respective average weekday ridership. Note that almost all stations have more riders than available parking; only two have a near one to one ratio, one car per one rider.

5-Table 12a NJ TRANSIT Station Used Parking Spaces to Average Weekday Ridership

Station	Parking Space Utilization	Ridership	Parking to Rider Ratio
Aberdeen-Matawan	1,508	2,790	1.9
Hazlet	434	971	2.2
Middletown	1,110	1,735	1.6
Red Bank	623	1508	2.4
Little Silver	446	916	2.1
Long Branch	248	1362	5.5
Elberon	74	217	2.9
Allenhurst	74	171	2.3
Asbury Park	38	642	16.9
Bradley Beach	70	286	4.1
Belmar	96	340	3.5
Spring Lake	80	239	3.0
Manasquan	102	243	2.4

Source: NJ TRANSIT 2010 Parking Guide Rail

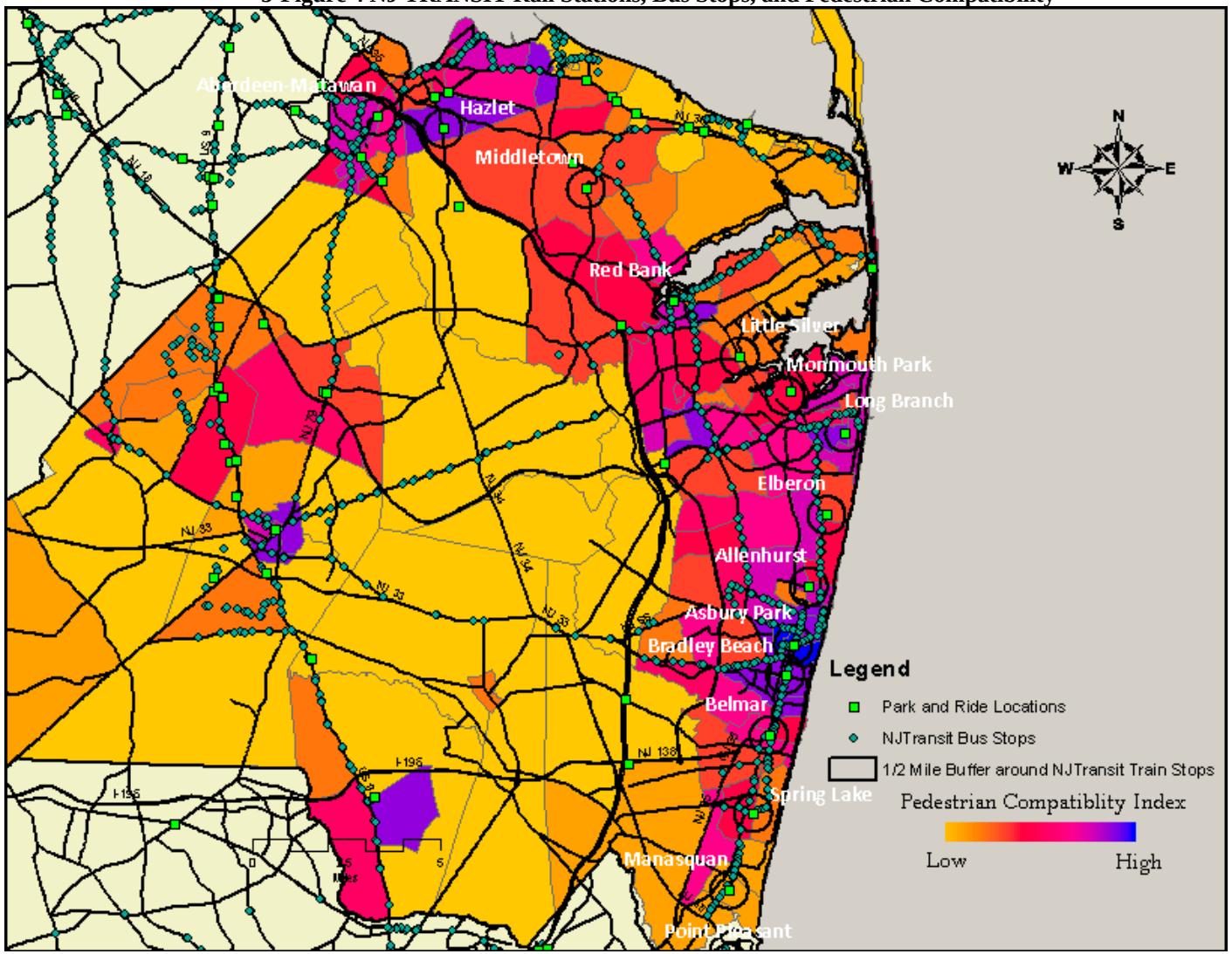
The conclusion from this analysis shows that not all rail riders are single occupants in their vehicles and that riders may either carpool to the station, get dropped off (partial carpool), use mass transit such as a bus to get to the station, or walk or bike. However, the riders could be using shared parking spaces not listed in the NJ TRANSIT database. To review these findings further a comparison of stations in terms of pedestrian compatibility and bus availability, a map of the NJDOT Pedestrian Compatibility Index and NJ TRANSIT's bus stops with Rail Station Park and rides is provided. Figure 4 presents a ½ mile buffer around the rail stations and their proximity to pedestrian compatible areas and bus stops. In addition, NJ TRANSIT's 2005 Rail Access Survey provides additional information on how residents access the rail stations. The data from the survey is presented in Table 12b below.

5-Table 12b NJ TRANSIT Rail Access Survey for Monmouth County Stations

Station	Drove alone and parked	Carpooled and parked	Car-Dropped off	Walk Only
Aberdeen-Matawan	**72%**	**6%**	**16%**	**5%**
Hazlet	63%	3%	17%	17%
Middletown	**76%**	**4%**	**12%**	**4%**
Red Bank	55%	2%	20%	18%
Little Silver	**67%**	**6%**	**16%**	**11%**
Long Branch	58%	5%	23%	9%
Elberon	**75%**	**9%**	**8%**	**8%**
Allenhurst	66%	1%	19%	10%
Asbury Park	*21%*	*2%*	*31%*	*37%*
Bradley Beach	*35%*	*6%*	*13%*	*39%*
Belmar	*54%*	*1%*	*14%*	*30%*
Spring Lake	*43%*	*7%*	*13%*	*37%*
Manasquan	53%	N/A	21%	22%

Source: NJ TRANSIT 2005 Rail Access Study (High Walking Rates **High Drive Alone Rates)**

5-Figure 4 NJ TRANSIT Rail Stations, Bus Stops, and Pedestrian Compatibility



Source: NJDOT, NJTPA

The map provides some confirmation that highly pedestrian friendly areas such as Long Branch, Red Bank, Asbury Park, Hazlet, and Bradley Beach have higher than average rider to parking ratios (which means more riders than parkers). Figure 5 also presents the interconnections between bus service and those stations as well. More suburban stations such as Middletown, which has a low pedestrian compatibility score and no NJ TRANSIT bus service, has nearly a 1 to 2 space to rider ratio.[83] In addition, the population density around stations that have high ridership to parking ratios is higher than more suburban setting that has a population that is spread out more, as seen in Figure 5. Currently the county runs a shuttle bus along Route 35 to the Middletown train station. The shuttle runs in the middle of the day and late at night to provide workers with a dependable mode of transportation to the rail station from the highly commercial corridor. This type of service provides a useful model of how the county can connect commercial corridors with rail service.

Bus and Ride Share Related Park and Ride Facilities

A majority of the park and ride facilities are present along major roadways such as the Garden State Parkway, Routes 9, 35, and 36. They are strategically located to allow easy access to and departure from the roadway. There is also a high correlation between the park and ride lots and bus stops. In addition, the park and ride lots are within areas with a higher population density and more frequent bus services. This allows them to have a higher efficiency in terms of mode changing. Figure 6 provides a detailed map on the locations of the park and rides defined by NJDOT. This figure provides support that the park and rides are within more populated areas and along major arterial roadways making them more accessible for people who live in the area.

The NJDOT website identifies five park and ride lots[84] in Monmouth County that are "at or reaching capacity". Three of the identified lots, Exit 109, the Academy Airport Plaza lot, and the Freehold Road/Route 9 lots are also used by the Academy Bus or NJ TRANSIT systems. However, two of these lots, Freehold Road and Airport Plaza lots, have additional parking around them to capture overflow.[85]

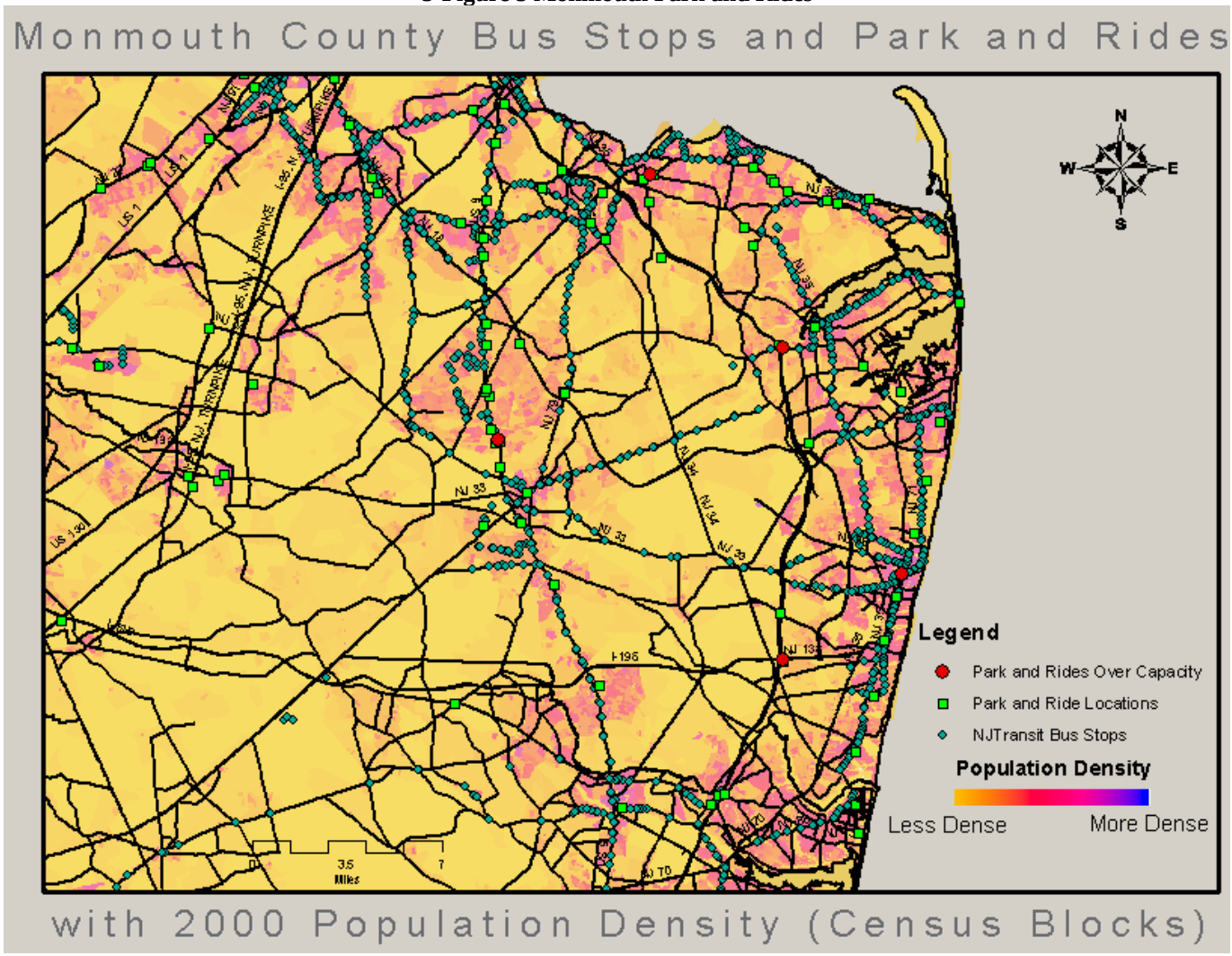
In addition to lots reaching capacity, other park and ride lots may not be managed properly. The mismanagement of parking facilities can leave empty spaces that are reserved and have only a limited number of spaces available to everyone. For instance, daily parking may only take up 20% of a lot, while the other 80% is reserved for monthly or annual pass holders. The reserved spots are 50% filled on a daily basis. This leaves the

[83] The 2010 parking data includes the Sears park and ride once serviced by the municipal shuttle. The municipal shuttle is not running as of 2011.
[84] The Asbury Park and Ride use shared by the Rail Station. The other lots are: GSP Exit 109 and 98, the Academy Bus Terminal at Airport Plaza, and Freehold Road and Route 9 lot.
[85] The Airport Plaza lot users can park across Route 36 in the Airport Plaza Mall. Freehold Road lots are adjoined by shopping mall parking. The Exit 109 lot has additional adjacent parking, lot; however, the adjacent lot is privately owned and does not allow public parking in their lots.

lot only 60% utilized. However, if the demand for daily parking is greater than the daily spots available, the lot is effectively over capacity for these types of users.

