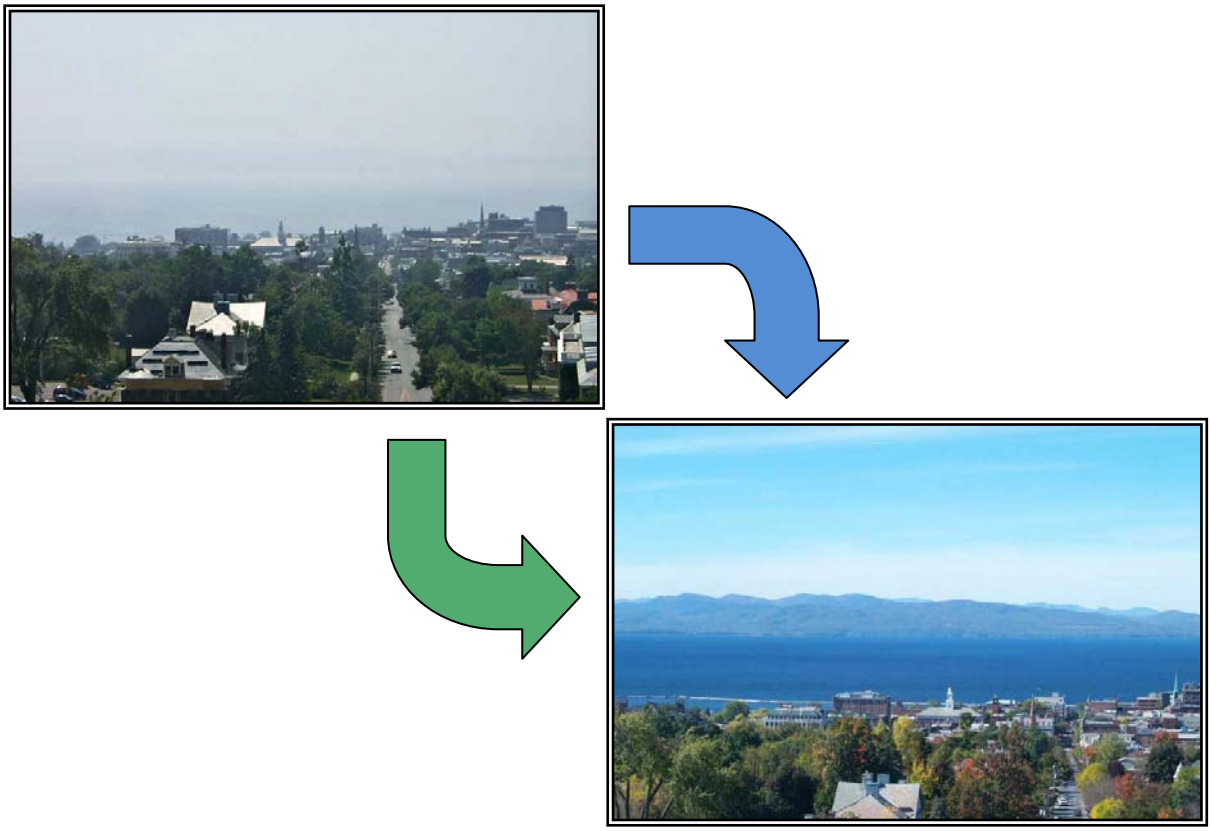
Keeping Our Air Clean

Local and Regional Strategies to Improve Air Quality in Chittenden County



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Abstract

This report was prepared by the Chittenden County Metropolitan Planning Organization and the Chittenden County Regional Planning Commission to be a primer on air quality issues affecting Chittenden County. **The purpose of this report is to identify a wide range of potential options to improve air quality that could be implemented by individuals, employers, municipalities and regional organizations.** This report is not a plan that requires adoption of all the identified strategies. This report is also intended to inform and guide the boards of the Chittenden County Metropolitan Planning Organization and the Chittenden County Regional Planning Commission in prioritizing Work Program tasks related to air quality.

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Executive Summary

Air pollution is usually thought to be a big city problem, but it can be a concern in rural and small urban areas as well. Chittenden County's air quality currently meets the National Ambient Air Quality Standards (NAAQS), however monitoring data for ground-level ozone and fine particulate pollution indicate that our air quality is close to exceeding acceptable levels. Based on recent health studies showing that ground-level ozone is even more dangerous than previously thought, the US Environmental Protection Agency is proposing to make the standard for ground-level ozone more stringent.

Exceeding the NAAQS levels has serious consequences and costs for the environment, human health, businesses, local governments and transportation planners.

The Chittenden County Metropolitan Planning Organization (CCMPO) and the Chittenden County Regional Planning Commission (CCRPC) have conducted this study to address four goals:

1. *Identify a wide range of potential strategies that could be employed within Chittenden County to improve air quality and help maintain compliance with the NAAQS;*
2. *Document the impacts on Chittenden County if air quality fails to meet the NAAQS;*
3. *Document the regulatory process and requirements associated with non-attainment of the NAAQS; and*
4. *Document the interconnected relationship between air quality, energy use and climate change.*

Chapter 1 of this report provides an introduction to the issue of air quality in Chittenden County. Subsequent chapters identify and discuss potential strategies that could be employed to improve air quality.

Chapter 2 on individual strategies identifies strategies related to transportation, and home and recreation.

Chapter 3 on employer strategies identifies strategies related to employee transportation, and employer operations.

Chapter 4 on municipal strategies identifies strategies related to municipal plans and policies, zoning and regulations, and municipal infrastructure.

Chapter 5 on regional strategies identifies strategies related to education and outreach, energy and climate action plans, regional transportation plans, and land use planning.

Chapter 6 recommends priority strategies for implementation by CCMPO and CCRPC:

- *Work with VTrans, employers and TDM and transit service providers to expand and enhance Transportation Demand Management services in Chittenden County.*
- *Develop and implement a regional Energy and Climate Action Plan that includes air quality, energy and climate strategies.*
- *Develop and implement a regional education and outreach program to increase understanding and change behaviors that adversely affect air quality.*

Implementation of these priority strategies is occurring through tasks in the CCMPO *Unified Planning and Work Program* (UPWP) and the CCRPC *Annual Work Program* for FY2010.

The Appendices present more detailed information related to air pollution, the National Ambient Air Quality Standards and non-attainment, air quality relationships with energy use and climate change, and the connection between land use, transportation and air quality.

Acknowledgements

This study is a joint effort by the Chittenden County Metropolitan Planning Organization (CCMPO) and the Chittenden County Regional Planning Commission (CCRPC). CCMPO and CCRPC are the regional entities in Chittenden County responsible for transportation planning and regional planning respectively. In conducting this study, the objective of both organizations is to identify ways to improve air quality *before* any national air quality standards are exceeded, with a focus on strategies that can be implemented within Chittenden County.

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Christine Forde, CCMPO Senior Transportation Planner, and Julie Potter, CCRPC Senior Planner, served as co-Project Managers for this study. Julie Potter was principal investigator and author. Michele Boomhower, CCMPO Executive Director, and Charlie Baker, CCRPC Executive Director, provided overall direction.

The project team received invaluable assistance and advice from the Air Quality Advisory Committee. Their input is greatly appreciated. The Advisory Committee was comprised of local and state experts on various aspects of air quality, public health, business, land use, transportation and local government. Members of the Advisory Committee include:

Edmund Booth (Chair) – Town of Huntington Selectboard, and CCRPC Commissioner

Amy Bell – Vermont Agency of Transportation, CCMPO Board Member Designee for VTrans, and CCMPO Transportation Advisory Committee Member

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Chapter 1
Introduction

Most people think of air pollution as a "big city" problem. But ground-level ozone and particulate pollution – the principal components of smog – also occur in rural and smaller urban areas such as Chittenden County. Air pollution is visually evident on sunny days when haze obscures the view of the Green Mountains or the Adirondacks. Fine particles suspended in the air scatter light and obscure the view. Figure 1-1 illustrates this effect. While we can't see ground-level ozone, conditions that create ozone pollution are similar to those that create particulate pollution.

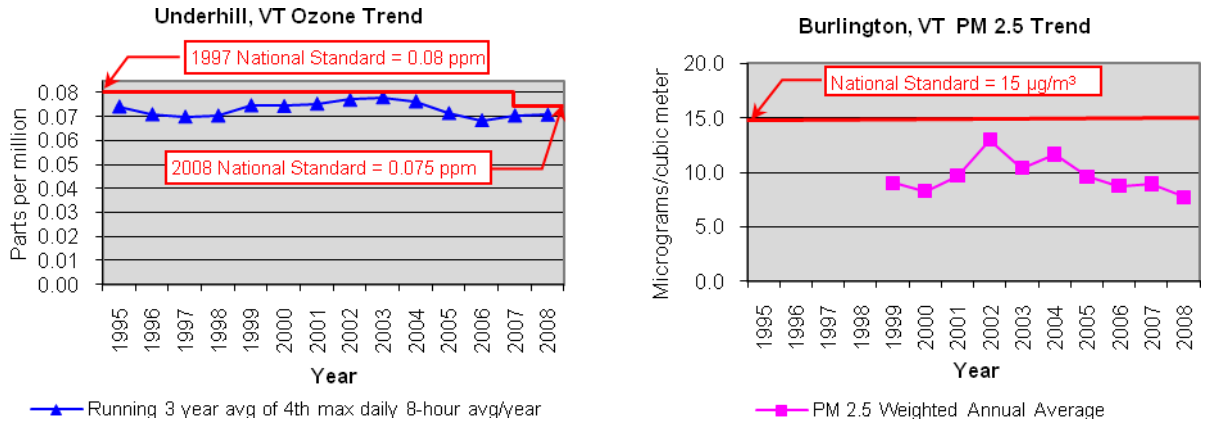
Figure 1-1
Clear vs. Hazy Day, Burlington, VT

Clear day in Burlington, 10/9/01 — Hazy, polluted day in Burlington, 6/15/01

Photos courtesy of VT ANR & NESCAUM, www.hazecam.net

Air quality monitoring confirms that Chittenden County's air quality meets the National Ambient Air Quality Standards (NAAQS), the federal regulations that set the maximum acceptable pollutant levels. But ground-level ozone levels are close to the current national standard and fine particle pollution ($PM_{2.5}$) has approached the standard in recent years (Figure 1-2). Current ozone levels exceed the stricter standard recently proposed by the US Environmental Protection Agency. Failure to comply with the NAAQS imposes burdensome regulatory requirements on state and local governments and businesses.

Figure 1-2
Ozone and Fine Particulates Trends in Chittenden County



Source: US Environmental Protection Agency

Ground-level ozone pollution is caused by a reaction between volatile organic compounds (VOCs) and nitrogen oxides (NO_x). Several types of contaminants can cause fine particulate pollution; some particles occur naturally while some result from human activity. Appendix A has more information about ground-level ozone and particulate pollution.

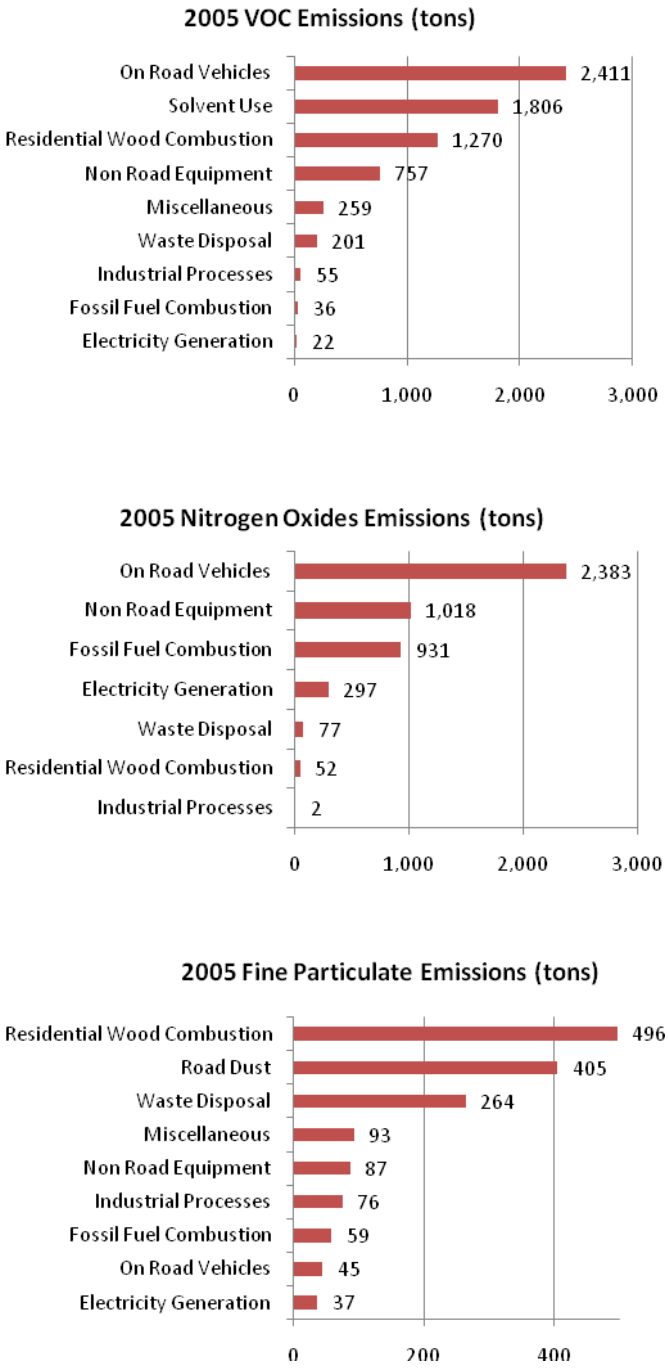
The NAAQS are established based on pollution impacts to public health and the environment. With the increasing incidence of children and adults with asthma, air quality is a serious health concern as well as a regulatory concern. Appendix A describes the health and environmental effects of ground-level ozone and particulate pollution. Discussion about the NAAQS and requirements for areas that don't meet the standards is found in Appendix B.

Air pollution can be caused by both local and distant emission sources. There are no available data that identify how much ozone and particulate pollution is generated locally, compared to the amount that blows into our area from areas upwind of Vermont. The only pollution sources that we can directly affect are local sources. When a region does not comply with the NAAQS, state and local governments are required to take aggressive actions to improve air quality – regardless of where the pollution is actually generated.

Many factors contribute to ground-level ozone and fine particulate pollution: weather conditions and the types and amounts of pollutants emitted from local and distant sources. These interactions are complex, making it difficult to scientifically demonstrate how much pollutant reductions are needed to bring an area back into compliance with the NAAQS. It makes sense, however, to start with the largest pollutant sources that we are able to affect.

Figure 1-3 shows pollutant sources in Chittenden County that contribute to ground-level ozone and particulate pollution. Cars and trucks are the largest

Figure 1-3
Sources of Ground-Level Ozone and Fine Particulate Pollution in Chittenden County



Source: US EPA, *2005 National Emissions Survey,* State and County Emission Summaries

local source of VOC and nitrogen oxide emissions that cause ozone pollution. Wood burning and road dust are the largest sources of fine particulate emissions. Other fuel combustion sources also contribute to both types of pollutants, including heating of buildings and homes, lawnmowers, motorized recreational vehicles, and construction and farm equipment.

Many of the emission sources that contribute to ground-level ozone and fine particulate pollution are the same sources that emit climate-altering greenhouse gases. Appendix C describes the relationships between air quality, energy use and climate change.

As a major source of pollutant emissions, transportation directly affects air quality. By influencing the form and efficiency of our transportation system, land use indirectly affects air quality. Appendix D discusses the connection between land use, transportation and air quality.

Because transportation is such a large and increasing source of pollutant emissions, strategies that improve transportation efficiency and meet mobility needs, while slowing down or decreasing the number of miles driven alone, will have the greatest impact in improving air quality. At the same time, these strategies will reduce toxic air emissions, climate-altering gases and energy consumption.

Actions at the local and county level to improve air quality won't directly affect out-of-state pollution sources, however, we can support the State of Vermont's efforts to address out-of-state pollution sources through Congress and the courts. We can, however, directly affect local sources of air pollution through actions at the individual, employer, municipal and regional levels to improve local air quality while reducing the overall regional air pollution burden.

The primary goal of this study is to identify strategies that can be employed within Chittenden County to improve air quality and aid in maintaining compliance with the National Ambient Air Quality Standards. Actions at the national and state-level are beyond the scope of this study. Some of the identified strategies may be accomplished through local regulation, but many of the identified actions are voluntary in nature. Individual, employer, municipal and regional strategies are identified in Chapters 2 through 5 respectively. Chapter 6 identifies priority recommendations for action by CCMPO and CCRPC.

The secondary objectives of this report are to document the regulatory process and requirements associated with non-attainment, the impacts to Chittenden County if air quality fails to meet the national standards, and the interconnected relationship between air quality and other current issues such as energy efficiency and climate change. The Appendices to this report contain this supplemental information.

The principal audiences for this study are the boards of the CCMPO and CCRPC. The boards need to have a shared understanding of Chittenden County's air quality in order to make policy decisions on how the organizations should address air quality issues. In addition, air quality status impacts the programming of transportation projects in Chittenden County through the CCMPO's Transportation Improvement Program, the TIP. Other audiences may also find this study useful.

Chapter 2

Individual Strategies to Improve Air Quality

Although we may not think much about it, each of us makes dozens of choices each day that affect the quality of the air that we all breathe. How we get to work, school or stores impacts air quality. How we heat our homes, mow our lawns or clear snow from the driveway impacts air quality. This chapter addresses strategies that can be implemented by individuals to reduce pollutant emissions and improve air quality in Chittenden County.