Other management strategies that alienate users are municipal only lots that do not have spaces for non-municipal or charge a fee that cannot be paid readily at the park and ride (i.e. parking passes need to be purchased at city hall). These types of strategies can make utilized mass transit cumbersome and difficult.

5-Figure 5 Monmouth Park and Rides



Source: U.S. 2000 Census, NJDOT, NJTPA

ii. *Recommendations*

The rail ridership to parking supply data lends support for Monmouth County to promote more Transit Oriented Development (TOD) around stations. It is recommended that the county advocate that municipalities rezone areas around existing rail stations for higher density mixed use development. If a Locally Preferred Alternative for the MOM line project advances in the future, Monmouth County should review the zoning and plans around proposed station areas to better advocate to municipalities and other stakeholders for TOD studies. The county should aggressively seek funding for studies that can better plan for changes in land use around the potential new rail line to both maximize ridership and minimize auto use.

The expansion of parking facilities around rail stations should be done with caution since the data shows that riders often find alternative ways to get onto the rail system without using parking. In addition, most rail stations in the county are within town centers or downtown areas where additional parking may interrupt the town's commercial character. The construction of large lots, decked parking, and similar types of facilities should be done with economic development and other development strategies in mind.

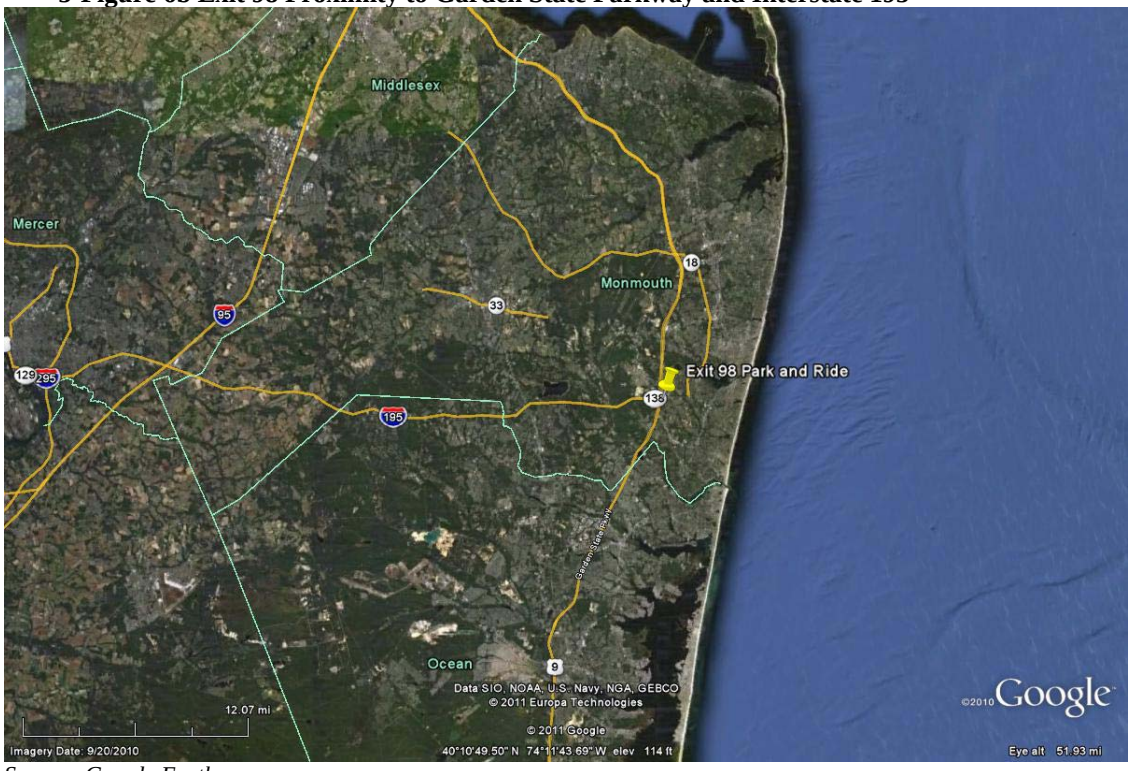
The county should look to expand park and ride facilities that have been identified as "at or reaching capacity". Although, as mentioned previously, these facilities may have land constraints, some lots may lend themselves to expansion.

Only one Park and Ride on the list of "at capacity lots" has the potential for expansion: the Exit 98 Park and Ride. As shown in Figures 6a and 6b, Exit 98's Park and Ride is fairly small, but is located at the cross section of two major arterial roadways, the Garden State Parkway, and Route 138/I195, that provides one of the only effective North/South and East/West links. However, the Exit 98 Park and Ride is limited in land as it is penned in by the right of way (ROW) ,but still has the ability expand by taking the entire parcel within the ROW. Although destroying the existing vegetation currently within the ROW for parking may not seem like the best solution, the loss of trees can be mitigated by providing newly planted trees and a more ecologically friendly Park and Ride. For instance, if trees are dispersed throughout the park and ride, they can provide shade which reduces gas vapor leakage, reducing evaporative emissions while the car is parked. The new park and ride can also use sustainable design to minimize stormwater run-off. The expansion of this park and ride would be responsibility of state agencies including the Turnpike Authority and NJDOT, but it is worth discussing in this report in that it is a strategy that could result in GHG emissions reductions.

5-Figure 6a Exit 98 Park and ride facility

Source: Google Earth

5-Figure 6b Exit 98 Proximity to Garden State Parkway and Interstate 195



Source: Google Earth

Monmouth County should also review municipally owned park and ride strategies to determine their impact on the total park and ride system. Part of this review should be an updated parking census of the park and ride lots along the Route 9 corridor. The census should identify the owner of the lots, types of spaces available (daily, monthly reserved, handicapped, other), the cost of use of the spaces, and monthly receipts if the lots charge for parking. The county should analyze this information on a basis for comparison between lots and the parking system as a whole. This effort should yield better understanding of utilization of parking in Monmouth County and allow the county to identify and fix problems caused by management strategies and not physical constraints.

iii. *Estimated Cost and* ***Emissions Reduction Benefit***

The expansion of the burgeoning Exit 98 lot would have a positive impact on the potential for ride sharing.

The Exit 98 park and ride lot is used by vanpool riders and carpoolers. The lot is already owned by either NJDOT or the Turnpike Authority since it resides in a right of way of the GSP and Route 138. Based on the park and ride lot's location and ownership, no additional studies would be needed and permitting for expansion and construction should be quick. Park and Ride construction costs can vary widely depending on the type of lot and the amenities the lot may possess such as bus stops, restrooms, so on. The construction cost estimate for the Exit 98 Park and ride assumes no amenities. Similar completed park and ride project construction costs have been $900,000 for a new 200 space parking lot.[86] Since the lot already has a little over 100 spaces an expansion could cost half of that amount, or $450,000.

It is assumed that there could be up to at least another 100 parking spots within the right of way that could be used by carpoolers. It is also assumed that the carpoolers travel further than 20 miles from the park and ride to get to their work that there would be at least two people, one driver and one carpooler, in the car thereby reducing the total trips by 50%. Tables 13a and 13b present the cost and GHG reductions from increased carpooling caused by the expansion of the Exit 98 park and ride.

5-Table 13a Exit 98 Park and Ride Assumptions for VMT and GHG Reduction

100	Carpool Users
$3.50	Price of Gasoline ($ per gallon)
50	Percent Reduction in Commute Vehicle Trips
20.0	Average One-way Commute Length (mi)
19.7	Average Passenger Vehicle Fuel Economy
480,000	Annual Vehicle Mile Reduction
24,365	Annual Gasoline Savings (gallons)
$85,279	Annual Cost Savings

Source: The Louis Berger Group, ICLEI's CAPPA1.3

[86] http://www.civiltechinc.com/parknridefacility/

5-Table 13b Estimated GHG Emissions and Criteria Pollutant Reductions Due to Additional Carpoolers at Exit 98 Park and Ride

CO_2e (metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM10 (lbs)
229	73	5	16,472	1,727	35

Source: The Louis Berger Group, ICLEI's CAPPA1.3

Depending on the overall cost of the park and ride construction, the county could reduce CO_2e emissions by 1.1 pounds per one dollar of investment assuming the low range ($450,000) of the construction costs. Over a decade the return on investment could grow to 11.2 pounds of CO_2e per dollar.

e. Pedestrian and Bicycle Facilities

At the time of the 2000 U.S. Census, 2% of Monmouth County residents walked to work, while bicycling accounted for 0.3% of commutes. As a "zero emissions" mode of transportation, increasing pedestrian and bicycle mode share (for both work and non-work trips) is a key strategy for reducing transportation-related GHG emissions. The provision of safe and attractive pedestrian and bicycle accommodations is essential to increasing walking and biking, and has numerous co-benefits in terms of public health and livability.

According to the Bureau of Transportation Statistics bicycling is the second most preferred form of transportation after the automobile, even ahead of public transit. Yet nearly half of all car trips are less than three miles in length. With the lack of safe bicycle or pedestrian options available the auto becomes the only feasible choice. If a family chooses to take their bicycles that three mile distance only twice a month instead of their auto, they have reduced their VMT by 75 miles.

i. Existing Conditions

The existing accommodations for pedestrians and bicyclists in Monmouth County are highly variable from place to place. Many traditional centers and communities and other centers have extensive sidewalk networks, while more suburban areas typically were developed with only motorized transportation in mind and lack sidewalks and pedestrian connections between adjacent developments.

The county has four multi-use bike/pedestrian trails that traverse through several municipalities. These trails are the Henry Hudson Trail, the Union Transportation Trail, the Freehold and Jamestown Rail Trail[87], and the Edgar Felix Memorial Bikeway.[88] A majority of all four of the bike/pedestrian trails have been used for rail transportation in

[87] The Freehold and Jamestown Rail Trail extends from Allaire State Park and turns into the Edgar Felix Memorial Bikeway at Hospital Road.

[88] Both the Henry Hudson and Union Transportation Trail are owned and operated by the County's Parks Department. The Edgar Felix Memorial Bikeway is owned and operated by Manasquan.

the past, but have since been abandoned and converted into multi-use trails.[89] Figure 7 shows Monmouth County's bike/pedestrian trails and their proximity to areas with high pedestrian compatibility.

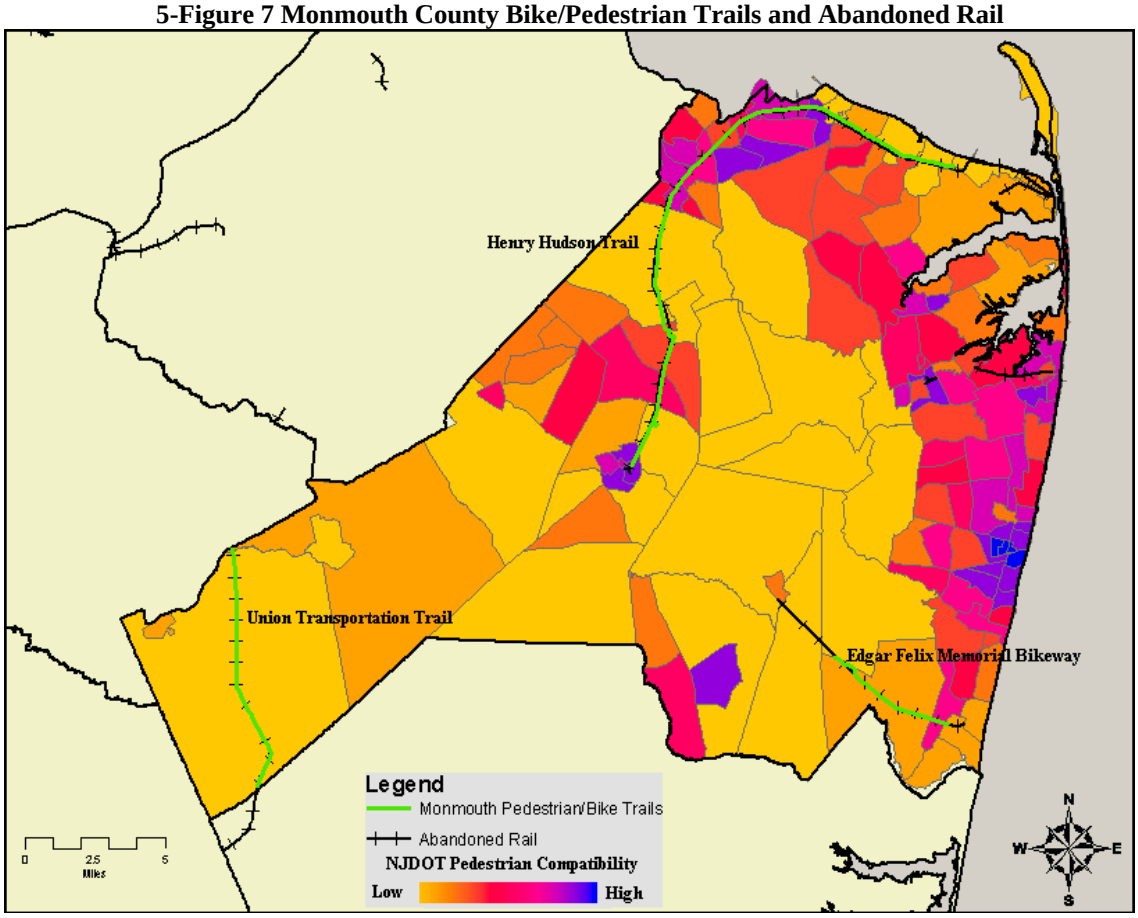
In addition to the development of the trails described above, Monmouth County has taken an active role in undertaking bicycle and pedestrian initiatives, including the following activities:

- Adoption of the first county Complete Streets Policy in New Jersey (See Section 5.2 for more information on Complete Streets).
- Multiuse trails within and connecting the County Park System.
- A Bicycle Map that includes ratings (good, fair and poor) of many roads in Monmouth County for bicycling based on consideration of traffic volumes, speeds, shoulder width, sight distances, curb cuts and other factors. See bike map in Appendix E.
- Participation in the NJDOT Planning Assistance Grant Program that generated bicycle and pedestrian plans for Red Bank, Ocean Township and Freehold Borough.

Monmouth County is about to embark on a Comprehensive Bicycle and Pedestrian Master Plan funded through the NJTPA's Subregional Study Program.. The Bicycle and Pedestrian Master Plan is expected to be adopted as an official policy in the county to ensure pedestrian and bicycle accommodations are incorporated into county road maintenance and new road projects, to encourage municipalities to incorporate pedestrian/bicycle considerations in their plans and understand future connectivity options and to better position the county for funding opportunities to develop new pedestrian and bicycle facilities. The plan is expected to place an emphasis on bicycle/pedestrian accessibility to, and travel for, residential, commercial and retail needs rather than simply for recreational purposes.

[89] The Freehold and Jamesburg Agricultural Railroad was a short-line railroad in New Jersey. Its former right-of-way, along with a portion of the Farmingdale and Squan Village Railroad's right-of-way, has become the Edgar Felix Bikeway and the Freehold right-of-way has become the Henry Hudson Trail.

5-Figure 7 Monmouth County Bike/Pedestrian Trails and Abandoned Rail



Source: NJDOT, NJTPA, The Louis Berger Group

ii. Recommendations

Complete the Comprehensive Bicycle and Pedestrian Master Plan

Monmouth County is already in the early planning stages for this project, which is expected to provide a strong basis for prioritizing future pedestrian and bicycle improvement projects in the county to create a connected bicycle and pedestrian network. The plan will have to involve the participation of the Monmouth County Engineering Department to ensure the feasibility and cost effectiveness of the recommendations. The plan will also provide crucial baseline conditions information on available infrastructure and areas of concern based on the occurrence of accidents involving pedestrians. To ensure a strong emphasis on pedestrian and bicycle issues in the planning process, Monmouth County should set countywide or region-specific pedestrian/bicycle mode share goals in the Comprehensive Bicycle and Pedestrian Master Plan.

For example, the Philadelphia Pedestrian and Bicycle Plan[90] includes the following goals:
• Increase Bicycle commute mode share from 1.6% to 5% by 2020
• Increase Walk commute mode share from 8.6% to 12% by 2020

Different areas of Monmouth County have different land use and urban environments with varying suitability for walking and biking to serve a larger proportion of transportation needs. Therefore, it may be reasonable to set higher goals for urban areas and lower goals for dispersed suburban and rural areas.

Ocean City: A Case Study in Effective Planning to Encourage Bicycling

Ocean City is an excellent example for Monmouth County communities in the successful planning and implementation of bicycle and pedestrian friendly streets. The centerpiece of Ocean City's efforts is the Haven Avenue Bike Boulevard, which runs 27 blocks between Route 52 and Roosevelt Boulevard, two access points connecting Ocean City, which is located on a peninsula, with the mainland. Completed in less than a year, the bike boulevard connects Ocean City's downtown, transportation center, community center and intermediate school. Automobiles have access, but are discouraged from using the bicycle boulevard through the use of "sharrows," imposing a 15 mph speed limit, and installing four-way stop signs. Implemented by city ordinance, these traffic calming measures were received positively by the community and have catalyzed bicycle connectivity throughout the community.

The bicycle boulevard is featured prominently in Ocean City's marketing materials, which use the tag line "America's Greenest Family Resort." For more information on Ocean City's bicycle initiatives and the ways in which these projects are used to attract visitors, refer to:

http://www.bikeocnj.org/

The plan should include a GIS inventory to establish priority roadways for bicycle and pedestrian improvements. This approach would include attributes such as proximity of destinations, and the land use at these destinations (i.e., the reasons for making the trip) should be incorporated into the inventory. The GIS should identify:

- existing bike/pedestrian paths on both county roads and roads maintained by municipalities,
- road segments best suited for bike/pedestrian improvements by application of attributes such as proximity and destination land use (short distances with high utility factors like schools or shopping areas), and
- roadway segments with rights-of-way or shoulders sufficient for development of bike/pedestrian improvements.

Planning for new bike/pedestrian paths should incorporate existing paths to ensure continuity between existing and new paths, and the county should coordinate municipal-level planning to ensure continuity at jurisdictional boundaries. By identifying roadways that link destinations most likely to attract bicycle and pedestrian transportation, and

[90] http://tooledesign.com/philadelphia/pdf/Pedestrian_Bicycle_Plan_Vision_Goals.4.20.pdf

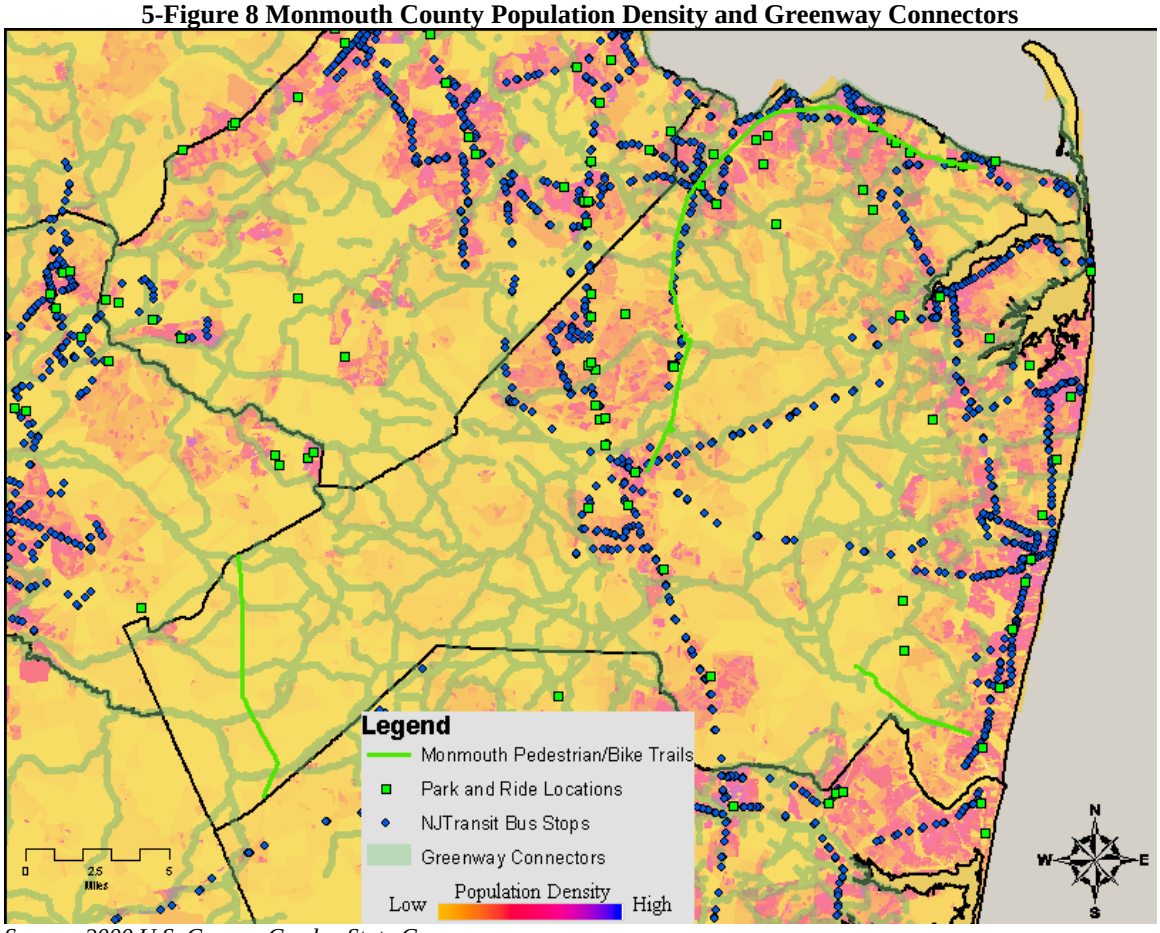
where development of bike/pedestrian paths is feasible, the county could develop a network of alternative transportation routes throughout the county.