Government regulations have helped reduce air pollution from industry and commercial products; factories pollute less than they used to, and the automobiles we drive today are much cleaner than those we drove 20 years ago. However, improvements in automotive technology can be offset by people choosing to drive further. Individual behaviors and choices, such as where we live and how we commute to work, cannot be legislated. Consequently, it is important that people understand the connection between their choices and air pollution, and voluntarily adopt individual strategies to improve air quality.

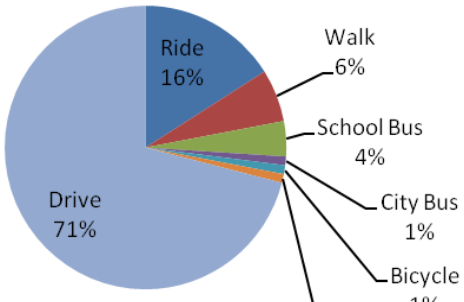
Individuals may not be able to adopt all of the strategies described in this chapter, however, most people will find many strategies that they can do. Choosing the most appropriate and effective individual strategies to improve air quality depends on each individual's circumstances. Some strategies require changing behaviors and practices, others require an investment in new materials or equipment. Many offer substantial cost savings through reduced energy use and reduced operational costs. Some even save time and improve the quality of life.

The first group of individual strategies deals with transportation, because this is the largest source of air pollutant emissions. The second group of individual strategies addresses pollution emissions from our homes and recreational activities.

Transportation

As shown in Figure 2-1, 71% of Chittenden County household trips are made by car. The percentage of commuter trips by car is even higher, with 89% of commutes occurring by driving and only 5% by riding with someone else.[1]

Figure 2-1
Chittenden County Daily Trips By Mode



Source: *1998 Household Travel Diary Survey*

Strategy 1 *– Drive less.*

The average Vermonter drives 17,000 miles annually. With a little planning this could easily be reduced 10% or more, resulting in lower costs, less wear and tear on the car, and fewer emissions. Participating in the annual Way to Go Week is an easy and fun introduction to using these transportation alternatives.[2]

- Walk or bike to your destination. Walking and bicycling generate no pollution. This is a low cost way for you and the air to get in better shape.
- Take transit if available. Even if just once or twice per week, taking transit will save money and reduce traffic congestion and air pollution.

- Ride share or car pool. Sharing a ride also saves money and reduces air pollution. Go Vermont (www.connectingcommuters.org) can help you find a carpool partner or van pool. Local programs may also be an available resource: Hinesburg Rides, a program of the Hinesburg Community Resource Center, offers a web-based ride-sharing program (www.hinesburgrides).
- Telecommute. If your job allows it, working from home just one day a week for a year could save 1,000 miles on your vehicle. This translates into over 30 hours a year of time saved by not commuting, over $500 savings in total driving costs, and significant air emission reductions.
- Join a car share program. Car share programs allow individuals and businesses to have the benefits of a car for transportation, without having to own a car. The car share program owns and maintains a fleet of cars. Car share members reserve a car and pay based on how much they drive. Car share members tend to drive much less than car owners; some studies show that car share members cut their driving in half. Members of car share programs tend to walk, bike and take transit more – using a car only when it is really needed. Car sharing saves money by providing mobility without the costs of purchasing, maintaining and insuring a car yourself. In the Burlington area, CarShare Vermont provides car sharing services to members.[3] Zipcar is a national organization providing car-sharing services at Middlebury College, Vermont Law School and Dartmouth College.
- Walk, bike or bus to school. Children can help parents drive less by walking, bicycling or taking the school bus to school. Fifty years ago, 70% of children in Chittenden County walked or biked to school; today about 13% walk or bike to school. Working with Local Motion, 18 elementary and middle schools in nine Chittenden County towns are participating in Safe Routes to School programs.[4] Safe Routes to School uses a team approach to identify safe, fun ways for children to walk and bicycle to school. Even if children walk or bicycle to school only a few days a week in good weather, they will help save gasoline, stay healthy, and improve air quality.

Strategy 2 *– Drive fuel-efficiently.*

Studies indicate that altering your driving style can improve fuel economy. Generally, improving vehicle fuel economy also reduces air emissions. There are a variety of simple techniques that drivers can use to improve their fuel economy and reduce air emissions. Collectively, these techniques are sometimes referred to as "Eco-Driving."[5] Moderate use of Eco-driving techniques can improve fuel economy 10-15%; full application of Eco-driving techniques can improve fuel economy even more.

- Avoid rapid starts and stops. A few seconds of high-powered driving can use as much gas as driving for several minutes at more measured speeds.

- Coast to slow down or stop. This requires anticipating traffic conditions, but saves on fuel and brake wear. It takes 20% more fuel to accelerate from a full stop than from 5 miles per hour.
- Maintain a steady speed. Anticipate traffic flow and traffic signals to keep your car running efficiently and avoid red lights when traffic lights are synchronized.
- Drive slower. Fuel economy usually decreases rapidly at speeds above 60 miles per hour (mph); every 5 mph

you drive over 60 mph is like paying an extra $0.24 per gallon for gasoline. Most vehicles get their best gas mileage at speeds between 30 and 55 miles per hour. Driving within this optimal range will increase fuel economy 10-15%.

- Avoid idling. Idling gets 0 mpg, and can use more than a half gallon of fuel for every hour spent idling. Turn off the engine for stops anticipated to be more than 60 seconds (e.g., picking up a child from school, waiting in a drive through).
- Drive your car to warm it up. Today's cars generally need only 30 seconds to be ready to drive, and the car will reach an optimum operating temperature much faster when driving, rather than idling.
- Combine errands and trips. Cars emit more pollutants when the engine is cold than when the engine is warmed up. Grouping trips together, or "trip-chaining," will save both fuel and time and will reduce air emissions. Driving to a central location and walking to complete multiple errands will save even more gas and increase physical activity too.
- Use the air conditioner selectively. Air conditioning can reduce mileage by as much as 20%. Minimizing use of the air conditioner will reduce the load on the engine, decreasing fuel consumption and air emissions. Park in the shade to shield the vehicle interior from the sun. Open the windows when getting into a hot car to blow out the hot air. At speeds less than 40 mph, keep the windows open when you drive. Over 40 mph, close the windows to reduce aerodynamic drag and use the vents, or use the air conditioner and recycle the inside air to avoid drawing in hot air from the outside that has to be cooled.
- Travel light. An extra 100 pounds in the trunk reduces fuel economy by up to 2%. A loaded roof rack or carrier can decrease fuel economy by 5% because of the weight and aerodynamic drag. Remove luggage racks, roof-top carriers and ski racks when not needed.
- Avoid evaporation when refueling. In hot weather, fuel your car in the cooler morning or evening hours. This reduces the amount of fuel lost to evaporation during filling. Stop refueling when the gas nozzle clicks off. This avoids gas spillage and evaporation. It also avoids exposure to benzene. Close the gas cap tightly to prevent evaporation from the fuel tank; many gas caps click to let you know when they are closed properly.

Strategy 3 *– Maintain your car.*

A well-maintained vehicle produces 20% less ozone-related emissions, lengthens the life of the vehicle, and can save the average driver over $300 per year on gas.

- Change the oil. Regular oil changes can increase gas mileage and reduce emissions. Use the manufacturer's recommended grade of motor oil to increase fuel economy by 1-2%.
- Replace dirty air filters. Replacing a clogged air filter can increase fuel economy by 10%.

- Tune up your car. Regular tune ups can increase fuel efficiency by 4%.
- Check your tire pressure. Properly inflated tires can improve gas mileage by 3%. Check tires monthly, or when there is a sudden temperature change of more than 10° F. When time to replace, consider getting low rolling-resistance tires. These cost more than traditional tire replacements, but reducing rolling resistance by 10% can improve gas mileage by 1-2% for most passenger vehicles.

Strategy 4 *– Choose a low-polluting vehicle.*

The least polluting vehicle is the one you don't own or drive. If the transportation alternatives in Strategy 1 are not enough for you to go without owning a car, then choose the lowest-polluting vehicle that meets your needs.

Vermont has adopted the California standards for vehicle air emissions. This means that new vehicles sold by dealers must meet the same emission requirements as new vehicles in California. Vehicles are classified by the emission limit standards that they meet. From low to lowest emissions, these categories are:

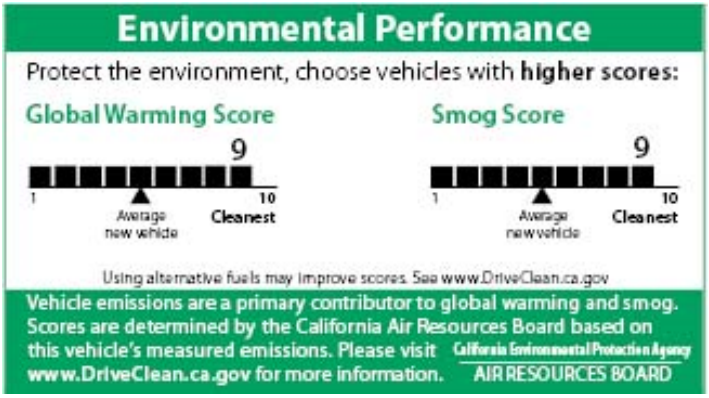
- **LEV** – Low Emission Vehicle
- **ULEV** – Ultra Low Emission Vehi**c**le
- **SULEV** – Super Ultra Low Emission Vehicle
- **PZEV** – Partial Zero Emission Vehicle
- **ZEV** – Zero Emission Vehicle

Both vehicle technology and fuels influence the amount of air emissions from cars:

- Newer gasoline-fueled vehicles include many cleaner models. Generally, cleaner gas-fueled vehicles have fewer cylinders, multiple catalysts, oxygen sensors, and exhaust gas recirculation systems.
- Flex-fueled vehicles can burn E85 ethanol fuel as well as gasoline. Emissions from burning E85 are similar to gasoline-powered vehicles.
- Diesel-fueled vehicles have traditionally been a major source of particulate pollution. The introduction of low-sulfur diesel fuel has allowed for the development of better diesel-engine control systems to reduce emissions. Emissions from diesel-fueled vehicles still have room for improvement. Biodiesel fuels generate lower emissions of many air pollutants, but emissions of nitrogen oxides, which contribute to ozone pollution, may actually increase.
- Compressed natural gas vehicles have low air emissions, but are limited by the availability of fueling stations. Compressed natural gas vehicles are increasingly being used for public transit buses and business fleets that have their own fueling stations.
- Hybrid electric vehicles have fewer emissions than comparable conventional vehicles because an electric motor is used in combination with the gasoline motor. Depending on the type of hybrid technology, some hybrids have fewer emissions than other types of hybrid vehicles.
- Electric vehicles have very few air emissions, but are not widely available yet.

California is a leader in cleaner vehicle technology. Their Drive Clean website (www.driveclean.ca.gov) has good information on emissions from different vehicle types and models. The Green Vehicle Guide website (www.epa.gov/greenvehicles) can help you identify the emissions level of most vehicle makes and models, as well identify the lowest emitting vehicles by size class and model year. New vehicle emission control information can also be found on a label under the hood.

Figure 2-2
Environmental Performance Label



Starting in 2010, all new vehicles sold in Vermont will have an Environmental Performance Label (Figure 2-2) that shows a global warming score and a smog score. This label will help consumers know which vehicles are the most efficient and least polluting. Generally, vehicles with the lowest air emissions are also more fuel efficient. Choosing a less polluting vehicle will also help drivers save money on gas.

Home and Recreation

Strategy 5 *– Choose an accessible neighborhood to live in.*

One easy way to drive less is to live in a neighborhood where it is convenient to drive less. When looking for a place to live, let your real estate agent know you prefer an accessible community. Consider choosing a home in a community that is close to work and has sidewalks, good conditions for bicycling, nearby shops and community services, and transit service. These features promote fewer and shorter automobile trips.

Strategy 6 *– Heat your home more efficiently.*

With our cold winters, it is not surprising that residential energy use is a close second to transportation energy use in Vermont. Burning fuel to heat homes – whether oil, natural gas or wood – generates emissions that contribute to ozone and fine particulate pollution. Actions that improve a home's energy efficiency will reduce air emissions and help save money.

- Conduct a home energy audit. An energy audit typically evaluates building tightness, insulation effectiveness, heating system, lighting, appliances and windows. The audit will provide advice on ways to lower your energy bills. Audits can assist in prioritizing energy-saving home improvements and help accessing financing for those improvements. Efficiency Vermont, Vermont Gas Systems and Burlington Electric Department can provide information about energy audits and help identify qualified energy audit contractors.
- Seal air leaks and seal and insulate air ducts to reduce heat losses. Close the damper when not using the fireplace. An energy audit can help find heat losses.
- Lower the thermostat in winter. Dress warmly and lower the thermostat. Open the curtains during the day to let in the sun's warmth, and close them at night to help keep in the heat. Install a programmable thermostat and use the automatic set back to reduce the temperature when sleeping or not at home.

- Conduct regular heating system maintenance. Changing the air filter regularly helps the heating and cooling system run more efficiently. Regular maintenance according to the manufacturer's recommendations will also help keep the system operate more efficiently.
- Consider upgrading to a more efficient system. The energy savings from upgrading to a more efficient heating system will help pay for the additional cost. For homes heating with wood, new EPA-certified wood stoves and fireplace inserts are more efficient and produce much lower air emissions. Vermont has proposed regulations requiring new outdoor wood boilers to meet the same particulate emission limits as in neighboring states.[6]

Strategy 7 *– Keep a low-emission lawn.*

Smaller, non-road gasoline engines, such as found in lawnmowers, string trimmers and snow blowers, are a surprising source of air pollution. According to US EPA, the typical gas-powered push lawnmower emits as much pollution in an hour as 11 cars and the typical riding mower emits as much pollution as 34 cars!

- Shrink your lawn "footprint". Homeowners can reduce air emissions, and save time and money by shrinking the size of their lawn. "Natural yard" plantings with trees, shrubs and native wildflowers require little maintenance and reduce the amount of lawn area that needs to be mowed. Vegetable gardens and edible landscaping don't need mowing and provide fresh, healthy food. Where lawn is desired, low-maintenance turf grasses and grass/flower seed mixtures grow more slowly and require less mowing.
- Don't burn brush. Brush, tree limbs and stumps are accepted without charge at the McNeil Wood and Yard Waste Depot in Burlington's Intervale. The Chittenden Solid Waste District Drop-Off Centers (except Burlington and Hinesburg) accept smaller amounts of brush for free, and charge for larger volumes. Or, if you have the space, pile the brush up for wildlife or just leave it to decompose naturally.

Good operating practices can help reduce the amount of air pollution from lawn mowing.

- Maintain the equipment. Follow the manufacturer's guidelines for maintenance, including changing the oil and cleaning/replacing the air filters regularly.
- Mow when it is cool. Mow the lawn and refuel during cooler morning and evening hours to reduce fuel evaporation.
- Use a higher mower height. Setting the mower height higher requires less power to mow the lawn, so less fuel is used.
- Avoid spilling gasoline when fueling. According to US EPA, more fuel is spilled each year filling up garden equipment (lawnmowers, string trimmers, chippers and shredders) that was lost in the entire Exxon Valdez oil spill in Alaska! Use a gasoline container that is easy to handle and hold securely. Pour the gasoline slowly and smoothly, using a funnel or spout with an automatic stop device to prevent overfilling the gas tank. Keep the cap or spout and vent hole on gasoline containers closed tightly. Consider replacing your old gas storage container with a new one that meets EPA standards.
- Consider less-polluting equipment as a replacement. Hand reel lawn mowers and other manual tools are pollution-free, and may be realistic options for smaller yards. Electric mowers can work well for urban and smaller suburban lawns; the Neuton electric mower is even made in Vermont. Starting in 2011, new lawnmowers and other motorized garden equipment will be required to meet tighter air emission standards.

Strategy 8 *– Choose less-polluting recreational craft and vehicles.*

Non-motorized boats and vehicles don't cause air pollution. Try a canoe or kayak on the water, take a spin on a bicycle, or glide over the snow on cross-country skis. You will have fun, get a good workout, and keep the air clean.

Motor boats, personal watercraft, snowmobiles, dirt bikes and all-terrain vehicles are sources of air emissions during fueling and operation. As with lawnmowers, fueling practices that avoid spilling and evaporation will help reduce emissions during fueling. Two-stroke engines are highly polluting; a typical two-stroke snowmobile engine produces as much harmful pollution in seven hours as a passenger car driven for 100,000 miles. Four-stroke engines are significantly cleaner.

Federal emission standards for new recreational vehicles have been established. New dirt bikes and ATVs have been required to meet the new standards since 2007. New personal watercraft and inboard and outboard marine engines have to meet new standards by 2010. Standards for new snowmobiles are being phased in through 2012. Choosing boats and vehicles that meet the new standards will help reduce air emissions from motorized recreational activities.

Conclusions

In order to achieve meaningful improvements in air quality, individual strategies should:

- Address the most important emission sources that cause ozone and fine particulate pollution. In Chittenden County, on-road vehicles are the top source of ozone precursors, and road dust is the top source of fine particulates. Other significant sources for both ozone and fine particulates include fossil fuel and wood combustion for heating and non-road equipment (such as lawnmowers, snowmobiles, all-terrain vehicles, boats and personal watercraft). Individual efforts to reduce emissions from these sources will have more impact on Chittenden County's air quality than efforts that focus on less important sources.
- Address behaviors, as well as technologies, to reduce air emissions. Strategies that depend on individual behaviors or choices to improve air quality will be more successful if they also offer other benefits, such as saving money, increased convenience, or personal fitness and health benefits. These additional benefits will make it easier to sustain new behaviors that benefit air quality.

The online air emissions calculator from AirHead is an easy tool to calculate household air emissions (criteria air pollutants and greenhouse gases).[6] In addition to showing how your household compares to the national average, the emissions calculator clearly shows how automobile transportation alone accounts for over half of the air pollutants our households generate on a normal basis.