The bike plan should have a high emphasis on connectivity in terms of mass transportation, connectivity to other municipal existing walkways or bikeways, public facilities such as parks, libraries, schools, commercial nodes and other amenities. Another key element to bike and pedestrian use is that bike and pedestrian transportation demand has less of a lower age limit. School children who would usually need a ride to a school would have the ability to use a bike or pedestrian facility to get to school. Therefore, the plan should include the Safe Route to Schools program. Safe Routes to School (SRTS) is a federal, state and local effort to enable and encourage children, including those with disabilities, to walk and bicycle to school - and to make walking and bicycling to school safe and appealing. In New Jersey, as in other parts of this country, travel to school by walking and bicycling has declined dramatically over the past several decades. The adverse impacts of this trend on air quality, traffic congestion and childhood health are alarming. The goal program is to assist New Jersey communities in developing and implementing projects and programs that encourage walking and bicycling to school while enhancing the safety of these trips.[91]

The plan should also include an evaluation of "Green Infrastructure" in Monmouth County and how bike and pedestrian investments can leverage this type of infrastructure to enhance connectivity in the county. Figure 8 shows Garden State Greenway's Greenway Connectors, a form of "Green Infrastructure", and the Monmouth County's population density along with transportation facilities. Greenways are often natural areas that conserve wildlife, but they can also be places that provide recreational opportunities, such as parks or biking trails. A prime example of a greenway is the Appalachian Trail, which runs from Georgia to Maine. However, not all greenways are vast, open trails. Greenways can also be a city's interconnected system of parks.

[91] http://www.state.nj.us/transportation/community/srts/

5-Figure 8 Monmouth County Population Density and Greenway Connectors



Source: 2000 U.S. Census, Garden State Greenways

Bike Sharing Pilot Program

Bike sharing is a strategy for making bicycles available to people who may not own their own bicycle but would use a bicycle for short trips if one was available. In Monmouth County, there is a specific opportunity for a bike share program to take advantage of the large number of visitors in the shore communities of Monmouth County during the summer months. Many visitors would likely be interested in biking, but may not be able (or motivated) install and use bike racks on their vehicles. Others may not own a bicycle due to storage limitations at their residence (e.g. small apartments). A bike share program would give these visitors a convenient alternative for getting to local attractions within a few miles of their vacation property. Designing the bike share program to be complementary to NJ TRANSIT could encourage some visitors to take the train and use bikes at their destination.

It is recommended that Monmouth County seek grant funding as it may become available to partner with a local shore community, NJ TRANSIT, Meadowlink (the transportation management agency that covers Monmouth County), and a bike enthusiast organization

(profit, or non-profit) to help establish a pilot program to gauge the interest of a weekender bike program. The pilot program would not be a full scale operation but rather a small program whose mission is to test the feasibility of a program's success for the summer tourist season. To date, no publicly-owned and administered bicycle sharing program has yet been able to consistently operate as a self-funding enterprise, using only revenues generated from membership subscriptions or user fees and charges. As a consequence, most publicly-owned bicycle sharing systems utilize funding from public governmental and/or charitable sources. These types of programs have been used extensively in parts of Europe and South America.

NJTPA has recently funded a pilot bike share system in Newark that will consist of six automated stations and 48 bicycles in a network around the New Jersey Institute of Technology and Rutgers Newark campuses. The bicycles will be available for rental 24 hours a day, 7 days a week for a small fee. The project is being implemented by Meadowlink and will include the creation of a toolkit to assist other agencies with the development of bike share programs.

iii. Estimated Cost and Emissions Reduction Benefit

The Comprehensive Bicycle and Pedestrian Master Plan is estimated to cost $250,000. The cost of the facility improvement aspects of the pedestrian/bicycle recommendations cannot be quantified in a straightforward manner because the costs would depend on the number and extent of projects undertaken. However, it is important to note that numerous federal funding sources for pedestrian and bicycle projects are available, including Transportation Enhancements, the Congestion Mitigation and Air Quality (CMAQ) Improvement Program, and Community Development Block Grants for streetscape improvements intended to revitalize neighborhoods.

The GHG emissions reduction benefits of the various recommended strategies that can come from the Master Plan are difficult to precisely quantify at this time. To help put the GHG savings from bicycle and pedestrian trips into context, Table 14 summarizes the GHG savings associated with varying levels of displaced auto trips based on the CAPPA software.

5-Table 14 Greenhouse Gas Emissions Reduction from Increased Bicycle and Pedestrian Trips

Number of Weekly Trips Switching From Car to Bike or Walking[92]	Annual CO_2e Reduction (metric tons)
100	7
500	37
1,000	75
5,000	373
10,000	745

[92] Assumes a 3 Mile trip

Based on the Newark Bike Sharing Program's budget of $400,000 for 48 bikes, the Monmouth County pilot project would likely be half the size. Therefore the pilot bicycle sharing pilot program in a shore community would cost $200,000 to cover initial capital costs for purchasing the bicycle fleet, installing the bike racks, advertising and program administration. Some operational revenues for the program could be recovered through advertising on the bicycle and the rental fees charged to users, but it is expected that the program would require continued operational support.

Based on a 24 bike fleet and assuming that each bike will be used for at least ten miles a day for the summer season (120 days), the pilot program would reduce GHG emission by 14 tons of CO_2e annually. Tables 15a and 15b present the assumptions and the GHG emissions reductions.

Table 15a Bike Share Pilot Program Assumptions for VMT and GHG Reduction

24	Number of Bicycles Available
$3.50	Price of Gasoline ($ per gallon)
5	Average Trips per Bicycle per Day
2.0	Average Trip Length (mi)
100	Percent of Trips Displacing Car Trips
$8,304	Program Implementation Cost per Bicycle
19.7	Average Passenger Vehicle Fuel Economy
28,800	Annual Vehicle Mile Reduction
1,462	Annual Gasoline Savings (gallons)
$5,117	Annual Cost Savings
38.9	Simple Payback (years)

Table 15b
Estimated Greenhouse Gas and Criteria Pollutant Emissions Reductions from Bike Share Pilot Program

CO_2e (metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM10 (lbs)
14	4	0	988	104	2

The pilot project would have a .15 pounds of CO_2e reduction per dollar. If it is assumed that the pilot project's life cycle is five years, then total return on the investment in terms of pounds of CO_2e reduced per dollar of .76.

f. Transit Facilities and Services

Monmouth County has some transit options available to residents who may need, or choose, to travel without using their own vehicle. The bus and rail systems are somewhat limited but do provide some alternatives in certain locations throughout the county.

i. Existing Conditions

Bus System

Monmouth County has a variety of bus services offered throughout the county which provide both local and regional services. Of the regional services a significant amount are dedicated commuter buses that travel to New York City on weekdays. Figure 2 presents bus stops and their proximity to population centers in Monmouth County. Note that a significant amount of bus services are present within densely populated corridors.

A majority of the bus services in Monmouth County originate from "Transportation Hubs" that include rail stations. These "hubs" are Asbury Park Rail Station and the Red bank Rail Station. Another "hub" that does not include rail service, but includes a variety of bus services is the Freehold Center. As shown in Figure 2 Monmouth County's bus services branch out from these locations, but most of the bus services do not cross west of the Route 9 corridor. Many of the bus routes are limited to weekday service and do not run in the evenings or weekends.

A review of 2009 commuter patterns provided by the Census's Local Employment Dynamics shows that a majority of Monmouth County residents either stay in the county or travel north for work. Only a small fraction of residents travel westward to Mercer County. Table 16 shows the percentage of county residents based on where they work by county.

Table 16 Residential Commuter Patterns
(Live in Commuter Shed-Work in Counties)

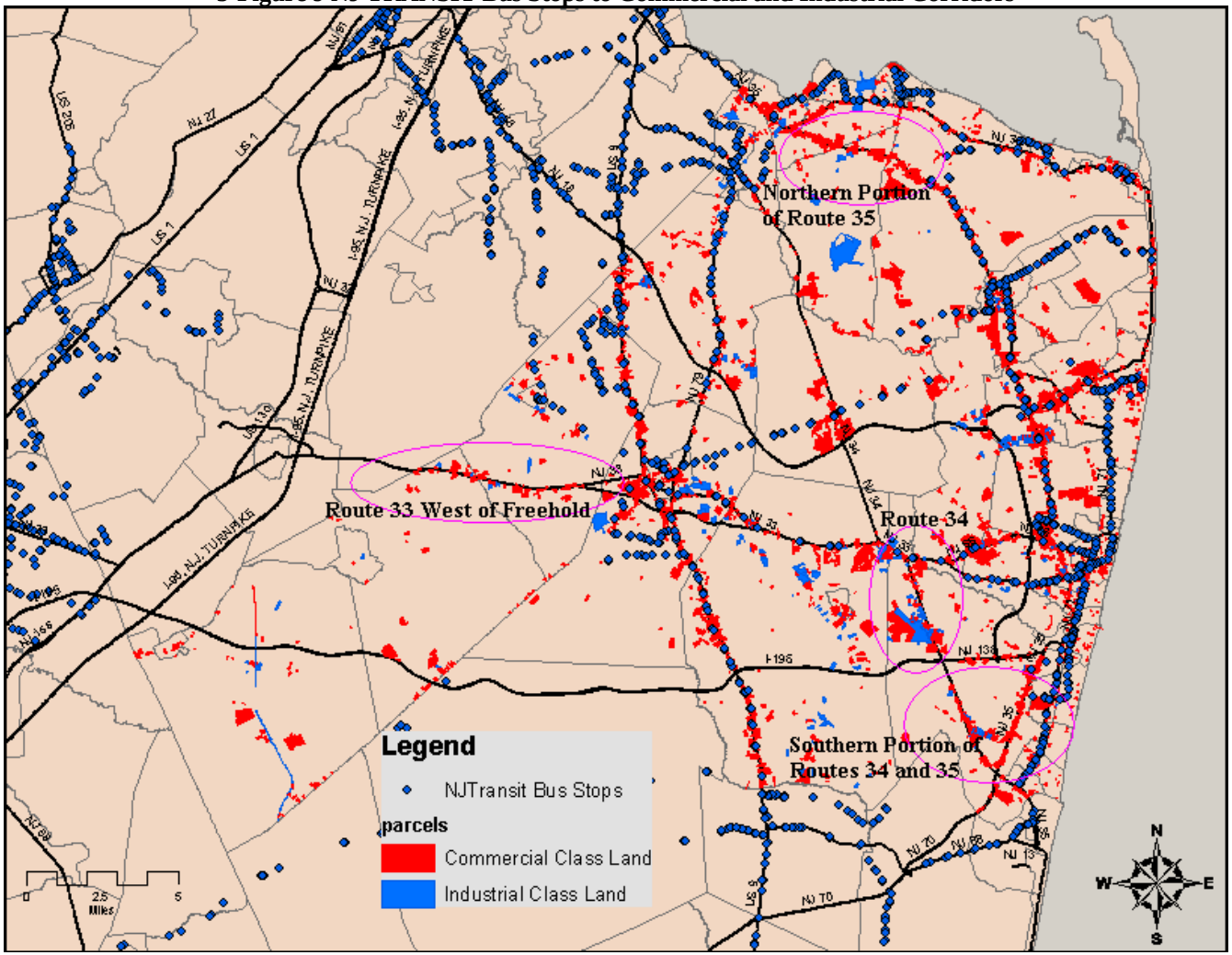
Where Monmouth County Residents Work	Countywide	
	Count	Share
Monmouth County, NJ	129,593	45.5%
Middlesex County, NJ	33,129	11.6%
New York County, NY	19,571	6.9%
Mercer County, NJ	8,386	2.9%
Ocean County, NJ	14,899	5.2%
Essex County, NJ	10,036	3.5%
Union County, NJ	9,855	3.5%
Bergen County, NJ	8,592	3.0%
Hudson County, NJ	7,510	2.6%
All Other Locations	43,322	15.2%

Source: 2009 LEHD Census

Since a nearly half of Monmouth County residents both live and work in Monmouth County, a review of the NJ TRANSIT bus stops and commercial and industrial corridors was undertaken to assess whether the bus system services major employment centers in the County. Figure 9 presents the parcels for commercial and industrial classed[93] land. The areas circled in red are commercial and industrial clusters that are not currently being serviced by any bus stops. These underserved commercial corridors include Route 33 west of Freehold, Route 34 (south of Route 33 and north of Route 138), the northern portion of Route 35 in Hazlet and Middletown, and the southern portions of Routes 34 and 35.