The 10 Percent Challenge program has a residential emission calculator for carbon dioxide that shows how the everyday activities of individuals add up, and offers practical suggestions on how to reduce environmental impacts. CATMA has a similar Carbon Footprint calculator on its website. (Because ozone and particulate pollutants share most of the same sources with carbon dioxide, many changes that help reduce greenhouse gases also help reduce air pollution.) Emission calculators like these are useful for quantifying our own air pollution "footprint" and allowing us to see how changes in how we live can reduce air pollution and help improve air quality.

Some of the strategies identified in this chapter can be implemented by individuals quickly, with immediate benefits. If sustained, these strategies will yield benefits long-term as well. Other strategies have longer lead times, or the opportunity to implement them occurs infrequently.

The benefits from this second group of strategies therefore occur in a longer-term timeframe. Because on-road transportation is the largest source of pollutants that contribute to ozone and fine-particulates, strategies that reduce vehicle miles traveled will have the greatest regional air quality benefits. Figure 2-2 summarizes the timeframe and benefits from the individual strategies.

Figure 2-2

Summary of Individual Strategy Timeframe and Regional Benefits

Strategy	Benefits Timeframe		Regional Benefits	
	Immediate 0-5 years	Long-Term 5-20 years	Major	Moderate
Strategy 1 *– Drive less.*	√		√	
Strategy 2 *– Drive fuel-efficiently.*	√		√	
Strategy 3*– Maintain your car.*	√		√	
Strategy 4 *– Choose a cleaner and fuel-efficient vehicle.*	√		√	
Strategy 5 *– Choose an accessible neighborhood to live in.*		√	√	
Strategy 6 *– Heat your home more efficiently.*	√			√
Strategy 7 *– Keep a low-emission lawn.*	√			√
Strategy 8 *– Choose more efficient, less-polluting recreational craft and vehicles.*	√			√

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Useful Resources

Emissions Calculators

10% Challenge Residential Calculator. Available at: http://www.10percentchallenge.org

AirHead Emissions Calculator. Available at: http://airhead.cnt.org/calculator/

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Chapter 3

Employer Strategies to Improve Air Quality

Whether in the public sector or the private sector, employers impact air quality through daily operations and employee commutes. Fuel consumption for space and process heating also results in air pollutant emissions. Employees driving to work alone generate more air pollutants than employees who share rides, take transit or walk or bicycle to work.

Employer strategies to improve air quality can benefit the employer as well as the environment by:

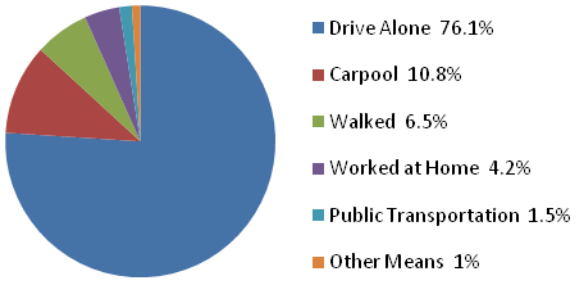
- Lowering operating costs from increased energy efficiency, the reduced need for workplace parking spaces, and the accompanying reduction in stormwater controls;
- Increasing worker productivity resulting from strategies that increase work-life flexibility;
- Improving employee recruitment and retention through alternate commute benefits and increased work-life flexibility;
- Providing tax-free commute benefits for employees;
- Improving public reputation and image for reducing air pollutant emissions, reducing roadway congestion and conserving energy; and
- Avoiding costly new regulatory burdens imposed on employers in regions that don't meet federal air quality standards.

Employers may not be able to adopt all of the strategies described in this chapter, however, most workplaces will find many strategies that they can implement. The first group of employer strategies deals with transportation, because this is the largest source of air pollutant emissions. The second group of employer strategies addresses pollution emissions from operations.

Employee Transportation

Strategy 1 *– Promote and support alternatives to peak-hour and drive-alone employee commuting.*

Figure 3-1
Chittenden County Journey to Work



Source: *2000 Census*

Chittenden County is often described as the economic engine of Vermont. In 2006, 31% of all jobs in the state were located in the County[1]. As shown in Figure 3-1, over 75% of employees residing in the County drive alone to work. Air emissions and vehicle miles traveled (VMT) would be substantially reduced if many of the drive-alone commuters chose a different way to get to work.

Transportation demand management (TDM) is a term used to describe strategies that reduce commute trips. TDM reduces workplace parking needs and roadway congestion, as well as improving air quality. Employers play an important role in TDM by educating employees and promoting commuting alternatives to change employee commuting behavior. Studies of alternative commuting options have found that providing enhanced commute alternatives (such as vanpools) can reduce vehicle trips by about 8.5%. Providing financial incentives and disincentives (such as transit subsidies and parking pricing) can reduce vehicle trips

16.4%. Combining enhanced alternatives with financial incentives and disincentives have been shown to be the most effective way of reducing vehicle trips (24.5%).[2]

Websites[3], publications[4], government agencies[5], transit providers[6], and associations[7] can help provide employers with information, tools and programs to assist employers with implementing effective TDM programs that help improve air quality. Participating in the Best Workplaces for Commuters[8] program provides national public recognition for employer TDM efforts, as well as access to information and tools to support successful TDM implementation.

Specific actions that employers can take as part of a TDM program include:

- Encourage employees to share rides to work. Employers can offer a ride-matching service, or promote existing ride-matching services, such as Go Vermont, so that employees can find ride-sharing partners more easily. Go Vermont will soon be expanding its commuter ride matching services to include rides to meetings. The Campus Area Transportation Management Association's (CATMA's) confidential RidesWork program helps campus-area and state employees in Burlington find rideshare partners. Hinesburg Rides includes an Employer Partner Transportation Program that works with local employers to coordinate low-cost commuting options such as vans, carpooling and bus services; NRG Systems is a key partner in this program.

  Employers can provide reserved parking for car and van pools; campus-area employers and IBM provide preferential parking for car- and van pools. Go Vermont works directly with van pools to provide a van and turn-key service, including insurance, vehicle maintenance and fare collections. VTrans is partnering with Vermont Economic Development Authority to provide no-interest loans to employers to purchase vans for van pools.

- Encourage employees to use public transit to get to work. If public transit is available, employers can encourage its use by offering transit discounts or passes, providing a guaranteed ride home, and working with CCTA to provide a convenient bus stop and shelter. Chittenden County Transportation Authority (CCTA) recently launched its Smart Business Program to assist employers promote employee transit use. Employers participating in this program include: City Market, Champlain Housing Trust, Healthy Living, Hilton, Marriott Burlington Harbor, Nothing but Noodles, Ring Master Software Corporation, Vermont Federal Credit Union, and Vermont Housing Finance Agency. Similarly, CATMA works with its member employers, the University of Vermont, Champlain College, Fletcher Allen Health Care, the American Red Cross, and, most recently, the Chittenden County Metropolitan Planning Organization and the Chittenden County Regional Planning Commission to provide incentives to use transit. Through CATMA, UVM and Champlain College utilize CCTA's Unlimited Access program to provide students and staff with free, unlimited rides on CCTA's buses. Saint Michael's College also uses the Unlimited Access program. CCTA also provides a free shuttle bus service between the hospital, campus and downtown Burlington. IBM has a bus stop and a ticket outlet on-site, making it easier for employees to take the bus. NRG Systems has been working with the Town

of Hinesburg, Hinesburg Rides, CCTA and Addison County Transportation Resources to try to bring transit to Hinesburg and Bristol.

- Encourage employees to walk or bicycle to work. Providing shower facilities and covered bicycle parking can make this a more attractive commuting option for employees. In addition to the air quality benefits, walking and bicycling to work can be promoted for their substantial employee health and fitness benefits. IBM has a summer bicycling program. CATMA provides walk and bike incentives for employees of its members. City Market provides fringe benefits for bicyclists. NRG Systems provides bike racks and shower facilities.

- Encourage alternate commuters with an emergency ride home. Employees often worry about how they will get home in an emergency if they do not drive themselves. A guaranteed ride home program in an emergency can encourage employees to become "alternate commuters" who share rides, use transit, walk or bicycle to work. CATMA provides an emergency ride home service to enrolled alternate commuters working for its member employers. CCTA's SureRide program provides an emergency ride home program for employees of its Smart Business program. Go Vermont offers a similar program to its participants.

- Encourage employee telecommuting. Many employers allow employees to work from home one or more days a week, if compatible with their job responsibilities. When drive-alone commuters telecommute, one fewer single-occupant vehicle is being driven to and from work. The CCMPO's *2006 Transportation Survey* revealed that 91% of residents desired to work from home given the opportunity, and 29% actually held a job that could be performed from home.

- Offer alternate work schedule options. Alternate work schedules allow employees to work the standard number of weekly hours in fewer days, which reduces the number of days employees commute to work. Common alternate work schedules include 9 hour days (with a day off every other week) and 10 hour days (with a day off every week).

- Provide transportation fringe benefits that offer incentives to not drive alone to work. Employers can offer transportation benefits in addition to compensation, as tax-free benefits, or both. The Internal Revenue Service allows employers to offer transportation benefits that are relatively simple to administer and are tax free to the employee.[9] Benefits might include transit or van-pool subsidies, or flexible transportation benefits that cover more commute expenses for alternate commuters than for drive-alone commuters. In areas where parking is limited or expensive, benefits might include paying employees who don't use parking spaces (a parking "cash-out") instead of offering a parking subsidy, or not offering free parking if transit is available. Chittenden Bank provides employees a subsidy to park at a satellite lot and ride the bus to the office. City Market in Burlington is one of the first companies to provide a pre-tax benefit for bicycling to work.

Employers can also offer non-monetary "smart commute" incentives. CATMA has monthly drawings for registered alternate commuters. Since 2007, National Life in Montpelier has used a scorecard system for employees to track the number of times each month that they walk, bike, carpool or use public transportation. If employees meet the program's goals, they are eligible for bike tune-ups, gas cards, and gift certificates specific to their commute method. The program has over 120 active participants, and has reduced over 90,000 average miles per month since the program started. More recently, Merchants Bank has established a Smart Commute Program using an employee benefits scorecard, much like National Life's program.

Strategy 2 *– Participate in a collaborative TDM program with other employers.*

Employers do not have to implement TDM strategies alone; they can join with an existing TDM program or combine with other employers to establish a joint TDM program, such as CATMA. Collaborative TDM programs can increase the number of employees reached, enabling expanded TDM services to match the greater scale. Collaborative TDM programs may be managed by state, regional or local governments, a private-sector Transportation Management Association (TMA), or a partnership between a TMA and a private business stakeholder organization.

VTrans' Go Vermont: Connecting Commuters program[10] is a good example of a state-sponsored TDM program. Go Vermont provides statewide ride-matching services and assistance for vanpools, as well as information about commuting alternatives. These services are useful to employers and employees. Go Vermont is modeled on the more mature Go Maine[11] program, which also offers emergency ride home benefits and monthly rewards drawings.

CATMA[12] is a well-established, privately-managed TMA with a full suite of TDM services. CATMA serves its member organizations: UVM, Champlain College, Fletcher Allen Health Care and the American Red Cross. Recently, CATMA has started a pilot program for state employees working in downtown Burlington. TMAs are funded by member dues and deliver TDM services that are customized to member needs.

Hinesburg Rides is a community-based transportation program working with local employers, the town and regional transportation organizations to provide viable commute options for the community. Hinesburg Rides has launched an on-line rideshare matching service, and is actively working to implement a bus route from Burlington to Hinesburg and Bristol.

TMAs work best when member employers are in close proximity, share common transportation needs, and are able to devote the resources to building a stand-alone organization. Because of their scale, and member and geographic focus, TMAs can often provide more services and deliver more effective results than employers can individually. CATMA's award-winning programs not only provide a comprehensive suite of commuting benefits for employees, they have substantially reduced both student/employee vehicle trips and the amount of parking needed for the Hill Institutions (Figure 3-2).

Figure 3-2
CATMA Mode Shift Results

	Drive-Alone Commuters
Chittenden County residents 2000	75%
CATMA member employees 2005	46%
CATMA member employees 2007	43%
CATMA member employees 2008	41%

Source: 2000 US Census; CATMA Employee Survey Data

Partnerships between local or regional government TDM programs and business stakeholder groups (sometimes referred to as a Transportation Management Initiative) can focus on service delivery without creating a new, stand-alone organization that needs to raise funds and recruit members. The South Shore TMA[13] in Massachusetts has partnered with the South Shore Chamber of Commerce to help provide focused TDM programs.

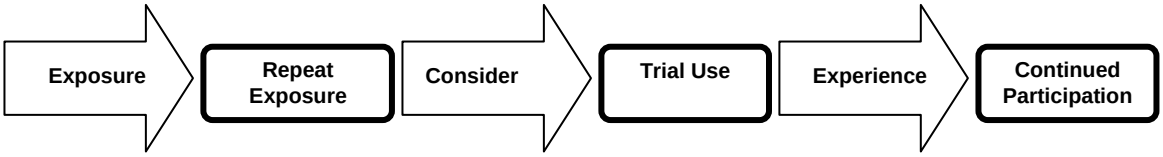
The CCMPO's *2025 Metropolitan Transportation Plan* identified ten areas in the region that have the relatively high numbers of workers within a small geographic area needed in order to focus TDM efforts.[14]

Strategy 3 *– Educate employees on the air quality, energy, health and economic benefits of transportation alternatives and energy conservation.*

Education alone will not improve air quality, but education is a necessary first step for behavior changes that can keep our air clean. Employers are well-situated to provide information to employees about how their actions and transportation choices affect energy use and the environment. There are many ways that employers can provide information to employees, including: newsletters, information inserts with paychecks, energy and environment fairs, and eco-driving workshops. Promoting the annual Way to Go! Commuter Challenge[15] is a fun way to introduce employees to commute alternatives.

One educational experience is not enough to change individual behavior. As illustrated in Figure 3-3, continued exposures, a good first experience, and sustained experiences are required to change behaviors.

Figure 3-3
The Behavior Change Continuum



Source: *URS, 2005*[16]

Studies have found that information and promotion alone is not effective in reducing vehicle trips, but can be useful when combined with other TDM measures. Consequently, most TDM programs include an on-going information and education component to supplement other program elements.

Strategy 4 *– Include availability of public transit and employee commute alternatives as important location criteria when siting new facilities.*

Employers typically consider size, cost, workforce availability, quality of life, and proximity to other facilities, customers or suppliers when deciding where to locate new facilities. Employers should also consider accessibility to public transit and other commute alternatives as part of their location criteria. Locations that allow employees to get to work by alternate commuting means increase the potential workforce, reduce the need and space required for commuter parking, and help reduce air pollutant emissions from commute trips.

Employer Operations

Strategy 5 *– Select, retrofit and maintain fleet vehicles to reduce air emissions.*

Private and public sector employers may lease or own many types of vehicles, including car fleets, trucks and construction equipment. Several approaches can be used to reduce emissions from employer vehicles:

- Include low-pollutant emissions in vehicle selection criteria. This may include fuel-efficient vehicles, vehicles running on clean fuels (e.g., electric, compressed natural gas), and trucks and construction equipment with new or retrofitted diesel engines.

- Retrofit diesel engines in trucks and construction equipment. The Northeast Diesel Collaborative provides information about diesel retrofitting and clean diesel technologies.[17]
- Provide proper maintenance to help keep vehicles operating more efficiently, including maintaining the appropriate tire pressure.

Strategy 6 *– When practical, use rail for freight shipments.*

Rail freight is often the mode of choice for shipping large or heavy goods. Goods shipped by rail in Vermont include farm products, food products, lumber, petroleum, pulp and paper and minerals. Rail freight is three times more fuel efficient than trucks: a gallon of diesel fuel can move a ton of freight 457 miles by rail.[18] This fuel efficiency makes rail freight a good economic choice and a good environmental choice. US EPA estimates that a locomotive emits only a third of the nitrogen oxides (an ozone precursor) and particulate matter than a typical truck. Rail freight indirectly improves air quality by reducing highway congestion. One box car can carry the load of about three trucks; one train load hauls the same amount of freight as 500 trucks. Less congestion on our highways means that other highway vehicles can operate at more fuel-efficient speeds. Some areas of Chittenden County are not served by rail, and rail shipment is not the best choice for all goods. However, when rail shipments make good business sense they will also help improve air quality.

Strategy 7 *– Implement idling-reduction practices.*

Idling vehicles emit pollutants, even when they are not moving. Idling increases engine wear, contributes to vehicle air-pollutant emissions, and can impair indoor air quality if exhaust from idling vehicles is pulled into building air intakes. Numerous strategies can be used to reduce idling, including behavior change practices (e.g., anti-idling policies, incentives for drivers to not idle, contracts with outsourced transporters) and technology-based approaches (e.g., automatic engine shutdown, direct-fired heaters, and auxiliary power units for heating and air conditioning). Many of these practices are relatively low-cost, or have a quick payback through operating cost savings. US EPA's SmartWay Transport Partnership[19] provides information, tools and recognition to participating transport employers. Green Mountain Coffee Roasters, a SmartWay partner since 2005, has successfully implemented idling reduction strategies that save money as well as reduce air emissions.

Strategy 8 *– Control track-out from construction sites.*

Vehicles leaving construction sites can track out dirt and mud on their tires. Tracked out materials contribute to road dust and fine particulate pollution. Employers can establish no-track-out policies and practices, including cleaning facilities at construction sites.

Strategy 9 *– Conduct an energy audit of facilities and operations, and implement feasible recommendations.*

Energy audits look for cost-effective opportunities to reduce the amount of energy used by a building or process without negatively affecting its operation. Energy audits typically look at space and process heating, as well as lighting and electrical use. Energy audits could be expanded to evaluate energy consumption beyond immediate operations, such as energy consumed by employee commuting, transport of materials and products to and from employer locations, and even product life-cycle energy consumption. Energy efficiency improvements that reduce vehicle fuel consumption and thermal energy consumption will benefit air quality by reducing pollutant emissions. Efficiency Vermont and Burlington Electric Department offer energy efficiency information and services to employers, as does Vermont Gas[20]. Rebates may be available to implement some energy audit recommendations.