[93] The parcel classification system is used by the tax assessor's office in the MOD IV tax parcel data collected by municipalities. The tax parcel classification system is not zoning related and is only limited to the parcel which is being assessed and how it is represented for tax purposes.

5-Figure 9 NJ TRANSIT Bus Stops to Commercial and Industrial Corridors



Source: NJTPA, NJ TRANSIT, NJ Office of Information Technology, Office of Geographic Information Systems

To gauge the supply of bus services to meet the demands of Monmouth County residents, a full inventory of bus services was created. Table 17 presents an abbreviated NJ TRANSIT and Academy bus service inventory for the Monmouth County area.

5-Table 17 Bus Service in Monmouth County

Carrier	Bus Route or Number	Monmouth Stops	From/To	Weekday Service times	Avg. Headways
NJ TRANSIT	64*	Marlboro, Manalapan, Freehold, and Howell	Lakewood/Jersey City and Weehawken	*Morning and Evening Rush Hours*	Peak Service
NJ TRANSIT	67*	Marlboro, Manalapan, Freehold, and Howell	Lakewood/ Newark	*All Day*	1 Hour
NJ TRANSIT	133*	Aberdeen and Matawan	Lakewood/New York City	*Morning and Evening Rush Hours*	Peak Service
NJ TRANSIT	139*	Marlboro, Manalapan, Freehold, and Howell	Lakewood/New York City	*All Day (Reduced Afternoon Service)*	Peak Service
NJ TRANSIT	317*	Asbury Park, Belmar	Asbury Park/Camden, Philadelphia	*All Day*	2 Hours
NJ TRANSIT	830	Asbury Park, Belmar, Avon-by-the-Sea, Wall, Spring Lake, Sea Girt, Manasquan	Asbury Park/Point Pleasant	*All Day*	1 Hour
NJ TRANSIT	831	Red Bank, Shrewsbury, Eatontown, West Long Branch, Long Branch	Red Bank/Long Brach	*(5:55 am to 5:55 pm)*	1 Hour
NJ TRANSIT	832	Asbury Park, Ocean, Oakhurst, Eatontown, Shrewsbury, Red Bank	Asbury Park/Red Bank	*(6:40am to 9:30 pm)*	1 Hour
NJ TRANSIT	833	Freehold, Colts Neck,	Freehold/Red Bank	*(8:36am to 6:16*	1 Hour

Carrier	Bus Route or Number	Monmouth Stops	From/To	Weekday Service times	Avg. Headways
		Lincroft, Red Bank		*pm)*	
NJ TRANSIT	834	Highlands, Middletown, Leonardo, Red Bank	Highlands/Red Bank	*(7:00am to 8:00pm)*	1 Hour
NJ TRANSIT	835	Sea Bright, Rumson, Fair Haven, Red Bank	Sea Bright/Red Bank	*(5:30am to 6:20pm)*	1 Hour
NJ TRANSIT	836	Freehold, Neptune, Asbury Park	Freehold/Asbury Park	*(5:40am to 9:40pm)*	1 Hour
NJ TRANSIT	837	Ocean, Deal, West Long Branch, Long Branch,	Freehold/Asbury Park	*(8:00am to 6:50pm)*	1 Hour
Academy	Rt. 9 to New York*	12 stops in Howell Township, 6 Stops in Freehold, and 11 stops in Manalapan	Lakewood/New York City	*Morning and Evening Rush Hours*	Peak Service
Academy	Rt. 36 to New York*	Sea Bright, Port Monmouth, Leonardo, Atlantic Highlands, Highlands, Long Branch and North Middletown	Long Branch/New York City	*Morning and Evening Rush Hours*	Peak Service
Academy	Parkway to New York*	Exit 109, PNC Arts Center (Holmdel), Monmouth Rest Area	Forked River/New York City	*Morning and Evening Rush Hours*	Peak Service
Academy	Shore Points to Port Authority *	Sea Girt, Spring Lake, Belmar, Avon, Bradley Beach, Ocean Grove, Deal,	Point Pleasant/New York	5:00 am to 6:00 pm	Peak Service

Carrier	Bus Route or Number	Monmouth Stops	From/To	Weekday Service times	Avg. Headways
		West End, Long Branch, Oceanport, Little Silver, Eatontown, Fort Monmouth, Shrewsbury, Red Bank, Lincroft			

Source: NJ TRANSIT and Academy Bus Schedules **Commuter Bus Line*

As an enhancement to the services provided, NJ TRANSIT is equipping 1,040 buses in their existing fleet with GPS technology within 18 months. Another 1,145 new buses the agency is receiving by 2013, as it replaces older vehicles, will already have the technology.[94] Based on this investment NJ TRANSIT has instituted a text service for bus riders that provides the time of the next bus at a particular stop to assist riders. The service, called My Bus, uses a mobile phone's text service to alert the passenger about when the next bus is scheduled to stop. The service relies on a sign posted next to the stop which contains a "Bus Stop#". The user dials into the service, enters the number, then waits for the service to send a text message telling the user when the next bus arrives. However, this service assumes that riders have a cell phone and that the signage is in place.

Additional enhancements to the NJ TRANSIT fleet, and other fleets leased, or operated by other vendors such as Academy, that would reduce GHG emissions are vehicle upgrades. Currently New Jersey has a statute specifying upgrades for New Jersey Transit that incorporates cleaner fuel busses. The statue states:

All buses the New Jersey Transit Corporation (NJTC) purchases must be: 1) equipped with improved pollution controls that reduce particulate emissions; or 2) powered by a fuel other than conventional diesel. Qualifying vehicles include compressed natural gas vehicles, hybrid electric vehicles, fuel cell vehicles, vehicles operating on biodiesel or ultra low sulfur fuel, or vehicles operating on any other bus fuel the U.S. Environmental Protection Agency approves.
New Jersey Statutes 27:1B-22

In addition to cleaner burning buses, equipment enhancements can help in reducing GHG emissions. The installation of bike rack systems on all Monmouth County buses can foster bike use along with mass transit use. The racks can also be used as a catalyst for better biking facilities throughout the county.

[94] http://www.nj.com/news/index.ssf/2011/02/nj_transit_buses_to_be_equippe.html

Other equipment enhancements such as fuel efficient private shuttle services, SCAT services[95], and Meadowlink's seasonal Shorelink Shuttle would assist in reducing direct GHG emissions while also removing vehicles from the roadways.

Rail System

Monmouth County is serviced by NJ TRANSIT's North Jersey Coast Line and has thirteen stops in Monmouth County along the eastern (coastal) portion of the county. Riders who use stations south of Long Branch need to change trains in order to continue on the system.[96] Table 18 presents the average weekday boarding along the North Jersey Coast Line Train from its northern most station in Monmouth County, Aberdeen-Matawan to its most southern station in Monmouth County, Manasquan.

5-Table 18 Monmouth County NJ TRANSIT Stations
Average Weekday Passenger Boardings History, FY 2003 – 2010

Station	2003	2004	2005	2006	2007	2008	2009	2010
Aberdeen-Matawan	3,048	3,058	3,094	3,226	3,315	3,306	3,048	2,790
Hazlet	979	988	992	1,040	1,108	1,112	1,065	971
Middletown	1,876	1,632	1,880	1,955	2,006	1,970	1,886	1,735
Red Bank	1,740	1,643	1,599	1,625	1,630	1,689	1,607	1,508
Little Silver	943	924	916	930	982	1,031	994	916
Long Branch	1,310	1,294	1,320	1,393	1,432	1,450	1,369	1,362
Elberon	211	218	228	238	245	257	255	217
Allenhurst	144	139	156	160	198	210	202	171
Asbury Park	601	618	651	706	699	686	634	642
Bradley Beach	288	277	282	299	303	325	308	286
Belmar	298	312	330	360	397	402	298	340
Spring Lake	257	273	270	279	304	280	234	239
Manasquan	187	191	211	238	254	263	240	243
Total	11,882	11,567	11,929	12,449	12,873	12,981	12,140	11,420

Source: New Jersey Transit

The level of weekday boarding passengers has declined nearly 12% since the peak ridership in 2008. However, this might be attributed to the economy slowing down and therefore fewer commuters taking the train to work. Another contributing factor in reduced ridership may be the 2010 fare increase of 25% for all NJ TRANSIT commuter trains. However, the fare increase only had a small impact on the ridership shown in Table 18 since it occurred only in the last two months of the fiscal year in 2010.

Ferry System

Monmouth County has the great fortune of having a coastline that is amenable to ferry services traveling directly to New York City. The county has two main services in several ports along the Bayshore.

[95] Recommendations for the County's SCAT fleet is presented in Section 4.a of this report
[96] The Coast Line system uses an all diesel rail line south of Long Branch.

The ferries are also connected to other modes of transportation such as NJ TRANSIT local bus lines, the county's Route 35 shuttle, and the Henry Hudson bikeway making them an attractive alternative for commuters.

Although the ferries are convenient modes of transportation to the New York City and Jersey City, offering a traffic-free scenic commute, the major deterrence for many commuters is the steep price compared to other modes of mass transportation. A monthly pass on the Seastreak or New York Waterways ferries is $700 and $666 respectively and a 10 trip pass, which equates to 5 back and forth trips or one work week's commuting cost, is $200[97]. This is twice the price of the bus and rail services. Many commuters view the ferry system as a premium upgrade in the commuting experience and therefore are very sensitive to economic conditions such as job losses or gas price increases which get passed on as gas surcharge fees. As an example, the recent economic downturn has negatively impacted the ridership of the ferry services[98].

ii. Recommendations

Based on these observations of the existing conditions the following strategies can be applied to reduce GHG emissions. Although there are a variety of different strategies, this report reflects practical solutions and projects that are part of the Monmouth County's long term planning.

Bus System Recommendations

Expansion of bus services in Monmouth County can lead to reductions in GHG but also economic development for sections of the county and transportation for people who do not have their own means of transportation.

Improved Bus Service to Existing Commercial and Industrial Corridors
Bus service expansions into the commercial corridors presented in Figure 7 should also be a priority. The current political climate for expanding bus service to "select growth markets" is favorable and funding should be secured from the state to accomplish this goal[99]. Monmouth County should make itself identifiable as a "Growth Market" using its expanding industrial and commercial corridors as evidence. Support for these expansions can also come from other advocacy groups whose main purpose is to employ Monmouth County residents who may not be able to get to work using their own vehicle for one reason or another and therefore must rely on the bus system.

Consistency in Schedules and Stops for Existing Routes
Some NJ TRANSIT buses in Monmouth County have inconsistent schedules and stops. A bus may intermittently have stops along the to-and-from route that do not provide

[97] This would amount to 11% of a median family's income in Monmouth County.
[98] http://www.mycentraljersey.com/article/20080806/STATE/80806007/Ferry-ridership-down-between-NJ-and-NYC
[99] http://blog.tstc.org/2011/03/10/a-boost-for-bus-service-in-nj-govs-budget/

consistency. For instance, NJ TRANSIT bus number 836 has one stop at the Monmouth County Human Services building when traveling to Asbury Park, at 5:07 pm, but makes two stops, 8:29 am and 12:50 pm when traveling in the opposite direction from Asbury Park to Freehold.[100] The inconsistency can cause confusion and dissuade riders who prefer a more fixed route. Since these routes are slight deviations from the normal course, their impact would be minimal, but may attract more riders due to their consistency.

This holds true for similar stops along routes where waits between buses are inconsistent and can span several hours. Again, the NJ TRANSIT's bus line 836 schedule shows that some stops to shopping facilities along Route 66 can have a 1 hour, 2 hour, of even 2 ½ hour headways depending on the time of day. New riders or riders who cannot understand the schedule may have difficulty in understanding the headway time changes and decide not to take the system in the future due to the long waits that they perceive as unpredictable service. This problem is compounded if the buses are late, or have additional problems, like breakdowns or heavy traffic, and the patrons then get on the wrong bus thinking their stop is on the route.

"My Bus" Improvements

Although the addition of the "My Bus " smart bus location service is a great improvement, the county can recommend to NJ TRANSIT to install "Smart Bus Stops" in select areas that provide updated times when the next bus will arrive on a small screen to accommodate riders that may not have cell service, such as the elderly or low-income.

To assist NJ TRANSIT in making their system more attractive and safe the county and municipalities can provide improvements in planning around transit stations. Although NJ TRANSIT maintains the stations, proper planning in the vicinity of mass transportation facilities can determine the amount of riders that use each station and, therefore, the contribution of that station to overall system efficiency. County and municipal investment in transit stops and surrounding areas can help ensure that these facilities are safe and comfortable, and that they meet passenger needs, and that they contribute to the overall vision for the community. Several municipalities in New Jersey have enacted bus stop ordinances[101] to assist in the implementation of bus stop ridership needs. Through these ordinances, NJ TRANSIT provides the upgrading for the bus stop. Municipalities would need to provide funding for the bus stop signs and bus shelters in their area.

Expansion of Bus Service

Expansion of bus service for NJ TRANSIT costs approximately $7.40 per revenue mile for the agency. This cost is based on the 2009 fiscal year's financial data for the entire bus system and may change due to fuel costs. Table 19 presents the revenue miles that would be the base for the bus service expansion. The round trip length assumes the

[100] This should be reviewed in the context of the county's 836 Job Match Program which matches jobs with riders of the 836 bus line.

[101] Examples of municipalities with bus stop ordinances include Monroe, East Brunswick and Scotch Plains.

corridor's length for a two way trip however, a more efficient route could be found. The total annual cost for the additional services would be approximately $1.4 million.

5-Table 19 Operational Cost Estimates for Bus Service Expansion

Expansion Route Covered	Round Trip Length (in miles)	Annual Estimated Operating Costs[102]
Rt. 35 (Middletown and Hazlet)	10.4	$280,134
Rt. 34 (south of Rt. 66 and north of Rt. 70)	15.6	$420,202
Rt. 33 (East of Freehold)	14.4	$387,878
Rt. 35 (south of Rt. 138 and north of Rt. 70)	10.2	$274,747
Total Bus Service Expansion Estimates	50.6	$1,362,962

Source: The Louis Berger Group

As displayed in Tables 20a and 20b, the base ridership scenario's GHG emissions reduction are estimated to be 18 CO_2e annually. The success of this initiative will depend on the amount of new ridership captured by the new services. The dollar per pound value for the base scenario is for every $1 of operation to .01 pounds of CO_2e. However as the ridership estimate increased the higher scenario ratio is .06 pounds of CO_2e per dollar. This would equate to fifty new riders per line extension.

5-Table 20a Bus Service Assumptions for VMT and GHG Reduction

Estimation variables	Lower Scenario	Base Scenario	Higher Scenario
Number of Additional Daily Bus Passengers	50	100	200
Price of Gasoline ($ per gallon)	$3.50	$3.50	$3.50
Average Trip Length (mi)	5.0	5.0	5.0
Average Fuel Economy	19.7	19.7	19.7
Annual Vehicle Mile Reduction	57,500	115,000	230,000
Annual Gasoline Savings (gallons)	2,919	5,838	11,675
Increased Diesel Use (gallons)	1,945	3,891	7,781

Source: The Louis Berger Group, ICLEI's CAPPA1.3

[102] Assumes a 10 trip schedule for the entire week and a 52 week year. The operational costs do not reflect administrative overhead.

5-Table 20b Estimation of GHG Emissions Reduction Due to Bus Service Expansion

MOM Alignments

Ridership Estimate Scenario	CO_2e (metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM10 (lbs)
Lower Scenario	9	-61[103]	-9	1,884	178	-5
Base Scenario	18	-122	-18	3,769	357	-11
Higher Scenario	36	-244	-36	7,538	713	-21

Source: The Louis Berger Group, ICLEI's CAPPA1.3

These estimates also translate to the extension of bus service hours. Currently many bus lines in the county only operate during "working hours", 6:00 am to 6:00 am. However, a variety of businesses such as restaurants, retail, and others have longer work day hours. This limits the effectiveness of the bus system since many of the workers who could use the system must rely on other means of transportation after a certain time.

Upgrade of Bus Shelters (GPS enabled Shelters)

The costs for bus shelters can range wildly depending on the type of shelter and the amenities the shelter offers. For instance some shelters offer free wifi powered by solar while other offer basic shelter from the elements. The most credible resource for cost estimates are the signs that were installed at Rutgers University. Each GPS sign cost $3,000 with additional costs for installation[104].

The county should work with NJ TRANSIT to study bus shelter usage in the count to identify the most utilized bus shelters in order to maximize the technology's exposure and provide better service to a greater amount of riders.

Although the direct impact of enhanced bus shelters is currently unknown numerous studies have shown that a more predictable bus service increases ridership. It is assumed it may be comparable to the ridership increases shown in lower scenario in Table 12a and 12b. Therefore this initiative has a $30,000 expenditure and 9 tons of CO_2e reduction. The efficiency of this initiative would then be .65 pounds of CO_2e reduction per dollar.

Rail System Recommendations

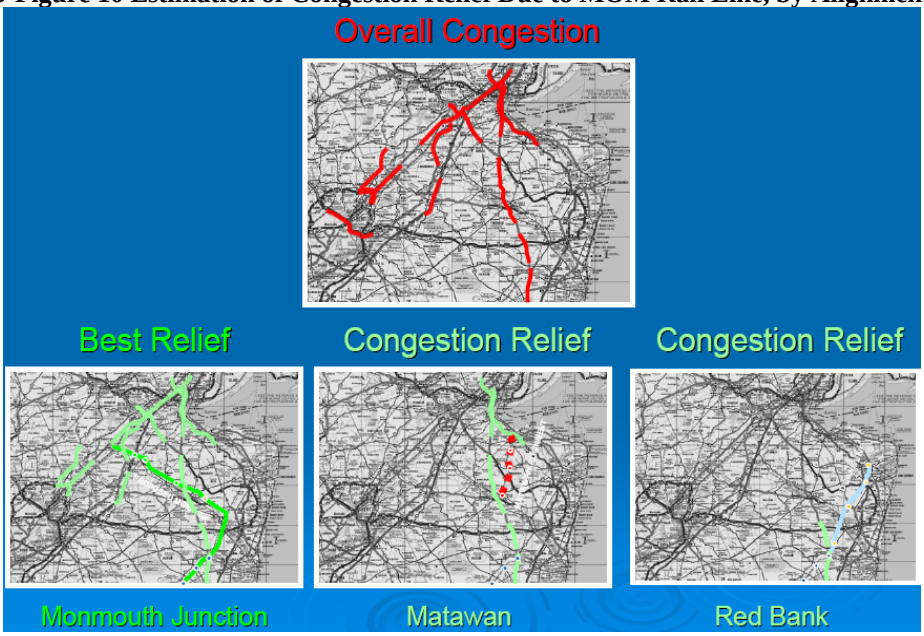
No additional service along the North Jersey Coast Line is anticipated by NJ Transit at this time. However, he addition of a rail service covering other parts of the County should be addressed The County can, and has, advocated for an additional rail line that reaches into Monmouth County's western areas which are un-served by rail and have very limited bus service.. The Monmouth-Ocean-Middlesex line, or MOM, is a proposed expansion on the NJ TRANSIT rail system that currently has three potential alignments

[103] Negative emissions equates to an increase due to additional diesel fuel use. These estimates do reflect a more efficient bus as outlined in the new purchasing statute (stated in Section 3.5.2)

[104] http://rneedsu.rutgers.edu/proposal_zeller.pdf, The total estimated cost according to the Rutgers budget is $305,225. This includes 45 GPS bus locator signs, 39 GPS installations on buses, installation and software, and annual costs for licensing and maintenance. It is assumed the County would use vendors provided by NJ TRANSIT to align with their existing technology.

under evaluation that cross Monmouth County in different ways. The most attractive alternative for Monmouth County, the Monmouth Junction Alternative, is estimated to have 41,000 boarding a day.[105] This could drastically reduce GHG emissions along the busy Route 9 corridor and surrounding roadways. Monmouth County will, and should, continue to advocate for the Monmouth Junction Alternative. It is a long term solution that would benefit Monmouth, Ocean and Middlesex Counties and would reduce VMT and associated GHG Emissions and congestion.

5-Figure 10 Estimation of Congestion Relief Due to MOM Rail Line, by Alignment



Source: Monmouth County Planning Board

Improvements to the North Jersey Coast Line

An additional option for the county is to advocate the use of bio-diesel in the existing North Jersey Coast Line Train that runs on the diesel only line south of Long Branch. Amtrak recently received a $274,000 grant from the Federal Railroad Administration to test the feasibility of using Bio-Diesel in one of its lines. Amtrak said stationary locomotive tests of burning B20 (which is 20 percent biodiesel and 80 percent diesel) cut hydrocarbons and carbon monoxide each by 10 percent, particulates 15 percent and sulfates 20 percent. If the same bio-diesel blend is used on the Coastline south of Long Branch and the same results occur, the estimated GHG emissions reduction would be nearly 1,600 tCO2e annually, or the annual greenhouse gas emissions from 285 passenger vehicles, on that section of the line alone.

A similar study conducted by Rowan University concluded that both the GP40FH-2 and PL42-AC, engine types used by NJ TRANSIT, can operate on alternative and B20 Summer blends with no unacceptable loss in power production and no increased fuel consumption. The PL42-AC can also successfully operate on the alternative winter fuel

[105] Not all 41,000 passengers will be boarding in Monmouth County. Data provided by the M.O.M. line Draft Environmental Impact Statement.

blends and actually showed an increase in horsepower. The alternative summer blends resulted in reductions in exhaust opacity of up to 50% with respect to the #2 diesel baseline[106].

To increase the efficiency of diesel only lines the NJ TRANSIT recently purchased "Dual-Power" locomotives which can use both the electrical line and its own diesel engine. However, the locomotive would still need to use its diesel engine in areas where no electrical service is available, such as the portion of rail service south of Long Branch. This could allow a one seat ride to New York or Hoboken from points south of Long Branch. Monmouth County should advocate that the Coastline alignment receive the new "Dual Power" locomotives.

Bio-Diesel Use in North Jersey Coast Train

Unlike the GHG reduction estimates used in the other proposed strategies in this report, the use of bio-diesel in the NJ TRANSIT Coastline system is fairly straight forward calculation. Instead of estimates of use, the GHG reduction can be calculated by using the differences in the bio-diesel and status quo diesel emissions and the price spread between the two fuels. Tables 21a and 21b present the GHG reduction of 10,000 gallons[107] of fuel used and the average price for both fuels.

5-Table 21a GHG Emissions reductions of using 10,000 gallons of B20 Blend

CO_2e (metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM10 (lbs)
14.6	29.82	8.82	142.17	16.78	12.81

Source: Biodiesel.org Emissions Calculator

5-Table 21b Regular Diesel and Bio-Diesel Prices 2010[108]

Fuel Type	$ Per Gallon
U.S. No 2 Diesel Retail Sales by All Sellers	$3.07
Bio-Diesel B-20 Blend	$3.14
Per Gallon Price Difference	$0.07

Source: DOE, EIA

Since no retrofitting or changes to the diesel engines being used is needed the cost of switching to a cleaner fuel is only the price difference between the two fuels, in this example 7 cents. On a dollar per pound of CO_2e basis, the bio-diesel initiative achieves a 46 lbs CO_2e per dollar. It is assumed that if ferries are able to use the B20 diesel blend, the same results would apply.