Strategy 10 *– Upgrade to low-emission and energy-efficient space and process heating systems.*

Fuel combustion for space and process heating (including hot water) emits ozone precursors and fine particulates. Upgrade options that would reduce air pollutant emissions include: switching to cleaner fuels (e.g., natural gas), switching to more efficient heating technologies, and switching to non-combustion alternatives (e.g., electric, solar, geothermal heating).

Strategy 11 *– Develop and implement an environmental, climate-action or sustainability plan that includes air emissions performance measures and goals for improvement.*

A variety of approaches have been used by public- and private-sector entities to improve environmental performance, including reducing air emissions. Based on continuous improvement models, the key steps common to these approaches are to:

1. Inventory and measure (or estimate) emissions;
2. Establish measurable performance indicators and goals;
3. Develop and implement a plan to achieve the goals;
4. Monitor and review performance; and
5. Set new goals, or modify the action plan if goals were not met.

Plans to reduce air pollutant emissions can be focused just on the air pollutants of concern, or incorporated into broader environmental, climate-action or sustainability plans. (Although greenhouse gas pollutants causing climate change are not the same as ozone-precursor and particulate pollutants, they share many of the same major sources. Climate action plans that successfully reduce greenhouse gas emissions will also help reduce emissions of other air quality pollutants.)

There are a number of tools and programs for climate action planning. The Alliance for Climate Action's 10% Challenge[21] has an emissions calculator for businesses. This tool can help businesses calculate their emissions and measure progress in meeting energy and climate action goals. The Global Environmental Management Initiative[22] is a source of free, practical information and tools for businesses addressing climate change. The Climate Registry[23] provides consistent and transparent standards for entities to calculate, verify and publicly report greenhouse gas emissions. ICLEI – Local Governments for Sustainability[24] is the leading organization helping local governments implement climate action plans. ICLEI offers information and software tools to help develop clean air and climate protection plans. Burlington developed its first climate action plan in 2000 using the ICLEI framework; the climate action plan has been incorporated into the Burlington Legacy Project[25] and is currently being updated. South Burlington has started climate action planning using the ICLEI framework.

Conclusions

Chittenden County and Vermont offer good examples of employers implementing strategies to improve air quality. Lessons learned here and elsewhere indicate that to achieve meaningful improvements in air quality, employer efforts to improve air quality should:

- Be implementable by the employer, or a group of employers.
- Address the most important emission sources that cause ozone and fine particulate pollution. In Chittenden County, on-road vehicles are the top source of ozone precursors and road dust is the top source of fine particulates. Other significant sources for both ozone and fine particulates include fossil fuel and wood combustion for heating and non-road equipment (e.g., construction, agricultural and motorized equipment). Employer efforts to reduce emissions from these

pollutant sources will have more impact on Chittenden County's air quality than efforts that focus on less-important sources.

- Address behaviors, as well as technology, to reduce air emissions. Employee choices about how to get to work can impact air quality as much as, or more than, their vehicle's fuel economy. Changing commuter behaviors can reduce air emissions – and save both employers and commuters money.

Some strategies can be implemented by employers quickly, with immediate benefits. If sustained, these strategies will yield benefits long-term as well. Other strategies have longer lead times, or the opportunity to implement them occurs infrequently. The benefits from this second group of strategies therefore occur in a longer-term timeframe. Because on-road transportation is the largest source of pollutants that contribute to ozone and fine-particulates, strategies that reduce vehicle miles traveled will have the greatest regional air quality benefits. Figure 3-4 summarizes the timeframe and benefits from the employer strategies.

Figure 3-4

Summary of Employer Strategy Timeframe and Regional Benefits

Strategy	Benefits Timeframe		Regional Benefits	
	Immediate 0-5 years	Long-Term 5-20 years	Major	Moderate
Strategy 1 *– Promote and support alternatives to peak-hour and drive-alone employee commuting.*	√		√	
Strategy 2 *– Participate in a collaborative TDM program with other employers.*	√		√	
Strategy 3 *– Include availability of public transit and employee commute alternatives as important location criteria when siting new facilities.*		√	√	
Strategy 4 *– Educate employees on the air quality, energy, and economic benefits of transportation alternatives and energy conservation.*	√		√ (when used with Strategies 1 or 2)	
Strategy 5 *– Select, retrofit and maintain fleet vehicles to reduce air emissions.*	√		√	
Strategy 6 *– When practical, use rail for freight shipments.*	√		√	
Strategy 7 *– Implement idling-reduction practices.*	√		√	
Strategy 8 *– Control track-out from construction sites.*	√			√

Strategy	Benefits Timeframe		Regional Benefits	
	Immediate 0-5 years	Long-Term 5-20 years	Major	Moderate
Strategy 9 *– Conduct an energy audit of facilities and operations, and implement feasible recommendations.*	√			√
Strategy 10 *– Upgrade to low-emission and energy-efficient space and process heating systems.*		√		√
Strategy 11 *– Develop and implement an environmental, climate-action or sustainability plan that includes air emissions performance measures and goals for improvement.*		√	√	

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Useful Resources

Transportation

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Chapter 4

Municipal Strategies to Improve Air Quality

Municipalities influence air quality in several ways. Municipalities are employers with day-to-day business operations. The strategies discussed in Chapter 3 apply to municipalities as employers. Municipalities also plan, regulate and make infrastructure investments that guide community development and quality of life. This chapter addresses air quality strategies related to these municipal governmental functions. **Municipalities may not be able to adopt all of the strategies described in this chapter, however, most communities will find many strategies that they can implement**.

Municipal Plans and Policies

Strategy 1 *–Update municipal plan language to support air quality and development patterns with air quality benefits.*

Municipal plans and policies provide the conceptual framework for the future that development regulations and guidelines are intended to implement. Most municipal plans include goals, objectives, policies and actions. Municipal plans can include clear statements that:

- Support air quality and reduction in pollutant emissions;
- Encourage compact, mixed-use development, smart growth and infill development;
- Support bicycle and pedestrian facilities planning (e.g., safe road crossings, complete streets, paths and trails connecting neighborhoods and destinations, bicycle parking);
- Support transit use, development of bus stops, park and ride facilities, and rail facilities; and
- Support alternative energy sources with air quality benefits (e.g., solar, wind, small-scale hydropower).

Municipalities often prepare functional plans, such as bicycle/pedestrian plans and open space plans, to supplement the municipal plan and provide a structure for implementation. These plans can also provide clear support for air quality and development patterns with air quality benefits.

Strategy 2 *– Support transit operations.*

One way to reduce VMT is to make transit services available. Transit service in Chittenden County is limited. Chittenden County Transportation Authority (CCTA) provides bus service to its member municipalities of Burlington, Essex, South Burlington, Shelburne, Williston, Winooski, and Milton. CCTA bus routes also serve a portion of Colchester. The Link Express bus to Montpelier stops in Richmond, the Middlebury Link Express bus stops in Charlotte, and the St. Albans Link Express bus stops in Colchester. Extending transit services to new municipalities requires municipal participation in, and municipal financial commitment to,

CCTA. Hinesburg is asking voters to vote on joining CCTA at Town Meeting in 2010, to enable commuter bus service between Burlington and Hinesburg. Looking further into the future, Essex Junction is seeking to bring back commuter rail between the village and Burlington. Municipalities anticipating future transit service can incorporate "transit-ready" features into development review and approval practices.

Strategy 3 *–.Establish a municipal energy and/or climate action committee to help the municipality, identify, plan and implement strategies that include reducing municipal transportation and heating fuel use.*

State law enables Vermont municipalities to establish energy committees. Over 60 municipalities in Vermont have established an energy and/or climate action committee, including the following Chittenden County communities: Burlington, Charlotte, Essex, Hinesburg, Huntington, Richmond, South Burlington, Westford, and Williston.[1]

Typical energy committee duties include advising the municipal governing body and other municipal boards and commissions, assisting in development of a municipal energy and/or climate action plan, assisting with energy and climate action education efforts, conducting inventories and energy audits, identifying and implementing energy and/or climate action strategies.

- Energy audits look for cost-effective opportunities to reduce the amount of energy used by a building or process without negatively affecting its operation. Municipal energy audits usually look at municipal buildings, but can also look at services such as street and traffic lights and activities using municipal vehicles. Some municipalities have also tried to look at the energy usage of the entire community.
- Energy efficiency and conservation projects – Municipal energy projects frequently include improving insulation, heating systems and lighting for municipal buildings and schools. Projects might also include upgrading to more fuel efficient (and less polluting) municipal vehicles, or energy efficiency upgrades for municipal pump stations and sewage treatment plants. A few Vermont communities, including Burlington, Montpelier and Brattleboro, are exploring the possibility of district heating, where a central heating plant provides hot water or steam to heat a downtown area. Projects that reduce electrical power usage, such as more efficient street lights and community light bulb exchanges, are worthwhile but have limited air quality benefits because much of our electricity is generated from nuclear and hydroelectric sources. Recent federal Energy Efficiency and Conservation Block Grants for energy efficiency and conservation projects have made it possible for communities to accelerate implementation of energy projects. Municipal energy efficiency and conservation projects might also address local transportation needs; Hinesburg Rides' ridesharing and local employer transportation programs are good examples of community-based approaches to meet transportation needs, save energy and improve air quality. Grass-root efforts, with their direct person-to-person connections, have the potential to build social support for strategies that require changing behaviors or making investments with environmental and economic returns. Energy efficiency improvements that reduce vehicle fuel consumption and thermal energy consumption will benefit air quality by reducing pollutant emissions

COMMUNITY
HINESBURG RIDES
TRANSPORTATION
A Program of The Hinesburg Community Resource Center

- Climate Action Plans – Public concerns about the impacts of climate change have led many local governments to prepare Climate Action Plans. The greenhouse gases that cause climate change are different from the pollutants that cause ozone and fine particulate pollution. However, they share some common emission sources: transportation and fossil fuel combustion. Climate action plans that support VMT reduction, heating efficiency, and shifts to non-combustion alternative energy sources will also improve air quality. (Some climate action strategies, such as shifting to wood burning or other bio-fuels will not help air quality, and depending on the combustion technology used may make air quality worse.) Burlington has adopted a climate action plan[2], South Burlington has started a plan, and other municipalities in Chittenden County are considering it.

Strategy 4 *– Update parking policies to provide air quality benefits.*

Municipal parking strategies can encourage alternatives to driving alone to work, which is a major component of transportation-related air emissions.

- Provide and promote park-and-ride facilities to encourage residents to share rides to work.
- Reduced or no parking fees at remote parking facilities with transit service can encourage all-day parking outside of central business areas.
- Increase the amount of all-day van pool parking to encourage ride-sharing, while limiting the amount of all-day commuter parking in central business areas to discourage drive-alone commuting.
- Short-term parking time limits in central business areas may discourage all-day commuter parking. Similarly, parking fees that give reduced rates for short-term parking, also discourage all-day parking. (Local circumstances will determine the effectiveness of this approach. If commuters merely move their cars during the day, then this approach will not reduce drive alone commuting and air emissions.)
- In residential neighborhoods near employment areas, parking districts allow residents with neighborhood parking permits to park on the streets but prohibit all-day non-residential parking.

Strategy 5 *– Support urban forestry for air quality benefits on municipal land, right-of-ways and private property.*

Improving air quality requires reducing or controlling pollutant emissions at their sources. Studies have found that trees can provide some additional help by cooling property (reducing energy demands for air conditioning) and by removing pollutants from the air. This is one more reason to support urban forestry efforts for parks and recreation facilities and street trees.

Zoning and Regulations

Strategy 6 *– Update local development regulations, standards and guidelines to encourage development patterns with air quality benefits.*

Local development rules can have a significant impact on VMT by specifying how and where new development may occur. Early zoning and subdivision regulations frequently favored single use, low-density development without sidewalks – patterns that are dependent on automobile use.

Municipalities can use a variety of tools such as scorecards and zoning code audits to review their zoning bylaws, subdivision regulations, street design standards, parking standards and design guidelines to identify opportunities for updates that would encourage development with air quality benefits. Opportunities for development requirements to support air quality benefits include:

- Subdivision regulations can include specific development standards to promote utilization of renewable energy and energy conservation.
- Zoning bylaws can encourage compact, mixed use development, smart growth, and infill development.
- Density can be encouraged with incentives such as density bonuses, dimensional waivers, and permit and impact fee reductions.
- Parking requirements for new development can be updated to encourage less reliance on automobiles. Minimum parking requirements can be reduced. Parking spaces can be centralized or shared with other properties. Buildings close to the sidewalk, with parking to the side or rear, will be more usable to pedestrians. Waivers of parking requirements can be given if transportation demand management (TDM) measures are adopted; Burlington, Colchester and Jericho all provide parking waivers for adoption of TDM measures.

- Provisions for bus stops can be encouraged or required of new developments in areas where future transit is anticipated.. Development that provides infrastructure for anticipated public transit service is called "transit-ready development."
- Complete streets policies require that pedestrian and bicycle facilities are provided on all new and reconstructed streets, and that pedestrian and bicyclists' needs are considered in routine roadway operation and maintenance.[3] Travel distances for bicyclists and pedestrians are minimized by interconnecting new streets and discouraging cul-de-sacs.
- Car-sharing can be encouraged with incentives for new developments to include a designated car-share "pod" or parking space. CarShare Vermont has established a car share program in Burlington.
- Workforce housing near jobs can help reduce VMT. Workforce housing can be encouraged through density bonuses in return for affordable units, inclusionary zoning (requiring that affordable homes be built along with market-rate housing), and linkage requirements that workforce housing be provided in return for approval of offices or industrial facilities.
- Energy efficiency can be encouraged through guidelines and incentives that encourage landscaping to reduce heating/cooling costs, and orienting buildings for solar gain. Energy efficient buildings can be encouraged, or incentives provided for meeting energy efficient standards such as LEED or Energy Star ratings.

***Strategy 7** – Adopt anti-idling policies and ordinances.*

Municipalities across the country and thirty states have adopted some form of regulations on idling of motor vehicles. These regulations are commonly directed at idling of trucks, buses and cars in downtown areas, schools, and truck stops. Diesel engine vehicles are frequently idled to keep the vehicle warm, but substantial amounts of NO_x and other pollutants are emitted in the process. Aimed at protecting children's health, Vermont Act 48 prohibits school bus idling at schools and

allows school boards to enact policies limiting idling of other vehicles at schools. Anti-idling legislation was introduced in the Vermont legislature in 2007, 2008 and 2009. At the local level, Burlington has adopted an anti-idling ordinance that prohibits vehicle idling for more than five minutes, with certain exceptions, between April and November.[4] Richmond's Energy Conservation Policy directs the town to post no-idling signs at town offices and establishes rules for idling of town vehicles.[5] Other Vermont towns have passed resolutions against vehicle idling, including Plainfield, Middlebury, Newfane and Brattleboro. Idle-Free VT, a volunteer organization, has been an advocate for state and local anti-idling rules.[6]

Strategy 8 *– Restrict or ban open burning of wood and yard debris.*

Smoke from open burning of wood, brush, leaves and other yard debris contains high concentrations of fine particulates. Open burning in more densely populated communities and towns where many people burn on "burn weekends" often creates problems for neighbors, asthmatics and others with respiratory problems who are unable to escape the smoke, even in their own homes. Winooski has completely banned open burning. Colchester has had public debate over eliminating its designated burn weekends. The Chittenden Solid Waste District accepts wood and yard waste for composting, and will work with towns to establish where residents can bring yard waste and brush. The Vermont Department of Environmental Conservation has information and model town ordinances for banning open burning.[7]

Municipal Infrastructure

Strategy 9 *– Fund construction, operation and maintenance of municipal facilities that support bicyclists and pedestrians.*

In addition to planning and zoning strategies for bicycle- and pedestrian-friendly development, municipalities can construct, operate and maintain bicycle and pedestrian facilities. A complete streets program includes bicycle lanes, sidewalks and crosswalks in street construction, reconstruction and maintenance. Burlington's draft Transportation Plan embraces the complete street concept and proposes to make Colchester Avenue the City's first complete street.[8] Off-road bike paths are also typically constructed, operated and maintained by municipalities. Safe bicycle parking can be made available at municipal facilities, including offices, libraries and parks. Pedestrian amenities, such as shade trees and benches, should be included when designing, operating and maintaining municipal streetscape, parks and recreation facilities.

Strategy 10 *– Review road construction, paving and maintenance practices to identify and implement opportunities to reduce pollutant emissions from road use and roadway construction.*

Road construction generates air pollutants both from construction equipment (e.g., diesel exhaust) and from the construction process (e.g., dust, erosion and track out by construction vehicles). Municipal roadway and construction contracts can include performance standards to use best management practices that prevent air pollution.

Road dust is the largest source of fine particulate emissions in Chittenden County. Road dust is made up of vehicle exhaust deposits, tire and brake wear, dust from unpaved roads and dust tracked out from construction and industrial sites. Vehicles traveling on dusty roads kick the dust into the air. Controlling road dust is a challenge. In urban areas, road dust is commonly suppressed by street sweeping. Wet sweepers should be used keep road dust from being kicked back into the air, and sweeping frequency should be increased. Road dust on unpaved roads can be suppressed with gravel or spraying with water. Calcium chloride application on gravel roads is effective in controlling road dust, but must be properly applied to avoid surface water contamination.

Strategy 11 *– Optimize traffic flow through monitoring and adjustment of traffic signals and intersection controls.*

Optimizing traffic flow allows traffic to move more steadily along roadways and through intersections, decreasing time spent idling or accelerating and thus reducing pollutant emissions from vehicles. Approaches may include:

- Coordinate adjacent signals to maintain movement and avoid intermittent flow.
- Shift more signals to flash earlier at night.
- Review all intersections with stop signs that do not meet the Uniform Traffic Control Device criteria and are there only to slow traffic through residential neighborhoods.
- Install actuated lights on intersections that are time-based only.