[106] http://www.nj.gov/dep/oce/biodiesel_NJ TRANSIT_fullreport.pdf

[107] It is assumed that 10,000 gallons of fuel translates into 150 round trips from Long Branch to Bayhead

[108] Regular diesel prices are sourced from the Energy Information Administration (EIA), Bio Diesel Prices are sourced from the Department of Energy's Clean Cities Alternative Fuel Price Report, October 2010

Monmouth-Ocean-Middlesex (M.O.M.) Rail Line

The M.O.M. line represents the long term plan for the Monmouth County's transportation future. Although the various alignments can have different impacts in terms of ridership and therefore local and highway traffic congestion relief, the final estimation of outcomes is too varied for detailed analysis.[109] However, there is little doubt that the additional rail service would provide VMT reductions in areas formerly un-serviced by a rail system.

Ferry System Recommendations

The ferry service during the summer months should be increased and coupled with shuttle services to move tourists from the ferry to points along the shore. According to Seastreak their service provides transportation to the beach from the city to over 600 people a day during the summer. They note that the first boat on a weekend is often packed, reaching the 400 person capacity[110]. The county has shuttle services that can be used to accommodate ferry passengers including the Route 35 shuttle (Dock and Roll), the Shorelink shuttle. The increase in popularity of the ferry service on weekends makes the services of shuttle more important. Increases in shuttle services can help spread out tourists throughout the shore area and the more frequent, reliable services will draw new tourists and bring other coming back.

One possibility that is currently being planned is the link between Manhattan and Long Branch's new Pier Village development using the ferry systems. Once a docking platform is created it would allow Monmouth County access to a large volume of tourists every weekend while eliminating the traffic that usually comes with them.

Much like the southern portion of the NJ TRANSIT system in Monmouth County, the ferries run on diesel fuel. It is recommended that the ferry operators do a study to test the feasibility of running their engines on bio-diesel.

Although a shuttle system that services only ferry customers during the summer season seems as if it can make only a small GHG reduction impact, the synergetic partnership of shuttles and the ferry make the total system of ferry and shuttle more attractive to tourists.

Tables 22a and 22b present estimations for both ferry ridership and shuttle service users. It assumes that an additional 100 people would use the ferry service due to the shuttle service and estimates that the new ferry riders would have traveled the 120 miles from and to New York City and approximately 10 miles, 5 miles to and from the ferry, on the shuttle service. The cost of the shuttle service for 12 hours of daily service for a four[111] day weekend is approximately $2,700 for the weekend according the Monmouth County's current shuttle costs.

[109] Additional rail ridership GHG emissions estimates use current emissions rates.

[110] http://www.mycentraljersey.com/article/20080806/STATE/80806007/Ferry-ridership-down-between-NJ-and-NYC

[111] Assumes a Friday to Monday weekend service to accommodate people staying an extra day or leaving early Monday morning

5-Figure 22a Ferry and Ferry Shuttle Service Assumptions for VMT and GHG Reduction

Shuttle Service Use	Ferry Service Use	Total	
100.0	100.0		Number of Additional Ferry Passengers
$3.50	$3.50		Price of Gasoline ($ per gallon)
20.0	120.0	140.0	Average Trip Length (mi)
19.7	19.7		Average Passenger Vehicle Fuel Economy
2,000	12,000	14,000	Vehicle Mile Reduction
102	609	711	Gasoline Savings (gallons)
68	406	474	Increased Diesel Use (gallons)

5-Figure 22b GHG Emissions Reduction Due to Ferry and Ferry Shuttle Service

Type of Service	CO2e (metric tons)	NOx (lbs)	SOx (lbs)	CO (lbs)	VOCs (lbs)	PM10 (lbs)
Ferry Shuttle	0.3	-2	0	66	6	0
Ferry Service from New York	1.9	-13	-2	393	37	-1
Total	2.2	-15	-2	459	43	-1

Without the shuttle service the additional riders would not have used the ferry system since they would have felt as if they were stranded at the landing area. On an average weekend the dollar to CO_2e is 1.8 pounds of CO_2e reduction per one dollar to run the shuttle service. This estimate capitalizes on the $45 ferry ticket the riders have purchased to use the ferry service. The combination of shuttles and ferry service makes this project a unique public private partnership.

g. Prioritized List of Transportation-Related Greenhouse Gas Emissions Strategies and Projects

Below is a list of the prioritized transportation-related investments that will reduce GHG emissions. All of the data is presented as mutually exclusive strategies which means that one project does not account for the impact on another. For example, if the Route 9 BRT project is completed then the MOM project also becomes active; the impact on ridership between these two projects is not accounted for in the numbers below.

In addition, synergetic initiatives, such as improvements in GPS enable bus shelters and additional bus service, are not calculated in a compounding fashion. In other words, new shelters that are GPS enabled may attract more riders on the new lines thereby making both of the GHG reduction to cost rations higher. Although each strategy is measured separately, they can be enacted upon as parts of a whole strategy, like a bus strategy whose components are new bus lines and better bus shelters.

The full list of project analyzed in this report and their attributes are presented in Table 23. This task of the report explored methods to reduce county-wide GHG emissions whether or not Monmouth County has direct control over making the project happen. It is understood that most of the strategies involve other agencies and organizations. It is important, however, to list the projects for future consideration anyway. Reducing Greenhouse Gases is an effort that cannot be done by one agency for one specific area. It requires cooperative efforts among many agencies and responsible parties. Potential GHG emission reduction strategies are listed here as a starting point for the region to work cooperatively on this issue. These top six projects have the most potential for reducing GHG emissions while maintaining fiscal prudence, with the understanding that Monmouth County cannot do many of them without cooperation and funding:

Create a County Bike and Pedestrian Master Plan- Although the GHG reduction is unclear, the potential upside for GHG reductions and improved livability in the County makes this initiative a high priority. It is a starting point upon which specific projects can be based in the future.

Bike Sharing Pilot- Recent efforts in the state as well as in other areas around the region to promote biking through bike sharing programs lends support to this project. This effort would require multiple agencies and funding sources and would likely be a public/private partnership.

Exit 98 Park and Ride Expansion – The expanding of a highly demanded park and ride would promote carpooling along a highly desirable east/west/north/south interchange. The costs should be minimal due to its current state (ownership and in a Right of Way) and the GHG emissions can be great. This initiative would have to be undertaken almost entirely by other agencies and is mentioned due to its cost effectiveness.

Local Shuttles to Park and Rides and Seasonal Shuttles for the Shore Area- There is potential to use a variety of federal and state funding sources to work with Meadowlink TMA and the private sector to provide shuttles that make it more convenient for people to use transit for all or part of their trip.

Run the NJ TRANSIT Coast Line south of Long Branch on Bio-diesel- The dollar to GHG emissions reduction is the highest and it takes no effort other than swapping out fuels.

Creation of the M.O.M. Rail Line- An additional rail line servicing Monmouth County would allow for additional growth in the county and limit the GHG emissions by providing a reliable alternative to driving. This is a long term strategy for which there is no current funding. It is included in this list because it is so critical to the future of Monmouth County.

5-Table 23 Summary of Potential Transportation Projects and Programs to Reduce GHG Emissions

Initiative	Cost	Pros	Cons	Potential GHG reduction	Dollar per GHG reduction
Time of day Toll Pricing	Small Marketing Campaign, But Long Term Revenue Generator	Reduce traffic congestion. Long-term revenue generator. Can support other initiatives such as Flex Time.	May not change driver behavior. Not likely given current economic and political conditions.	10.7% of GHG emissions along the Garden State Parkway	Potential for Revenue
Bus Rapid Transit	$600 and $700 million	Has the potential to enhance economic development along the Route 9 corridor. Can reduce Route 9 congestion	Significant capital investment to reconfigure the corridor. High amount of community input is needed. May not be practical at this time due to necessary ROW acquisition and availability of funds	Direct GHG impact 40,000 CO_2e tons Annually	1.5 pounds of CO_2e per $ (over 10 years)[112]
Route 9 Bus Improvements	$10 million[113]	Commuter Time Savings, Congestion reduction	Not a full BRT System	Direct GHG impact 20,000 CO_2e tons Annually	4.4 pounds of CO2e per $
Exit 98 Park and Ride Expansion	Between $450,000 and $900,000	Expands east-west/north-south car and vanpooling potential.	May not see additional use.	229 CO_2e tons Annually	Between 5.6 and 11.2 pounds of CO_2e per $ (over 10 years)

[112] *direct impact of riders only, assumes a ½ GHG emissions rate to account for future improvements is fuel efficiency in autos.*
[113] NJTPA lists this project's budget as to be determined. Conversations with NJ TRANSIT provided a range with 10 million as the midpoint.

Initiative	Cost	Pros	Cons	Potential GHG reduction	Dollar per GHG reduction
Bike and Pedestrian Master Plan	$250,000	Will provide a roadmap for Monmouth County and municipalities to develop an efficient bike and pedestrian network.	Only a plan, actualization needs to occur.	N/A	N/A
Bike Sharing Pilot	$200,000	Add to shore community character. Reduce traffic along local roads and highways. Make using transit to reach shore destinations more attractive.	Continued financial support would be needed for the program. Would need to have a local business partner. Potential for theft.	14 CO_2e Tons Annually	.75 pounds of CO_2e per $ (over 5 Years)
Expansions of Bus Routes	$1,400,000	Buses services can promote economic development. The employer pool for job seekers who do not have access to a car will expand.	Entirely dependent on NJ Transit and funding limitations.	Between 9 and 36 CO_2e Tons Annually	Between .01 and .06 pounds of CO_2e per $
Upgrading of Select Bus Shelters	$30,000	May encourage new ridership due to real time bus location information	Ridership may not increase. Potential for vandalism.	9 CO_2e Tons Annually	Between .65 pounds of CO_2e per $
M.O.M. Rail Line	Between $1.0 and $1.8 Billion	Would provide new rail service to western portions of the county. Provide a catalyst for economic development. Reduce Traffic Along Roadways in the County	Significant up-front capital costs when there are other priorities for the state.	N/A	N/A

Initiative	Cost	Pros	Cons	Potential GHG reduction	Dollar per GHG reduction
Using Bio-Diesel in NJ TRANSIT Trains South of Long Branch	An additional .07 cents per gallon	No initial capital investment needed. No changes in service needed.	Price of the fuel could become higher. Extended use could cause problems.	14.6 CO_2e Tons per 10,000 Gallons of Fuel	46 lbs CO_2e per dollar
Seasonal Ferry Shuttle Service	$2,700 for a four day weekend. The shuttle runs 12 hours a day	Can increase tourism and allow non-beach areas additional tourists		2.2 CO_2e Tons for one Weekend	1.8 lbs CO_2e per dollar of public investment

7. Recommendations for Reducing Greenhouse Gas Emissions Through Transportation and Land Use Policies/Regulations

a. Introduction

Although municipalities cannot restrict their residents' traveling and commuting patterns, they do have the opportunity to shape the future of their transportation options through land use planning. Land use has a significant impact on the transportation choices available to residents as the distance between different land uses affects a person's choice of travel between them. Communities that provide opportunities for work, shopping, recreation and schooling within walking or biking distance from housing, and also provide infrastructure to accommodate these alternative modes of transportation, can expect a decrease in private automobile use.

According to the Bureau of Transportation Statistics, bicycling is the second most preferred form of transportation after the automobile, even ahead of public transit. Additionally, the number of walking trips taken by Americans has more than doubled in the last 20 years, from 18 billion in 1990 to 42.5 billion in 2009, according to a new report. The number of bicycling trips has also more than doubled, from 1.7 billion to 4 billion. Perhaps even more significant, the share claimed by walking and bicycling of all trips taken by Americans has climbed by 50 percent, from a combined 7.9 percent to 11.9 percent.[114]

With the increased interest in biking and walking, it can be expected that if destinations were within a reasonable walking or biking distance, this transportation mode would increase at the expense of automobile transportation. However, even if destinations are within walking and biking distance, with the lack of safe bicycle or pedestrian options available the automobile may becomes the preferred mode of transportation.

The lack of pedestrian and bicycle facilities not only increases automobile use and the attendant GHG emissions they also can reduce resident's physical well-being, hurt the town's livability, and produce more costs for road maintenance and potential for accidents. For these reasons many areas are reviewing their land use plans, as well as their transportation networks, to provide better multi-modal access. Monmouth County has taken the progressive step toward safer more multi-modal friendly roadways by adopting a Complete Streets Policy and by initiating the process to develop a Comprehensive Bicycle and Pedestrian Master Plan for the county.

[114] Federal Highway Administration, The National Biking and Walking Study: a 15-Year Status Report, 2011.

b. Complete Streets Policy

i. Policy Issues

A review of the Complete Streets resolution that Monmouth County has adopted shows that the county follows many of the national best practices in the creation of the policy.[115] The policy appears to be modeled after the NJDOT Complete Streets Policy. However, there are ways the policy could be clarified and strengthened. The policy could wield greater influence if a few additional measures were enacted. For instance, the resolution states that the county will "Create a comprehensive integrated, multi-modal network," then later restricts itself to projects under its jurisdiction. This policy is correct in establishing the logical boundaries of control, but it should be noted that to create a truly comprehensive county-wide Complete Street Policy, all of the jurisdictions should be on board, not just the state and county roadways, which account for a small percentage of roads in Monmouth County. Currently only one municipality in Monmouth County, Red Bank[116], has passed a Complete Streets Resolution. The lack of other jurisdictions in Monmouth County to enact similar policies limits the success potential of the county's efforts.

ii. Recommendations

It is recommended that the county interpret the fore mentioned policy element more broadly to include the engagement of municipalities to enact their own Complete Street policies as part of the creation of a comprehensive multi-modal network. It is also recommended that the county follow the policy leads of other areas that have created a Task Force to spread the policy to other jurisdictions.

In that spirit, the county could set about providing an overall Complete Street vision for the county that is dependent upon municipal action. Existing documents and efforts such as the Western Monmouth Development Plan can be used to stimulate municipalities and coordinate plans with adjoining jurisdictions. To assist them in this vision, the county should establish a Complete Streets Task Force. The newly created Complete Streets Task Force should develop a checklist of community attributes and planning initiatives that promote the Complete Street community ideal. Similar checklists or audits[117] are available to municipalities through bicycling advocates and pedestrian research groups; however, without proper encouragement from the county these tools may not be utilized.

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[115] A review of comparable policies was made using the Complete Streets Coalition's model policy found at: http://www.completestreets.org/changing-policy/model-policy/model-state-legislation-options/

[116] A copy of the Red Bank's Complete Streets Resolution, which can be used as a model for other municipalities, is found in Appendix E.

[117] Some tools include:

- Bikability and Walkability Checklists from the Bicycle and Pedestrian Information Center (www.walkinginfo.org), evaluates how walkable your community is.
- Pedestrian-Friendliness Scorecard designed by the Voorhees Transportation Policy Institute, at the Rutgers University Bloustein School of Planning & Public Policy, is meant to can help citizens and local officials evaluate whether or not their community is pedestrian-friendly, and whether the right tools are in place to make it so. (http://www.smartgrowthgateway.org/howsmart.shtml#walk)

In order to encourage state-wide biking and pedestrian transportation alternatives, The North Jersey Transportation Planning Authority (NJTPA) is promoting walking and biking throughout the region. Its goal is to make these two travel modes convenient, safe, efficient, and attractive as viable alternatives to cars for shorter trips. Much of this commitment is made through direct investment in bicycle and pedestrian facilities. In addition, various transportation projects, such as bridge replacements and intersection improvements, incorporate features to make walking and biking safer and more attractive travel options in the region. The Complete Streets Task Force should coordinate with NJTPA.

In the interest of expanding Complete Streets to all municipalities, the county's Task Force would need to strengthen existing alliances and forge new ones. For instance, the Sustainable Jersey program has the adoption of a Complete Streets policy as one of its options for gaining certification. By working with Sustainable Jersey and the municipalities in trying to gain certification, the county would have the means to bring their vision and assistance to the municipality to fulfill a mutual goal.

In addition to the clear metrics of policy adoption by municipalities in the county, the recommended Complete Streets Task Force should also adopt and track metrics of success for the policy. These metrics should reflect the attainment of goals by the Task Force. Some metrics will build off of the municipal developments, such as adopted Complete Streets resolutions and pedestrian/ bicycle audits completed by the municipalities. Others can be more pragmatic. For instance, the county could complete a sidewalk audit using GIS and has access to other metrics for accounting infrastructure improvements on its network, and the Complete Streets Task Force could expand its metrics to include non-county roadways. One metric can be the number or length of safe roads used by bicyclists in the county. Exhibit B, see at end or report, shows a Bicyclists' Map of the County, Created by the Monmouth County Planning Department, with "perceived" road conditions. This type of map can provide insights and metrics for the county in terms of what some cyclists see as hazardous roadway conditions. In many ways it can be interpreted as a geographic infrastructure survey that directly addresses concerns of Complete Streets.

c. County of Monmouth Development Regulations

i. Policy Issues

The foreword to the County of Monmouth Development Regulations, and Section 1.02 Purpose, of the same document, states that "The Monmouth County Development Regulations, which are administered by the Monmouth County Development Review Committee, establish procedures and standards for the review and approval of subdivisions and site plans in accordance with New Jersey Statutes Annotated 40:27-6.2 et. seq. and 40:27-6.6 et. seq." The New Jersey statutes referred to and these Monmouth County Development Regulations provide the Monmouth County Development Review Committee with the authority to review all subdivisions located within Monmouth County and to review and approve subdivisions and site plans that affect Monmouth

County roads, Monmouth County drainage facilities and buildings and lands owned and maintained by the county and to require mitigation of adverse impacts to Monmouth County roads, Monmouth County drainage facilities and buildings and lands owned and maintained by the county that are anticipated to be caused by proposed development. The type of land use and the intensity of development are controlled by municipal zoning. The primary responsibility for the review and approval of the internal design of subdivisions and site plans rests with the municipality.

The regulations are not intended to promote development practices that would result in a reduction in GHG. Rather these regulations are more concerned with protecting county assets such as drainage facilities, stream crossings and county roads, and creating and maintaining safe roadway conditions at intersections, bridges, and where new development access utilizes county roads.

As seen in the foreword, "The type of land use and the intensity of development are controlled by municipal zoning. The primary responsibility for the review and approval of the internal design of subdivisions and site plans rests with the municipality." As such, the type of practices best suited to reduce GHG emissions are not addressed in the Monmouth County Development Regulations.

ii. Recommendations

The ability of the county to significantly change the scope of issues regulated under the Monmouth County Development Regulations is restricted by state law. However, specific changes to the standards can be made to accommodate GHG emission reduction strategies. For example, the county road plan could be modified to reflect right-of-ways adequate to allow bicycle and pedestrian facilities.

d. Roadway Design Standards

i. Policy Issues

Numerous state policies govern the design of the state highway system with respect to the incorporation of pedestrian and bicycle accommodations, including NJDOT's *Roadway Design Manual*[118], NJDOT's *Bicycle Compatible Roadways and Bikeways Planning and Design Guidelines*, and NJDOT's *Pedestrian Compatible Planning and Design Guidelines*. NJDOT's standards and guidelines incorporate by reference standards developed by the American Association of State Highway and Transportation Officials (AASHTO), including the *AASHTO Guide for the Development of Bicycle Facilities* (1999) and the *AASHTO Guide for the Planning, Design and Operation of Pedestrian Facilities* (2004).

NJDOT and AASHTO standards are also frequently referenced and applied to local roadway projects (including Monmouth County Engineering Department projects), although there is usually no formal requirement to do so. The lack of a single clear local

[118] http://www.state.nj.us/transportation/eng/documents/RDM/sec1.shtm

standard creates the potential for inconsistent application of the national and state standards. Any revisions to the standards would have to be evaluated by the Monmouth County Engineering Department for feasibility and cost effectiveness.

ii. Recommendations

Monmouth County can ensure pedestrian and bicycle considerations are incorporated into county new roadway and roadway reconstruction projects in a consistent manner by developing formal design criteria. This will provide the county an excellent opportunity to expand the provision of pedestrian and bicycle infrastructure in conjunction with needed roadway improvement projects. The criteria should be developed in close coordination with the Monmouth County Engineering Department to ensure they will be feasible from a design and cost perspective. The design criteria could also be part of the implementation plan for the county bicycle and pedestrian plan. Aspects of the AASHTO and NJDOT standards for pedestrian and bicycle facilities could be adopted as part of the design criteria. The development of the design criteria would also provide an opportunity to diverge from state and national standards to address Monmouth County-specific conditions, as appropriate.

e. Smart Growth Planning Strategies

i. Policy Issues

Significant reduction in county-level GHG emissions can be achieved by promoting development that reduces automobile use. A number of Smart Growth checklists circulating in the development community stress an approach to development that reduces the need for automobile use.[119] Elements of such development policies include:

- Development located within walking distance of public transit.
- Community accessibility by multiple modes of transportation, including bus, rail, pedestrian, bicycle and automobiles.
- Connectivity to the surrounding community, i.e. multiple routes to the project.
- Encouraging proximity of commercial, retail, housing, schools and recreational uses such that walking, bicycling and mass transit are viable transportation options.
- Development of Park & Ride facilities within walking distance of shopping so commuters can shop on their way to or from work, and thus reduce the number of "cold starts" and the number of vehicle miles traveled.

[119] Examples of smart growth checklists include EPA's *Smart Growth Scorecards*- http://www.epa.gov/smartgrowth/scorecards/index.htm
and the *Comprehensive Smart Growth Audit Checklist* developed in New Hampshire- http://www.nh.gov/oep/resourcelibrary/referencelibrary/m/masterplan/preparingamasterplan/documents/smartgrowthchecklist.pdf

ii. ***Recommendations***

The county should develop a Smart Growth Checklist to guide municipalities and developers. In addition to the above initiatives, the county should promote, through the Complete Streets Task Force and checklist, a county-wide bike/pedestrian transportation plan (currently in the works). The county should seek funding from a variety of sources to implement its Complete Streets and bike/ped visions.

In addition to transportation improvements, the Smart Growth Checklist should strengthen development guidelines to encourage higher-density, mixed use communities. Components of the checklist could:

- Allow a density bonus for developments with park and ride facilities,
- Strengthen language for pedestrian and vehicular connections in subdivision and land development ordinance,
- Encourage development of nodes in land use planning, and create a new overlay zoning district to promote pedestrian and vehicular connections, and mixed use opportunities,
- Locate commercial districts, especially retail, within walking or bicycling distance to medium and high-density residential areas, and promote multimodal transportation linkages through appropriate design guidelines.

8. Conclusions

For many, the transportation choices they make are the largest contributor of GHG emissions they have daily control over. Monmouth County's commitment to reduce GHG emissions created from transportation places it in a position where they need to provide the right transportation choices for their citizens.

Monmouth County has the potential through direct action, public advocacy, or policy facilitation to drastically reduce its county wide GHG emissions. By implementing long term strategies for congesting mitigation, expansion and proper management of existing park and rides and bus services, bringing the M.O.M. line to fruition, and using cleaner fuels in existing rail systems, the county has the potential to reduce its GHG emissions by over 270,000 CO_2e annually, or 10% of the county's direct annual emissions based on the NJTPA's 2006 baseline estimate.

If these projects were combined with sound land use policies and policies that upgrade the current roadway infrastructure to include more modes of transportation such as bicycles and pedestrians, the GHG emission reductions would be greater than 10%.