Conclusions

Municipal strategies to improve air quality will be most effective if they:

- Address the most important emission sources that cause ozone and fine particulate pollution. In Chittenden County, on-road vehicles are the top source of ozone precursors and road dust is the top source of fine particulates. Other significant sources for both ozone and fine particulates include fossil fuel and wood combustion for heating and non-road equipment (e.g., construction equipment and lawnmowers). Municipal efforts to reduce emissions from these sources will have more impact on Chittenden County's air quality than efforts that focus on less important sources.
- Address behaviors, as well as technology, to reduce air emissions. Strategies that provide municipal residents and commuters with benefits – such as convenience, safety, fitness, childrens' health, or lower costs – make it more likely that new behaviors will be tried and sustained.

Some of the strategies identified in this chapter can be implemented by municipalities quickly, with immediate benefits. If sustained, these strategies will yield benefits long-term as well. Other strategies have longer lead times. The benefits from this second group of strategies occur in a longer-term timeframe. Because on-road transportation is the largest source of pollutants that contribute to ozone and fine-particulates, strategies that reduce vehicle miles traveled will have the greatest regional air quality benefits. Figure 4-1 summarizes the time frame and benefits from the municipal strategies.

Figure 4-1
Summary of Municipal Strategy Timeframe and Regional Benefits

Strategy	Benefits Timeframe		Regional Benefits	
	Immediate 0-5 years	Long-Term 5-20 years	Major	Moderate
Strategy 1 *– Update municipal plan language to support air quality and development patterns with air quality benefits.*		√	√	
Strategy 2 *– Support transit operations.*	√		√	
Strategy 3 *– Establish a municipal energy and/or climate action committee to help the municipality, identify, plan and implement strategies that include reducing municipal transportation and heating fuel use.*		√	√	
Strategy 4 *– Update parking policies to provide air quality benefits.*		√		√
Strategy 5 *– Support urban forestry for air quality benefits on municipal land, right-of-ways and private property.*		√		√
Strategy 6 *– Update local development rules and guidelines to encourage development patterns with air quality benefits.*		√	√	
Strategy 7 *– Adopt anti-idling policies and ordinances.*	√			√
Strategy 8 *– Restrict or ban open burning of wood and yard debris.*	√			√
Strategy 9 *– Fund construction, operation and maintenance of municipal facilities that support bicyclists and pedestrians.*		√	√	
Strategy 10 *– Review road construction, paving and maintenance practices to identify and implement opportunities to reduce pollutant emissions from road use and roadway construction.*	√			√
Strategy 11 *– Optimize traffic flow through monitoring and adjustment of traffic signals and intersection controls.*	√			√

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Useful Resources

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Vermont Land Use Education and Training Collaborative. 2008. *Vermont Land Use Planning Implementation Manual – Energy Efficiency, Conservation and Renewable Energy*. Available at: http://www.vpic.info/pubs/implementation/pdfs/A-energy.pdf

Chapter 5

Regional Strategies to Improve Air Quality

By its very nature, air quality is a regional issue that is not confined within local boundaries. Because Vermont does not have county government, county-level regional strategies must be based on voluntary cooperation rather than command-and-control approaches. As regional organizations, the Chittenden County Metropolitan Planning Organization (CCMPO) and the Chittenden County Regional Planning Commission (CCRPC) are well-positioned to convene discussions of regional issues, build regional support for action, develop regional strategies and plans, and support local entities and governments with implementation. This chapter addresses regional strategies that can be implemented to improve air quality. **Regional organizations may not be able to adopt all of the strategies described in this chapter, however, they will find many strategies that they can implement**.

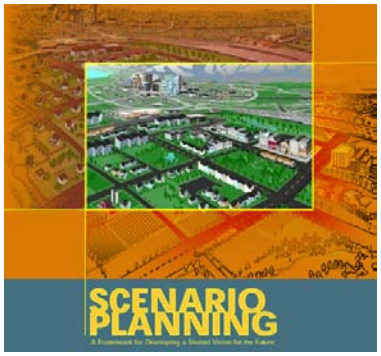
Transportation Planning

Strategy 1 *– Establish performance measures and include emission and VMT reduction goals in the long-range Metropolitan Transportation Plan.*

The link between driving and emissions of fine particulates and ozone precursors is clear: the more people drive, the more air pollutants are emitted into the atmosphere. Increasingly, long-term transportation plans are including performance measures and vehicle miles traveled (VMT) and emission reduction goals. Transportation system performance measures for air quality might include: VMT, congestion and delay, transit ridership, and non-motorized mode share.[1]

The current long-range transportation plan, the *2025 Chittenden County Metropolitan Transportation Plan*, does not identify performance measures or VMT and emission reduction goals. The CCMPO is currently updating this plan, with a 2060 planning timeframe. This update process provides an opportunity to include performance-based measures and goals to help guide transportation investment choices that impact regional air quality.

Strategy 2 *– Utilize land use/transportation scenario planning in long-range transportation planning.*



Scenario planning identifies alternative future land use scenarios to use when evaluating future transportation system investments and performance. One scenario is based on continuation of current growth trends; other scenarios usually include more compact, transit-oriented development patterns. Scenario planning is considered a best practice for long-range transportation planning and has been used in many regions, including Envision Utah, Charlottesville-Albermarle Metropolitan Planning Organization (VA), San Luis Osbisbo Council of Governments (CA), and the Binghamton Metropolitan Transportation Study (NY).

Scenario planning does not always lead to changes in development planning. However, the Sacramento Area Council of Governments and Portland Metro (OR) have used scenario planning to develop land use and transportation scenarios that achieve VMT reduction targets.[2] The CCMPO is using scenario planning in developing the *2060 Chittenden County Metropolitan Transportation Plan*.

Strategy 3 *– Enhance regional travel models to better evaluate air quality impacts in transportation studies and plans.*

Regional transportation planning models, such as the Chittenden County Transportation Model, are commonly used in long-range transportation planning. In areas that do not meet the national air quality standards, regional transportation models are used in conjunction with additional software developed by US EPA to evaluate transportation-related air quality impacts. Although regional transportation models are the most commonly used tool to evaluate the impacts of transportation changes on air quality, these models have certain limitations.

- Air quality modeling requires many assumptions about daily travel patterns when using peak hour models such as CCMPO's model. For this reason, CCMPO is currently updating its model to provide full-day travel data, which will better coordinate model outputs with EPA's air quality models.
- Chittenden County's transportation model evaluates trips between and within traffic analysis zones (TAZs). In urban areas like Burlington, a TAZ may be as small as a city block. In more rural areas, TAZs can be much larger due to the lower population and employment densities in these areas. The smaller size of the TAZs in urban areas is better suited to measuring the effects of compact, mixed use development on travel patterns. In rural towns with a small village center, like Hinesburg, changes in travel patterns within the village that reduce auto emissions can be lost in the analysis of the larger TAZs.
- Unlike many transportation models, the Chittenden County model considers shared rides, transit use and bicycle and pedestrian travel – all of which are transportation choices that benefit air quality. Model factors used to predict these non-auto trips are based on the most current data on transportation behavior. These factors will be updated in late 2009/early 2010 as newer household survey data becomes available from the National Household Travel Survey add-on that was jointly funded by CCMPO, VTrans and UVM. However, these factors may not adequately predict transportation behavior and choices if major changes occur, such as the provision of greatly-enhanced transit services or the effect of drastically higher gasoline prices on Single Occupant Vehicle (SOV) travel.

New types of models, such as micro-scale activity-based travel models, are starting to be used to simulate individual household travel. Such models may be better suited to looking at travel patterns for smaller areas (like Hinesburg village). Work is being done by the University of Vermont and Resources Systems Group to apply one of these models, TRANSIMS, to Chittenden County. This model is complicated to use and has other limitations for county-wide use, such as the current lack of a mode-choice component.

Strategy 4 *– Work with VTrans, employers and TDM and transit service providers to expand and enhance Transportation Demand Management services in Chittenden County.*

As discussed in Chapter 3, various Transportation Demand Management (TDM) programs already exist in Chittenden County. Opportunities exist to coordinate, expand and promote these programs with the goal of increasing individual and employer participation. The *Chittenden County TDM Education, Outreach, and Support Plan*[3] provides a framework for these activities. The 2009-2010 CCMPO work program includes a TDM implementation task.

Strategy 5 *– Work with VTrans and municipalities to optimize traffic flow through monitoring and adjustment of traffic signals and intersection controls.*

Optimizing traffic flow allows traffic to move more steadily along roadways and through intersections, decreasing time spent idling or accelerating and thus reducing pollutant emissions

from vehicles. Several approaches to optimizing traffic flow along road segments and through intersections are discussed in Chapter 4.

Strategy 6 *– Give compact, transit-served areas funding priority, and increase the share of funding to transit and bicycle/pedestrian infrastructure.*

Compact land-use patterns served by transit reduce dependency on the automobile, and will encourage travel choices that have fewer air emissions. Regional planning entities can designate and prioritize funding for areas where local governments have planned for compact growth. This approach has been applied in several non-attainment regions: the San Francisco Bay area; San Diego; Sacramento; Portland, Oregon; and Minnesota's Twin Cities. Sources of funding for these initiatives have ranged from federal transportation enhancement funds and Congestion Mitigation and Air Quality (CMAQ) funds, to regional sales taxes and regional property taxes.

Similarly, developing high-quality facilities for transit, bicycling and walking encourages use of these non-auto travel modes, which helps reduce air emissions. For example, the Sacramento Area Council of Governments increased the funding share for transit, bicycle and pedestrian projects in order to meet its VMT reduction goals. In its *2025 Chittenden County Metropolitan Transportation Plan*, the CCMPO increased the share of funding for non-automobile travel.

Strategy 7*– Evaluate the benefits and feasibility of a multi-county transit agency.*

The Chittenden County Transportation Authority (CCTA) provides bus transit service to member municipalities in the county. CCTA partners with transit agencies in adjacent counties to offer the LINK Express commuter routes to and from Montpelier, Middlebury and St. Albans. The LINK Express commuter routes are very successful: in 2008, LINK Express ridership increased 44% to Montpelier, 41% to Middlebury and 31% to St. Albans. The popularity of these regional commuter routes makes them effective in reducing congestion and transportation air emissions.

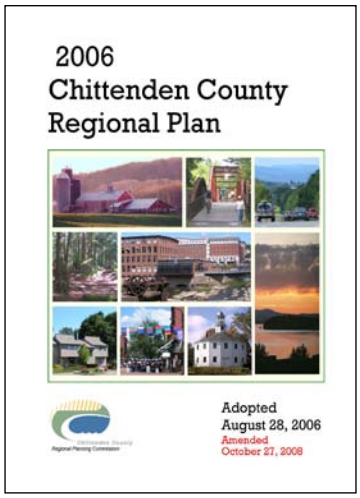
Although they are separate organizations, CCTA currently manages the operations of Green Mountain Transit Agency (GMTA) in Washington and Lamoille Counties. GMTA recently assumed transit operations in Franklin County as well. CCTA and GMTA have proposed merging the two organizations into a combined transit agency. Merging the organizations would provide greater organizational and operational efficiencies, but requires changes in state statute. Ultimately, creating a regional funding mechanism would help support more regional commuter routes which would relieve congestion and reduce air emissions.

Strategy 8 *– Support regional rail improvements to allow increased rail freight and passenger rail services.*

Current rail freight use in Chittenden County is limited to gross weights of 263,000 pounds due to track conditions. Statewide track upgrades to 286,000 pounds for tracks and 315,000 pounds for bridges, consistent with the State Rail Policy, would allow more through shipments of freight to occur by rail, rather than by truck. Since rail freight is more fuel-efficient and less-polluting than truck freight, shifting freight shipments to rail would help reduce pollutant emissions and improve air quality. Track upgrades would also help support increased passenger rail services. Regional organizations have an important role to play in supporting regional rail improvements and advocating for state-wide rail improvements that would enable optimal use of rail transportation in Chittenden County.

Land Use Planning

Strategy 9– *Provide clear support in the Chittenden County Regional Plan for air quality and practices that help improve air quality.*



The *2006 Chittenden County Regional Plan* discusses air quality and establishes air quality policies that address:

- Minimizing pollutant emissions;
- Encouraging municipalities, employers and households to undertake reasonable measures to reduce air pollutant emissions;
- Having regional and local land development patterns that reduce reliance on motor vehicles; and
- Encouraging energy conservation and using renewable energy sources with air quality benefits.[4]

These policies provide an underpinning for this air quality study and follow-on implementation tasks.

Strategy 10 *– Support local government efforts to obtain planning grants to plan and zone for transit-oriented development.*

Local land use patterns, such as higher densities and mixed uses near transit facilities, can help support goals for increased transit ridership and reduced VMT. Local plans and zoning may need to be updated to encourage such transit-oriented development (TOD). Updating plans and development rules requires funding, and sometimes special expertise. Planning grants can help fund these updates. The Vermont Department of Housing and Community Affairs provides municipal planning grants annually on a competitive basis. Municipal planning grants can be used to support municipal planning efforts, including transit oriented development plans, as well as updating town plans, bylaws and other projects. Municipal planning grants are only available to municipalities with an approved plan and confirmed local planning process; currently all Chittenden County municipalities meet these eligibility requirements.

Strategy 11 *– Evaluate the potential benefits of regional transfer of development rights.*

Transfer of development rights (TDR) programs have been used for several decades to protect farmland and open space. TDR programs are voluntary and market-based. Landowners in a "sending area" to be protected from development are allowed to sell their development rights to landowners in a "receiving area" designated for higher density development. These programs help direct new growth away from low-density areas and towards areas designated for higher-density growth. This would help reduce VMT and air emissions, especially if the receiving area is served by transit.

TDR programs are usually established by local governments. For example, South Burlington has a TDR program for the Southeast Quadrant. With appropriate state legislation, TDR programs could be implemented on a regional basis. Regional TDR programs have been implemented in the New Jersey Pinelands, the Lake Tahoe area, and Montgomery County (MD).[5] CCRPC and CCMPO could initiate a discussion among municipalities and state legislators to explore the possibility of enabling and implementing regional TDR programs in Vermont.

Strategy 12 *– Evaluate the potential benefits of regional emissions impact fees or incentives to reduce pollutant emissions.*

In many areas, new development has to pay impact fees for its predicted increase in the number of school pupils, traffic on the road, or other impacts to the community caused by the development. Impact fees use market-based forces to shift the costs of dealing with the impacts from the community as a whole to the development causing the impacts.

A few non-attainment areas assess impact fees for development projects that will result in increased air emissions. The San Joaquin Valley Air Pollution Control District, in the Fresno area, imposes fees based on the estimated 10-year total of NO_x and particulate emissions associated with new development projects above a certain size.[6]

Emission reduction incentives could be used as an alternative to impact fees, or in combination with impact fees. Incentives, such as tax credits, are often better received by the developer and business community than fees. (However, the mechanism to administer emission reduction tax credits on a regional basis would need to be determined.)

Used with impact fees, incentives allow for fees to be reduced for development features that reduce transportation-related emissions, such as: proximity to retail, balance of jobs and housing, proximity to transit services, high intersection density, and provision of sidewalks and bicycle facilities. The fees, combined with the incentives, encourage best development practices and increase the costs for developments with higher emissions.

CCRPC and CCMPO could initiate a discussion among municipalities and state legislators to explore the possibility of enabling and implementing regional emissions impact fees or incentives to encourage reduction of reduce pollutant emissions.

Energy and Climate Action Planning

Strategy 13 *– Develop and implement a regional Energy and Climate Action Plan that includes air quality strategies as well as energy and climate strategies.*

Energy and climate action plans can be developed at the state, local or regional level. Because actions in the plan are appropriate to the level at which the plan is prepared, plans at different levels reinforce each other. The State of Vermont has both an energy and a climate action plan. Locally, Burlington has a climate action plan, South Burlington has started preparing a climate action plan, and other Chittenden County communities are considering energy of climate action plans. The Champlain Initiative[7], a multi-sector effort to initiate community-wide visioning and strategic planning, has identified energy as one of four key topics driving quality of life in the region. (The other topics are demographic change, health, and access to information and communication technologies.) The Champlain Initiative's Energy Task Force identified four main sectors of energy use: economic development, business and institutional uses, land use and transportation, and home energy use. The Energy Task Force identified energy planning efforts throughout the county, brainstormed energy opportunities, and proposed county-level energy indicators for electricity, transportation and home heating. The *Chittenden County Energy Strategy Report 2009* documents the work of the Champlain Initiative's Energy Task Force. Developing a regional energy and climate action plan is a logical follow-up to these efforts.

Because fuel consumption underlies energy, air quality and climate change concerns in Chittenden County, it makes sense to combine action planning for these three areas. An action plan that supports reduction in vehicle miles traveled, efficient space and water heating, and shifts to non-combustion alternative energy sources will also improve air quality.

Air Quality Education and Outreach Program

Strategy 14 *–Develop and implement a regional education and outreach program to increase understanding and change behaviors that adversely affect air quality.*

People are often unaware that there is an air quality issue, how air quality affects them, or how their actions affect air quality. This is particularly true when air quality is a concern, but not yet a crisis. Nationally, many non-attainment areas have implemented air quality education programs with brochures and informational websites that help people understand the issue and what they can do.

However, information is only the first step in changing behaviors. Examples from water quality and public health demonstrate that social marketing approaches targeting key audiences and key behaviors can be effective in raising public awareness and fostering behavioral change. Research has shown that people tend to be able to change only one or two behaviors at a time. This means that a long-term education and outreach program, focusing on just one or two behaviors at a time, will be more effective than a one-time education campaign. Subsequent outreach activities can target the next couple of behavior priorities.

Education and outreach programs using social marketing approaches:

- Conduct baseline measurements of knowledge and behaviors;
- Segment and identify key audiences;
- Develop and implement targeted marketing messages; and
- Conduct post-message measurements of knowledge and behaviors to determine effectiveness.

A local example of this approach is the Smart Waterways campaign conducted twice a year by the Regional Stormwater Education Program.[8] The Vermont Department of Health regularly uses social marketing approaches to address public health issues – ranging from preventing unintended pregnancies to preparing for, and reducing the spread of, pandemic flu. An air quality education and outreach program using social marketing approaches would seek to promote adoption of key strategies identified in this report.

Conclusions

Regional strategies to improve air quality will be most effective if they:

- Address the most important emission sources that cause ozone and fine particulate pollution. In Chittenden County, on-road vehicles are the top source of ozone precursors, and road dust is the top source of fine particulates. Regional efforts to reduce emissions from these pollutant sources will have more impact on Chittenden County's air quality than efforts that focus on less-important sources.
- Address behavior, as well as technology, affects emissions. Strategies that provide convenient transportation options will encourage people to choose to live and travel with less reliance on automobiles.

Some strategies identified in this chapter are already being implemented. Some can be implemented relatively quickly with immediate benefits. Others can only be fully implemented with new state legislation, which can take time. Because on-road transportation is the largest source of pollutants that contribute to ozone and fine-particulates, strategies that reduce vehicle miles traveled will have

the greatest regional air quality benefits. Figure 5-1 summarizes the timeframe and benefits from the regional strategies.

Figure 5-1

Summary of Regional Strategy Timeframe and Regional Benefits

Strategy	Benefits Timeframe		Regional Benefits	
	Immediate 0-5 years	Long-Term 5-20 years	Major	Moderate
Strategy 1 *– Establish performance measures and include emission and VMT reduction goals in the long-range Metropolitan Transportation Plan.*		√		√
Strategy 2 *– Utilize land use/transportation scenario planning in long-range transportation planning.*		√		√
Strategy 3 *– Enhance regional travel models to better evaluate air quality impacts in transportation studies and plans.*		√		√
Strategy 4 *– Work with VTrans, employers and TDM and transit service providers to expand and enhance Transportation Demand Management services in Chittenden County.*	√		√	
Strategy 5 *– Work with VTrans and municipalities to optimize traffic flow through monitoring and adjustment of traffic signals and intersection controls.*	√			√
Strategy 6 *– Give compact, transit-served areas funding priority, and increase the share of funding to transit and bicycle/pedestrian infrastructure.*		√	√	
Strategy 7 *– Evaluate the benefits and feasibility of a multi-county transit agency.*		√	√	
Strategy 8 *– Support regional rail improvements to allow increased rail freight and passenger rail services.*		√	√	
Strategy 9 *– Provide clear support in the Chittenden County Regional Plan for air quality and practices that help improve air quality.*		√		√

Strategy	Benefits Timeframe		Regional Benefits	
	Immediate 0-5 years	Long-Term 5-20 years	Major	Moderate
Strategy 10 *– Support local government efforts to obtain planning grants to plan and zone for transit-oriented development.*		√		√
Strategy 11 *– Evaluate the potential benefits of regional transfer of development rights.*		√		√
Strategy 12*– Evaluate the potential benefits of regional emissions impact fees or incentives to reduce pollutant emissions.*		√	√	
Strategy 13*– Develop and implement a regional Energy and Climate Action Plan that includes air quality strategies as well as energy and climate strategies.*	√		√	
Strategy 14 *– Develop and implement a regional education and outreach program to increase understanding and change behaviors that adversely affect air quality.*	√		√	

References

[1] Sacramento Area Council of Governments. 2008. *Metropolitan Transportation Plan for 2035.* Accessed April 10, 2009 at: http://www.sacog.org/mtp/2035/final-mtp/

[2] Ewing, Reid, et. al. 2008. *Growing Cooler: The Evidence on Urban Development and Climate Change*. Urban Land Institute, Washington, DC.

[3] URS Corporation. December 2005. Chittenden County TDM Education, Outreach and Support Plan. Prepared for Chittenden County Metropolitan Planning Organization. Accessed May 7, 2009 at: http://www.ccmpo.org/TDM/

[4] Chittenden County Regional Planning Commission. *2006 Chittenden County Regional Plan*.

[5] Ewing, *op. cit.*

[6] San Joaquin Valley Air Pollution Control District. *Rule 9510 Indirect Source Review*. Accessed April 10, 2009 at: http://www.valleyair.org/rules/currntrules/r9510.pdf

[7] Champlain Initiative. Accessed September 20, 2009 at: http://209.198.98.117/indes.php?page=champlain_initiative

[8] SmartWaterways.org. Accessed April 10, 2009 at: http://www.smartwaterways.org

Useful Resources

Chittenden County Metropolitan Planning Organization. Adopted January 19, 2005. *2025 Chittenden County Metropolitan Transportation Plan*. Available at: http://www.ccmpo.org/MTP/

Chittenden County Regional Planning Commission. Amended October 27, 2008. *2006 Chittenden County Regional Plan*. Available at: http://www.ccrpcvt.org/index.asp?Type=B_BASIC&SEC={9611EE71-D664-4599-919B-64B6DF0C79CA}

Chapter 6

Priority Regional Recommendations

The primary goal of this study is to identify a broad range of potential strategies that could be employed within Chittenden County to improve air quality. Chapter 1 provides an overview of air quality concerns in Chittenden County. Chapters 2 – 5 identify individual, employer, municipal and regional strategies that could help improve air quality.

As regional organizations, the Chittenden County Metropolitan Planning Organization (CCMPO) and the Chittenden County Regional Planning Commission (CCRPC) are able to incorporate some strategies in updates to the Metropolitan Transportation Plan and the Regional Plan. Other regional strategies can be implemented though their respective annual work programs.

While all of the regional strategies can help improve air quality, some strategies are particularly compelling and should be addressed by the CCMPO and CCRPC as soon as they can be implemented. This chapter identifies three priority regional recommendations.

Priority Recommendations for CCMPO and CCRPC

Regional Strategy 4 *– Work with VTrans, employers and TDM and transit service providers to expand and enhance Transportation Demand Management services in Chittenden County.*

Commuters account for a high proportion of automobile trips in Chittenden County. Transportation Demand Management services can help reduce the number of these trips. As the regional transportation planning agency, CCMPO is well-positioned to take a leadership role in expanding the scope and utilization of TDM services in Chittenden County. The following task is included in, and quoted from, the CCMPO's adopted *2010 Unified Planning Work Program:*

3.4.3 Transportation Demand Management (TDM)

Objective: To pursue recommendations from the TDM Education, Outreach, and Support Implementation Strategy, and continue support for other TDM efforts.

Description: To advance TDM efforts in Burlington, the CCMPO will continue working with the Burlington Business Association (BBA) and CATMA toward establishment of a downtown Transportation Management Association (TMA) and/or implementation of TDM programs for downtown employees. Continued park and ride planning and coordination with VTrans, and coordination efforts with CarShare Vermont will also take place under this task.

Products and Activities:

1.	TDM/TMA efforts for downtown Burlington employees.	Ongoing
2.	Coordination meetings with VTrans on park and ride development.	Ongoing
3.	A revised and updated regional park and ride plan.	June 2010
4.	CarShare Vermont assistance.	Ongoing

Regional Strategy 13 *– Develop and implement a regional Energy and Climate Action Plan that includes air quality strategies as well as energy and climate strategies.*

Energy efficiency and climate change are receiving attention at all levels, from global to local. Both topics are important to the CCMPO and CCRPC. Together, these organizations are capable of developing regional action plans, and providing data and assistance in these areas to member municipalities. Recognizing this need, both organizations included a joint energy and climate action

task in their 2010 work programs. The following description is quoted from the CCMPO's adopted *2010 Unified Planning Work Program*; similar language is in the CCRPC's adopted *2010 Work Program*.

2.2.3.2 Transportation Environmental Planning: Energy and Climate Action Plan – CCRPC

Objective: To identify and recommend policies and actions at the regional, local and individual level that would help the region reduce global warming and energy consumption.

Description: This project is viewed as the next phase of the effort described in Task 2.3.4. Transportation makes up 44%of greenhouse gas (GHG) emissions in Vermont. In order to achieve the goals of the State to reduce the state's GHG emissions by 25% from 1990 levels by 2012; 50% by 2028; and, if practical, 75% by 2050 it will take a concerted effort not just by the state, but also by the region, municipalities, employers, and individuals.

CCRPC and CCMPO staff will begin what is anticipated to be a multi-year effort to develop an Energy and Climate Action Guide for the region. The Guide is anticipated to include: estimating current and future GHG emissions, identifying a tool for use by our municipalities to perform their own emission inventories, develop recommendations on actions for the region, municipalities, employers, and individuals, developing model plan and bylaw language for municipalities, and other techniques to encourage achievement of the objectives. The municipal recommendations are intended to support improved energy elements of their municipal plans and provide replicable models for implementing the recommendations of their plans.

In this first phase, staff will review what has worked in other regions to benchmark our efforts and identify successful indicators and best practices. Staff will conduct background research on municipal and regional energy planning, including: current efforts and challenges for Chittenden County municipal energy committees, municipal and regional initiatives in Vermont, best practices in municipal and regional planning in New England, existing web-based resources, and existing organizational resources to support municipal and regional energy planning in Vermont. As part of this effort, staff will establish contacts with, and training from, the network of state organizations and agencies involved in energy planning.

Staff will work with a technical project team, including agency partners and other interested parties, to identify and decide upon the best inventory estimating tool for our region and municipalities. We will begin to develop an inventory for our region depending on the complexity of the inventory tool and its data requirements. Work will also begin to identify appropriate emissions targets and performance measures for our region. We will establish an Energy and Climate Action public outreach process to include the municipal energy committees, VECAN, VEIC, VNRC, DPS, ANR and other interested parties to guide the work of developing a public outreach campaign. This may involve periodic regional energy forums. All of this work is expected to continue into FY2011. (Same as CCRPC Work Program Task 2.9.1)

Products and Activities:

1.	GHG inventory tool for the region and municipalities	June 2010
2.	Background research and potential implementation strategies	June 2010
3.	Regional Energy Forums	June 2010

Regional Strategy 14 *– Develop and implement a regional education and outreach program to increase understanding and change behaviors that adversely affect air quality.*

Driving less is the underlying theme to many of the strategies identified in this study. Getting people to do that is a challenge that requires education, convenient alternatives and incentives. A well-crafted education and outreach program using social marketing approaches can provide information,

social incentives, and track performance measures. With input from the Advisory Committee and appropriate assistance from marketing professionals, CCMPO and CCRPC can provide leadership in implementing such a program.

In response to this need, the following task is included in – and quoted from – the CCMPO's adopted *2010 Unified Planning Work Program* and the CCRPC's adopted *2010 Work Program*:

2.2.3.1 Transportation Environmental Planning: Air Quality – CCRPC

Objective: To examine the implications of possible non-attainment of federal air quality standards in Chittenden County and, in cooperation with the CCMPO, to identify and recommend policies and actions at the regional, local and individual level that would help the region stay in, or return to, attainment status.

Description: This project is closely related to, and seen as a first step towards, Task 2.2.3.2 – Transportation Environmental Planning: Energy and Climate Action Plan. This project is also viewed as part of a broader effort by CCMPO and its partners to plan for, or prevent, designation as a non-attainment area. This project is anticipated to include evaluation and recommendations on actions to include in CCMPO and municipal plans. This task helps to implement the Air Quality Policies of the *Regional Plan*.

Working with an Advisory Committee, CCRPC and CCMPO staff will finalize the Air Quality Report and recommendations for what municipalities, employers and individuals can do to maintain/improve air quality. The recommendations and next steps will be reviewed with the CCMPO Board and CCRPC Commission. With Advisory Committee input, staff will develop an outreach program for each target audience, prepare outreach materials, and implement the outreach program. This task may include additional efforts to improve the delivery of this information via the CCMPO and CCRPC web sites as appropriate. (Same as CCRPC Work Program Task 2.3.3)

Products and Activities:

1. *Air Quality Report* including recommendations for municipalities, employers and individuals September 2009
2. Outreach materials to be determined, but anticipated to include web-based materials, brochures, fact sheets, checklists, press releases and presentations. June 2010

This study completes the first part of this task. Developing a social marketing program is the second part of this task.

Conclusions

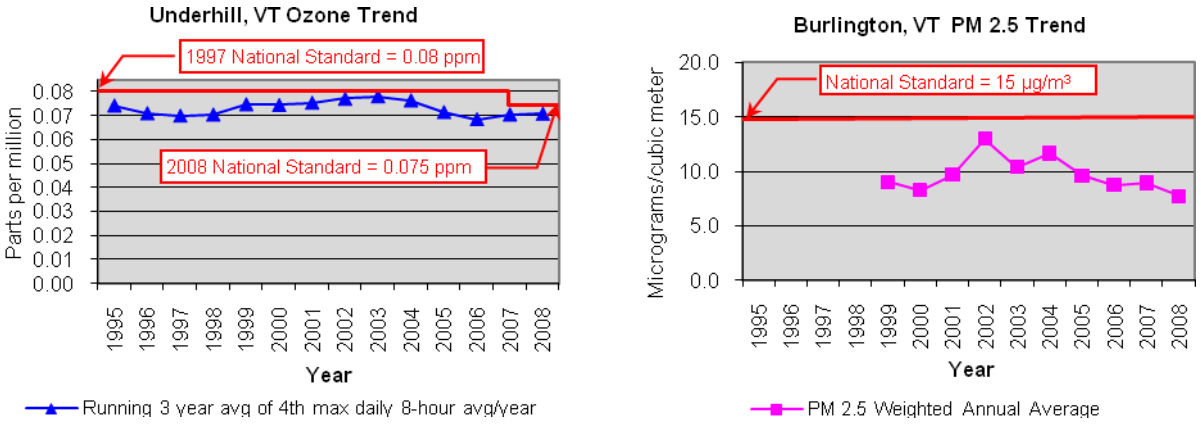
This study's identification of these three priority recommendations is intended to help the CCMPO and CCRPC focus immediate attention on strategies with the greatest needs and potential benefits for air quality. The influence of this study and the commitment of both organizations is seen in the tasks which were included in the 2010 annual work programs. Although not selected as priorities, other regional strategies should be implemented as the opportunities arise or can be created. Both organizations should also seek ways to assist in implementing the individual, employer and municipal strategies identified in this study.

Appendix A

Air Pollution in Chittenden County

The National Ambient Air Quality Standards (NAAQS) establish the maximum acceptable levels for eight common air pollutants. Two of these pollutants – ground-level ozone and fine particulates – are a concern in Chittenden County. Figure A-1 shows the measured levels of ozone and fine particulates, compared to the national standards. Levels of ozone are already close to the current national standard, which the US Environmental Protection Agency plans to make even more stringent in 2010. Levels of fine particulates have approached the national standard in recent years.

Figure A-1
Ground-Level Ozone and Fine Particulates Trends in Chittenden County

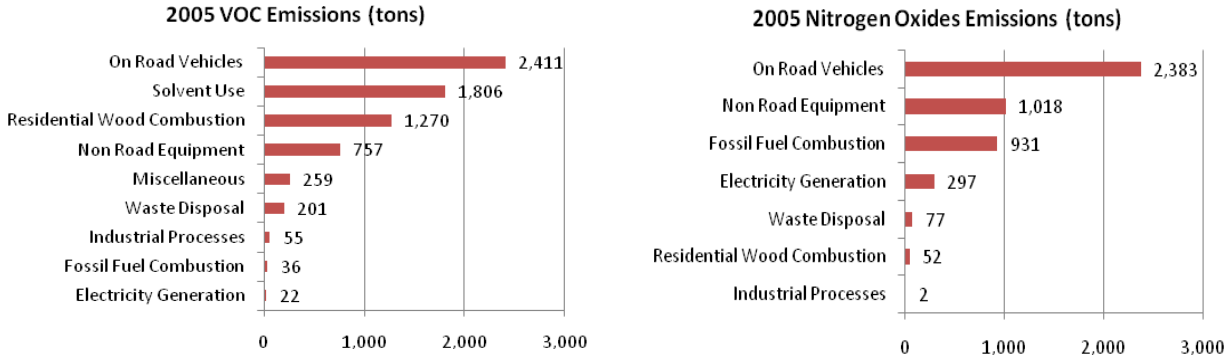


Source: US Environmental Protection Agency

Ground-Level Ozone Pollution

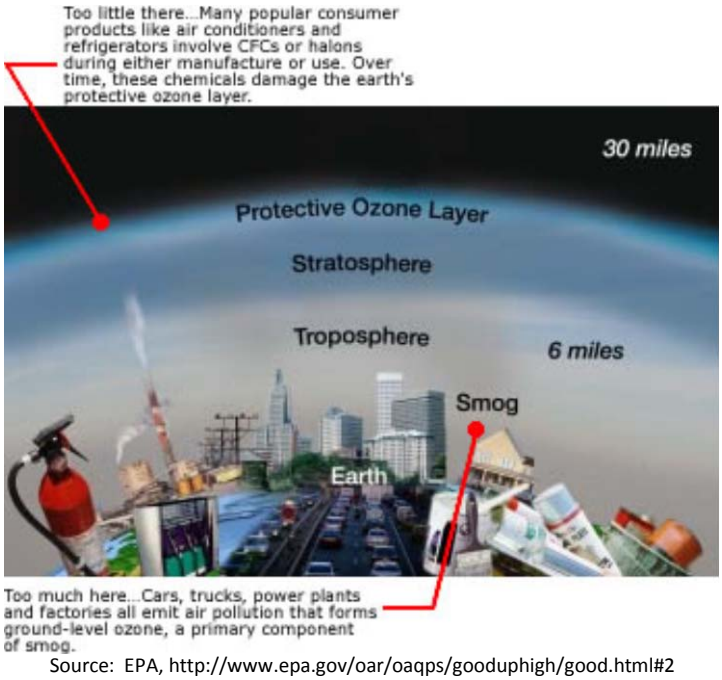
Most ozone is not emitted by motor vehicles or industrial sources. Instead, ozone in the lower atmosphere is formed by the reaction of other pollutants: hydrocarbons (also known as volatile organic compounds, or VOCs) and nitrogen oxides (NO_x). Sunlight is needed for this reaction to occur, which is why high concentrations of ground-level ozone are most likely to occur in warmer months with more daylight. Because of their role in the formation of ozone, VOCs and NO_x are often referred to as ozone precursors. Figure A-2 shows the local sources of ozone precursors.

Figure A-2
Chittenden County Sources of Ozone Precursors



Source: US EPA, *2005 National Emissions Inventory*, State and County Air Emission Summaries

Ozone in the Atmosphere



Source: EPA, http://www.epa.gov/oar/oaqps/gooduphigh/good.html#2

Ozone is present in low concentrations throughout the Earth's atmosphere. The highest concentrations of ozone are found in the upper atmosphere, in a region known as the ozone layer. The ozone layer plays an important role in filtering out ultraviolet light from the sun that can damage people, animals and plant life. The ozone layer can be thought of as the Earth's sunscreen.

Ozone precursors can be emitted locally, or can be emitted upwind and blown into an area and then undergo the reaction to make ozone. This transport phenomenon is why Burlington is the sampling location for most air pollutants, but ozone sampling is done at a site in Underhill.

Ozone precursors, particularly NO_x can be transported long distances before ozone is formed. This makes controlling ground-level ozone levels very challenging – emission sources can be miles, and even states, away from areas with high ozone concentrations. In the Northeast, ozone pollution is a regional problem. The federal Clean Air Act designated a Northeast Ozone Transport Region, comprising all of New England, the Mid-Atlantic, and the Metropolitan Washington D.C. area. EPA requires states in the Ozone Transport Region to take certain regulatory steps to control emissions of VOCs and NOx.

Ozone Pollution Health and Environmental Effects

Even at low levels, ground-level ozone can cause serious human health and environmental problems. Ozone is particularly associated with respiratory illnesses. When we breathe, ozone reacts with molecules in the linings of our airways and lungs, causing acute inflammation. Our airways respond by contracting muscles and secreting mucus. This makes breathing much more difficult. Common symptoms of ozone exposure include:

- Shortness of breath;
- Dry cough or pain when taking a deep breath;
- Aggravation of asthma, emphysema and other respiratory diseases; and
- Increased risk of respiratory infections, such as pneumonia and bronchitis.

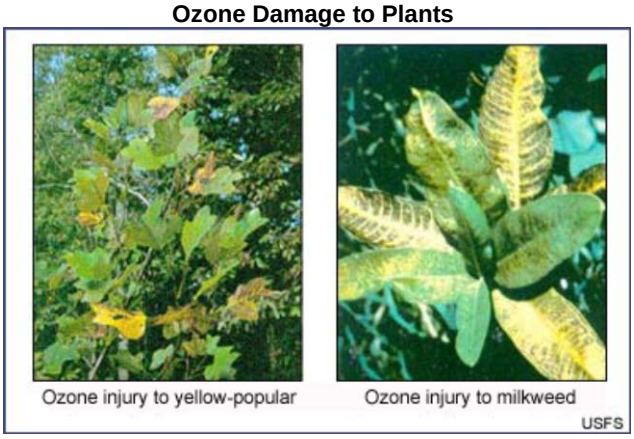
Children are most at risk from exposure to ground-level ozone. Children breathe more air per pound of body weight than adults, and their developing respiratory systems are more susceptible to environmental hazards. Additionally, ground-level ozone is a summertime problem, when children are more likely to be spending a lot of time playing and exercising outdoors.

Asthma is a growing problem, especially among children. According to US EPA, 14 Americans die every day from asthma – a rate three times higher than 20 years ago.[1] Ozone aggravates asthma,

causing more attacks, increasing the need for medication and medical treatment, and increasing hospital emergency room visits.

Even health adults working or exercising outdoors show 15-20% reductions in lung function from several hours of low-level ozone exposure.[2] Although the effects of short-term ozone exposure are reversible, repeated ozone exposures can cause permanent lung damage.

Figure A-3
Ozone Damage to Plants



Ozone pollution also damages the pigments in plant leaves. Crop yields decrease with exposure to ozone; broad-leaf crops such as soybeans have a more pronounced yield loss with ozone exposure than narrow-leaf crops such as field corn and wheat.

In addition to damaging people and plants, ozone pollution also damages materials and coatings. Elastic materials such as rubber and some plastics become brittle and crack. Paints and fabric dyes fade more quickly.

Air Toxics

The federal government has identified various hazardous air pollutants that are known or suspected to cause cancer or other serious health effects. These pollutants, often referred to as air toxics, include industrial chemicals, solvents, pesticides, metals and combustion by-products. There are no national air quality standards for air toxics, however, Vermont has established ambient air standards for over 380 air toxics.

Air quality monitoring in Chittenden County shows that four air toxics routinely exceed the state's standards:[5]

- Benzene – Benzene is a human carcinogen. It is used as an industrial solvent and is found in motor fuels. It is formed during combustion of petroleum and wood fuels.
- 1,3-Butadiene – 1,3-Butadiene is a probable human carcinogen. The primary source of 1,3-butadiene is vehicle exhaust; other sources include waste incinerators and wood fires.
- Carbon tetrachloride – Carbon tetrachloride is a probable human carcinogen. Consumer use of carbon tetrachloride was phased out in the 1960s; the compound is now used only in industrial processes.
- Formaldehyde –Formaldehyde is a probable human carcinogen and an irritant to eyes, nose and throat. Some people are known to be more sensitive to formaldehyde than others, and repeated exposure can increase sensitivity. Formaldehyde is used in glues and resins, notably in the resins used to make particleboard. It is also a byproduct of combustion, including motor vehicles and wood stoves.

These four problem air toxics come from a variety of sources, including motor vehicles, gas stations, home heating, dry cleaners and industrial sources. All are volatile organic compounds – and thus are precursors to ozone formation in the atmosphere. Except for carbon tetrachloride, all are considered to be generated locally. Actions taken in Chittenden County to reduce the emissions of benzene, 1,3-butadiene and formaldehyde will not only reduce ambient concentrations of these air toxics, but will also help reduce concentrations of ozone as well.

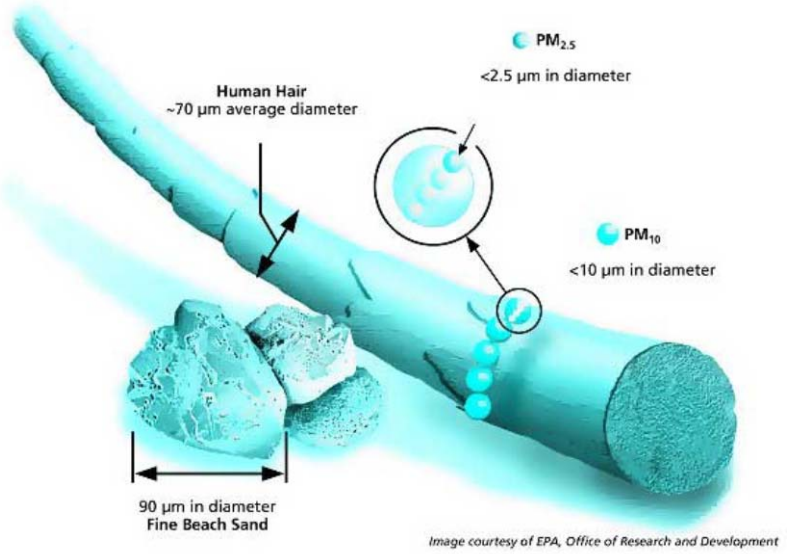
Fine Particulate Pollution

Even on clear days, haze can make it hard to see the mountains or across Lake Champlain. Fine particles suspended in the air scatter and absorb light, reducing visibility. On humid days, this effect is more pronounced. Haze is a visible sign of particulate pollution.

Microscopic particles suspended in the air are called particulate matter. These particles can be either solids (e.g., soot) or liquid droplets (e.g., salt spray). From a pollution and health point of view, two particle size ranges are important:

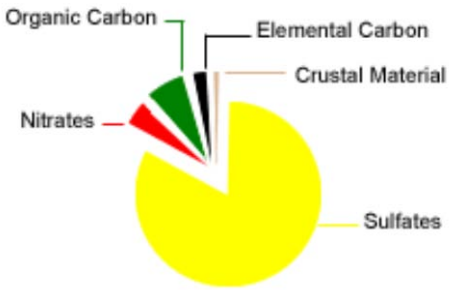
- PM_{10} – particles smaller than 10 micrometers (μm) in diameter. Particles this size can be inhaled and settle in the lungs.
- $PM_{2.5}$ – particles smaller than 2.5 μm in diameter. Particles this size can penetrate into the gas-exchange regions of the lungs. The smallest of these particles (less than 0.1 μm) are able to get into the bloodstream and migrate to other organs.

Particulate Matter Sizes



Particulate Types Contributing to Haze in the Eastern US

There are four general types of fine particulates, each arising from different sources.



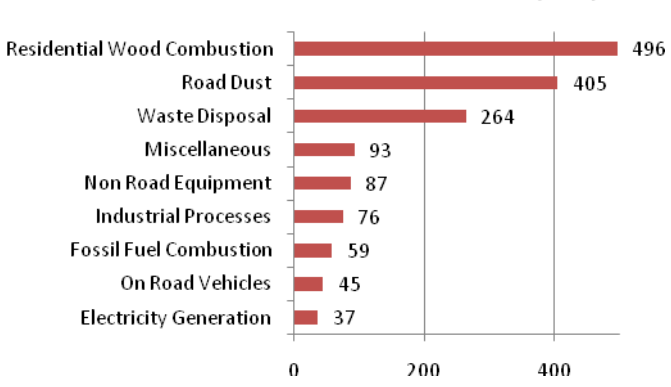
Source: USDA

- Sulfates and Nitrates – Sulfates and nitrates are acidic particles that are the cause of the acid rain that has damaged many lakes and ponds in the Northeast. Sulfates form from sulfur dioxide (SO_2) gas emissions, and are mostly released from coal-burning power plants and industrial sources, such as smelters, industrial boilers and oil refineries. Nitrates form from nitrogen oxide gas, which is released from combustion activities. Cars, trucks, construction equipment, lawn mowers, boats all contribute to nitrate particulates.
- Organic carbon chemicals – Some volatile organic compounds (VOCs) are emitted directly, and some form in the atmosphere as a reaction of gaseous hydrocarbons. The primary sources of organic chemicals are vehicle exhaust, vehicle refueling, solvent evaporation (e.g., paints), food cooking, and various commercial and industrial sources. Some organic chemicals result from fires, and some are naturally emitted from trees.
- Elemental carbon – These particles are composed of pure carbon, such as soot. These carbon particles are emitted directly from most combustion activities, especially from diesel exhaust and smoke from wood and waste burning. Carbon particulates are what cause the brown clouds in winter over urban areas and mountain valleys.
- Crustal materials – Essentially dust, these particulates enter the air from dirt roads, fields and other open spaces as a result of wind, traffic and other surface activities.

Both PM_{10} and $PM_{2.5}$ are regulated air pollutants. $PM_{2.5}$ is also referred to as fine particulate matter, and is the pollutant we are concerned with in Chittenden County.

Acids and organic chemicals are the most common types of fine particulate matter pollution in the Northeast. As with ozone, fine particulate matter pollution can originate locally, or can be blown into an area from hundreds of miles away, or both.

Figure A-4
Chittenden County Sources of Fine Particulates



Source: US EPA, *2005 National Emissions Survey*, State and County Emission Summaries

Four sources account for 80% of the fine particulates emitted in the County: residential wood combustion, road dust, waste disposal, and miscellaneous sources such as agriculture, construction and gas stations.

Fine particulate pollution can occur year round, but there are seasonal patterns. Large-scale high pressure systems create the classic conditions for severe fine particulate matter pollution in the Eastern US. Particularly in the summer, these high-pressure systems favor upwind conversion of SO_2 to sulfates, which are then blown into the region from the South and West and added to local emissions. The high pressure system can then stall for several days, allowing pollution concentrations to increase. This is why a long string of sunny days in the summer gets hazier and hazier; a change in the weather will then blow the particulate pollution away or wash it out in a rain storm.

In the winter, temperature inversions can occur and cause fine particulate matter pollution episodes. An upper layer of warmer air acts like a lid over the cooler air below and prevents air mixing. This causes locally-emitted fine particulate matter pollution to concentrate overnight and during the early morning. Use of wood-burning fireplaces and stoves can intensify fine particulate pollution during these temperature inversions.

Fine Particulate Pollution Health and Environmental Effects

The small size of fine particulates allows them to get deep into the lungs, where they can cause serious health problems.

- For healthy people, breathing fine particulates can cause temporary symptoms, including: irritation of eyes, nose and throat; phlegm; chest tightness; and shortness of breath.
- For children and adults with lung disease, exposure to fine particulates can trigger asthma attacks, and make them severe enough to require an emergency room visit or hospitalization.
- For people with heart disease, short-term exposure can cause chest pain; heart palpitations; unusual fatigue; strokes; and even heart attacks with no warning signs.
- Short-term exposure can increase susceptibility to respiratory infections, including acute bronchitis.
- Long-term exposure to fine particle pollution is associated with reduced lung function, chronic bronchitis, and can shorten life by one to three years.[3]

Fine particulate matter pollution also impacts the environment. The most obvious environmental impact is visual: fine particulates in haze reduce visibility. As the amount of fine particles increases,

more light is absorbed and scattered, resulting in less clarity, color, and visual range. In the eastern US, the typical visual range is 15 to 30 miles; this is about one-third of what visibility would be without particulate pollution.[4]

Particulates and Acid Rain

Rain washes fine particulates out of the air. Sulfate and nitrate particulates are acidic when dissolved in water; this is how acid rain is formed. These particles can also be directly deposited without rain, a process known as dry deposition. Many studies have been done on the impacts of acid rain and dry deposition of acidic particles on the environment.

Forests are impacted when acid rain dissolves nutrients and minerals from soil, making them unavailable to plants. It can also mobilize toxic substances in soil, such as aluminum, that can harm trees and other plants, or wash into lakes and streams to harm aquatic organisms. Acid rain, and acidic fog, can also directly damage plant leaves. Crops are generally less susceptible to damage from acid rain because farmers may fertilize and replace nutrients removed by acid rain and often apply crushed limestone which neutralizes the ability of acid rain to leach nutrients from the soil.

Lakes and streams, and the organisms that live in them, are particularly sensitive to acid rain if the local soils don't have a natural ability to neutralize the acid. Aluminum released by the acid rain from the soils is particularly toxic to many aquatic species. Native aquatic insects, shellfish, amphibians and fish have differing sensitivities to acid rain and to aluminum; some species can tolerate the acid conditions, other species will be weakened or killed. Tolerant species can be indirectly affected, however, if the food they eat is sensitive to acidic conditions. As lakes and streams become more acidic, the impacts cascade through the food chain and the overall number and types of aquatic plants and animals decrease. This is why some lakes and streams impacted by acid rain have virtually no plant or animal life. None of the 37 Vermont lakes listed as being highly acidic are located in Chittenden County.

Acid rain and dry deposition of acidic particles cause metal corrosion and deterioration of paint and stone. Buildings, statues, even tombstones made of marble or limestone will be eaten by the acid. Bronze statues will corrode. Acid rain and acidic dry deposition also deteriorate paint and other coatings. Cars are also damaged when acid rain and particles etch the paint; the auto and coatings industries have been trying to develop coatings that are more acid resistant.

Air Quality Index

To help inform the public about air quality, EPA developed a color-coded Air Quality Index (see next page) to quickly communicate what the air quality is and who needs to protect themselves. Air Quality Index (AQI) values are based on the actual pollutant concentration relative to the air quality standard.

People can get the forecast for ozone or fine particulates by checking the Vermont Air Pollution Control Division's website.[6] Following the Air

Air Quality and Chronic Respiratory Disease

Clean air is important to public health. Everyone breathes, and the air we inhale goes into our lungs. Chemicals and fine particles in the air can diffuse from our lungs into our bloodstream and be carried throughout our bodies. Ozone and fine particulate pollution can cause or aggravate chronic respiratory and cardiovascular diseases.

The Vermont Dept. of Health reports that:

- 9.8% of Vermont adults have asthma;[6]
- 8.2% of Vermont youth have asthma[7]; and
- 4.4% of Vermont adults have chronic obstructive pulmonary disease (chronic bronchitis and emphysema).[8]

While outdoor air quality is not reported as a primary risk factor for these respiratory diseases, outdoor air quality can aggravate these chronic conditions.

Quality Index guidance will help reduce health exposures on days with high ozone or fine particulate pollution levels.

Figure A-5

Air Quality Index			
Air Quality Index (AQI) Values	**Levels of Health Concern**	**Colors**	**Cautions**
0-50	**Good**	**Green**	None
51-100	**Moderate**	**Yellow**	Unusually sensitive people should consider reducing prolonged or heavy exertion outdoors.
101-150	**Unhealthy for Sensitive Groups**	**Orange**	Active children and adults, and people with lung disease, such as asthma, should reduce prolonged or heavy exertion outdoors.
151-200	**Unhealthy**	**Red**	Active children and adults, and people with lung disease, such as asthma, should avoid all outdoor exertion. Everyone else, especially children, should reduce prolonged or heavy exertion outdoors.
201-300	**Very Unhealthy**	**Purple**	Active children and adults, and people with lung disease, such as asthma, should avoid all outdoor exertion. Everyone else, especially children, should avoid prolonged or heavy exertion outdoors.
301-500	**Hazardous**	**Maroon**	Everyone should avoid all physical activity outdoors.

Source: US EPA. 2003. *Air Quality Index: A Guide to Air Quality and Your Health*

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[3] American Lung Association. *State of the Air: 2007, Health Effects of Ozone and Particle Pollution* Accessed April 10, 2008 at http://lungaction.org/reports/sota07_heffects_particlepollution.html?

[4] Camnet. *Realtime Air Pollution and Visibility Monitoring, Causes of Low Visibility*. Accessed April 20, 2008 at: http://www.hazecam.net/poor-vis.html

[5] Vermont Agency of Natural Resources, Air Pollution Control Division. *Real-time Air Quality Data*. Accessed September 23, 2009 at: http://www.anr.state.vt.us/air/Monitoring/cfm/RealTimeData.cfm

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[8] *Vermont Behavioral Risk Factor Surveillance System*, 2002. Cited in Vermont Department of Health. *Chronic Obstructive Pulmonary Disease (COPD)*, accessed August 4, 2008 at http://healthvermont.gov/research/copd/copd.aspx.

Useful Resources

Ozone Pollution

American Lung Association. *Ozone Fact Sheet*. http://www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=50328

AIRNow. *Smog – Who Does It Hurt?* http://airnow.gov/index.dfm?action=health2.smot1#1

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Vermont Agency of Natural Resources. *Air Toxics Program*. http://www.anr.state.vt.us/air/AirToxics/index.htm

Vermont Agency of Natural Resources. *Sources of Toxic Air Pollution*. http://www.anr.state.vt.us/air/AirToxics/htm/Sources.htm

Appendix B

Air Quality Standards and Non-Attainment

The Federal Framework for Protecting Air Quality: The Clean Air Act

The national framework for protecting air quality is based on a series of federal laws that set standards for air quality, require states to plan to meet these standards, and establish regulatory programs to control emissions of air pollutants.

The Air Pollution Control Act of 1955 was the first federal legislation related to air pollution. This act identified air pollution as a national problem and funded federal air pollution research. The Clean Air Act of 1963 created the first federal program to monitor and control air pollution.

The Clean Air Act of 1970 significantly expanded the government's role by creating a framework of federal and state regulations to limit emissions from stationary (industrial) sources and mobile (motor vehicle) sources. This legislation:

- Authorized outdoor air quality standards, referred to as National Ambient Air Quality Standards (NAAQS);
- Required states to develop State Implementation Plans to implement the Clean Air Act and achieve the National Ambient Air Quality Standards;
- Authorized standards to control emissions from new and modified industrial sources;
- Authorized requirements for controlling motor vehicle emissions;
- Authorized emission standards for hazardous air pollutants; and
- Increased federal enforcement authority.

At about the same time, the adoption of the National Environmental Policy Act created the Environmental Protection Agency, which was given responsibility for implementing the Clean Air Act. The 1977 Amendments to the Clean Air Act added requirements to keep air quality from deteriorating in national parks and wilderness areas, as well as requirements for areas that don't meet the NAAQS.

The 1990 Amendments to the Clean Air Act authorized new regulatory programs to control acid rain, toxic air pollutants, depletion of the ozone layer in the upper atmosphere, and establish a permit program for industrial sources. These amendments also expanded the requirements for meeting the NAAQS.

Clean Air Act Roles and Responsibilities

Under the Clean Air Act, EPA sets the standards for air quality and emission limits for industrial sources. State and local government are responsible for implementing plans and programs to implement the Clean Air Act. EPA assists state and local air pollution agencies with funding, research and expert studies.

States document their air quality plans, programs and regulations in the State Implementation Plan (SIP), which must be approved by EPA. Other roles for state and local air pollution agencies include:

- Monitoring air quality;
- Implementing permit programs for industrial air emission sources;
- Inspecting permitted facilities; and
- Enforcing the Clean Air Act regulations.

As the state agency responsible for air pollution, the Air Pollution Control Division of the Vermont Agency of Natural Resources (ANR) is responsible for preparing the SIP. Under the SIP, ANR monitors air quality at various locations, including Burlington and Underhill. ANR regulates and requires permits for businesses that emit air pollutants. To implement Clean Air Act requirements to control emissions from mobile sources, ANR has issued regulations for cleaner fuels, vapor control devices on fuel pumps, and a low emission vehicles program.

In Vermont, municipalities do not have a specific role in implementing the Clean Air Act. They can, however, pass local requirements to protect air quality. For example, Burlington, Colchester, South Burlington and Winooski prohibit open burning. Burlington also prohibits motor vehicle idling.

National Ambient Air Quality Standards

EPA has identified six air pollutants that are of nation-wide concern: ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide, particulate matter and lead. For each of these "criteria pollutants," EPA has established maximum acceptable standards based on scientific studies. Primary standards set concentration limits that will protect human health, including the health of sensitive populations such as asthmatics, children and the elderly. Secondary standards set concentration limits to protect public welfare, including protection against decreased visibility, damage to the environment, crops or buildings.

The National Ambient Air Quality Standards for each of the criteria pollutants are shown in Table B-1 (on the next page). To avoid having a temporary pollutant spike overly influence compliance, some of the standards are measured by 8-hour averages, 24-hour averages or annual averages.

EPA reviews these standards every five years to see whether they are still protective of public health and welfare, given current scientific evidence. In 2006, EPA significantly tightened the 24-hour average standard for $PM_{2.5}$. In March 2008, EPA reduced the ozone standard from 0.08 ppm to 0.075 ppm. EPA has taken a fresh look at the health studies for ozone, and in January 2010 proposed to tighten the primary ozone standard to a value between 0.060 and 0.070 ppm. EPA is also considering establishing a new secondary ozone standard based on the cumulative impacts of ozone on the environment.

ANR monitors air quality in Chittenden County for all of the criteria pollutants, except lead. (Vermont's lead levels in air have been determined to be too low to justify ongoing monitoring.) Monitoring stations in Burlington collect most of the data, however, ozone must be sampled downwind and therefore is monitored in Underhill.

Figure B-1

National Ambient Air Quality Standards (NAAQS)				
	Primary Standards		Secondary Standard	
Pollutant	**Level**	**Averaging Time**	**Level**	**Averaging Time**
Carbon Monoxide	9 ppm (10 mg/m^3)	8-hour[1]	None	
	35 ppm (40 mg/m^3)	1 hour[1]		
Lead	1.5 µg/m3	Quarterly Average	Same as Primary	
Nitrogen Dioxide	0.053 ppm (100 µg/m^3)	Annual (Arithmetic mean)	Same as Primary	
Particulate Matter (PM_{10})	150 µg/m^3)	24-hour[2]	Same as Primary	
Particulate Matter ($PM_{2.5}$)	15.0 µg/m^3)	Annual[3] (Arithmetic Mean)	Same as Primary	
	35 µg/m^3	24-hour[4]	Same as Primary	
Ozone	0.075 ppm (2008 std)	8-hour[5]	Same as Primary	
	0.08 ppm (1997 std)	8-hour[6]	Same as Primary	
	0.12 ppm	1-hour[7] (Applies only in limited areas)	Same as Primary	
Sulfur Dioxide	0.03 ppm	Annual[8] (Arithmetic Mean)	0.5 ppm (1300 µg/m^3)	3-hour
	0.14 ppm	24-hour[1]		

[1] Not to be exceeded more than once per year.

[2] Not to be exceeded more than once per year on average over 3 years.

[3] To attain this standard, the 3-year average of the weighted annual mean PM2.5 concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m3.

[4] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m3 (effective December 17, 2006).

[5] To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective May 27, 2008)

[6] (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.

(b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.

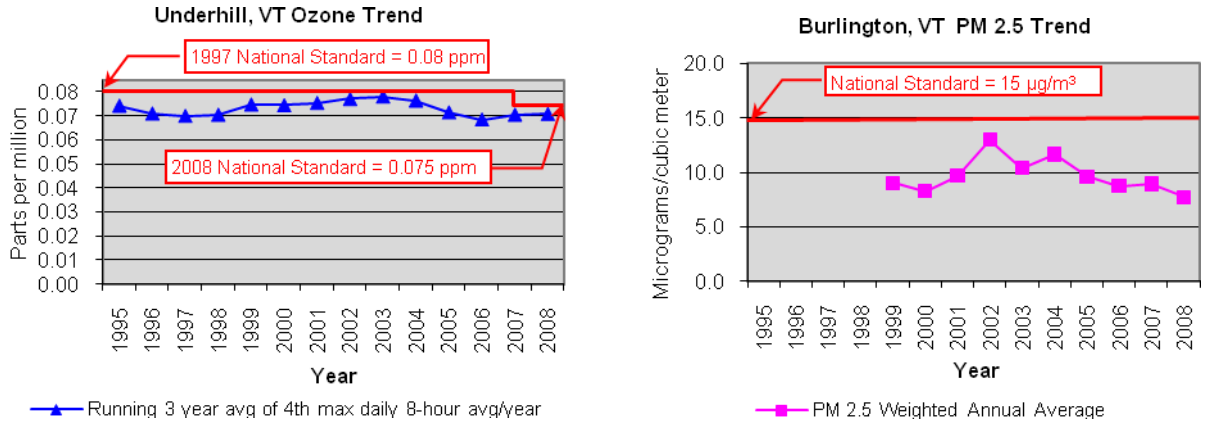
[7] (a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is $\leq$ 1.

Source: US Environmental Protection Agency

Monitoring shows that levels of sulfur dioxide, carbon monoxide, nitrogen dioxide, and particulate matter smaller than 10 microns in diameter (PM_{10}) in Chittenden County are well below their respective standards. However, Chittenden County's levels of ground-level ozone and fine particulates (less than 2.5 microns in diameter, or $PM_{2.5}$) are close to the current standards.

Figure B-2 shows Chittenden County air quality trends through 2008 for ozone and $PM_{2.5}$.

Figure B-2
Ozone and Fine Particulates Trends in Chittenden County



Source: US Environmental Protection Agency

- The 2008 ozone measures are slightly below the current ozone NAAQS,and exceed the concentration levels EPA is proposing for a new primary standard.
- The weighted annual average concentrations of $PM_{2.5}$ have declined in the past several years, but still are relatively close to the standard; the 2002 annual average value was 13 µg/m^3 (compared to the annual average NAAQS of 15 µg/m^3).

Based on the monitoring data, Chittenden County currently complies with all of the criteria air pollutant NAAQS and is considered to be an "attainment area." However, Chittenden County has only a slim margin in meeting the standards for ozone and $PM_{2.5}$. Should concentrations of these pollutants increase, or the standards be further tightened, then Chittenden County could face being out of compliance with the NAAQS. A region that does not comply with one or more NAAQS is considered to be a "non-attainment area."

The State Implementation Plan

The state implementation plan (SIP) outlines the measures that the state will take to implement the Clean Air Act and to protect, improve and/or maintain air quality. Approval by EPA means that the state is qualified to implement the Clean Air Act. If a SIP isn't submitted or is inadequate, EPA will prepare a plan to federally administer the Clean Air Act in that state. States that comply with the NAAQS but, like Vermont, are in the ozone transport region, have additional SIP requirements to address ozone reduction. States with a non-attainment area must also include additional elements in the SIP.

Vermont's Air Pollution Control Division, in the Agency of Natural Resources, is responsible for preparing Vermont's SIP. The plan was originally submitted to US EPA in 1972, and has been updated multiple times since then. The current Vermont SIP includes:

- State regulations prohibiting certain activities that cause air pollution (e.g., open burning);
- State regulations requiring air pollution controls for certain industries;
- State regulations requiring vapor recovery controls at higher-volume gas stations;
- State regulations establishing ambient air quality standards equivalent to NAAQS;
- State regulations, permits, controls, and reporting requirements for air pollution sources;
- State regulations for motor vehicle emissions (e.g., clean fuels, low emission vehicles, and on-board diagnostics);
- State sampling network and program for monitoring ambient air quality;
- State procedures to protect visibility in the Lye Brook Wilderness (a Class 1 federal area);
- State procedures for public involvement; and
- State resources to adequately implement the program.

Previous Non-Attainment Status for Chittenden County[1]

After the Clean Air Act was adopted in the early 1970s, monitoring indicated that Chittenden County did not meet all of the new NAAQS. Monitoring in Burlington showed that the daily and annual standards for total suspended particulates (TSP) were exceeded, triggering designation of all the counties along Lake Champlain as a non-attainment area for TSP. (Curiously, monitoring showed compliance with the standard for sulfur dioxide (SO_2), but the SIP designated the same region as non-attainment for SO_2.) The 1972 SIP concluded that Vermont's then-current regulations were adequate to bring the state into attainment by the 1975 deadline in the Clean Air Act. However, the TSP standard was still not met in 1977, when the criteria for designating non-attainment areas were changed in the Clean Air Act amendments.

The 1979 SIP designated non-attainment areas by town boundaries, or county boundaries for more regional pollutants. Burlington, Essex Town, Essex Junction, South Burlington, and Winooski were designated as non-attainment for TSP. Burlington, Colchester, Essex Town and Essex Junction, Shelburne, South Burlington, St. George, Williston and Winooski were all designated as non-attainment for carbon monoxide. All of Chittenden County was designated non-attainment for ozone.

The 1979 SIP identified strategies to improve air quality and achieve the air quality standards:

- A study was done to identify the most significant components of TSP. This study concluded that road dust was responsible for exceeding the TSP standard. The SIP detailed an approach to control road dust.
- The SIP strategy for carbon monoxide focused on cars and trucks in urban areas. Modeling calculations showed that the new federal emission control standards would adequately reduce carbon monoxide levels even with projected increases in driving. This proved to be true, and non-attainment areas for carbon monoxide were re-designated as attainment in the early 1980s.

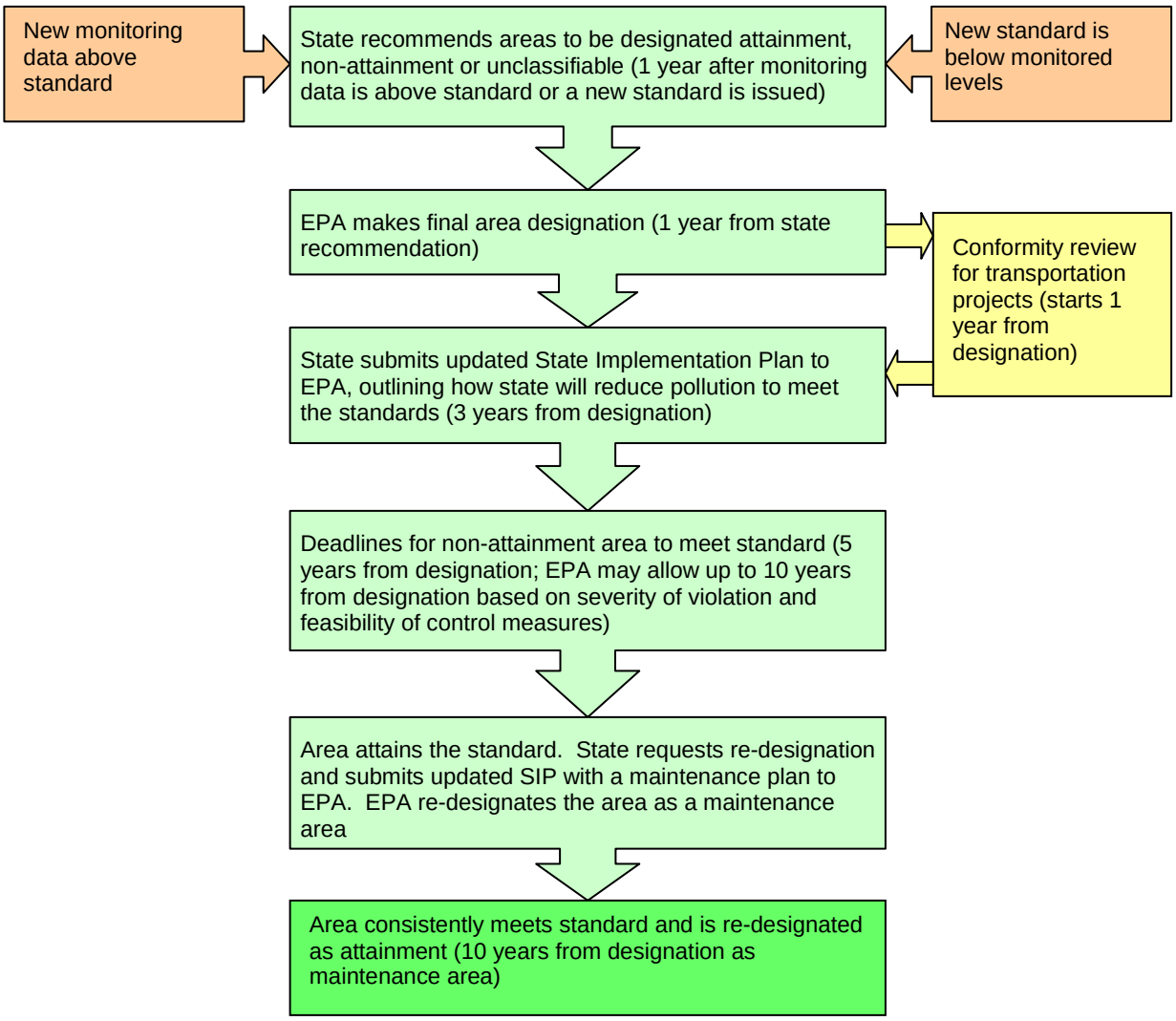
- Ongoing monitoring supported re-designation of Chittenden County in 1981 as an ozone attainment area.

When EPA replaced the standard for TSP with a standard for particulate matter smaller than 10 micrometers (PM_{10}) in 1987, Chittenden County met the new particulate standard. Currently, Chittenden County – and all of Vermont – are considered attainment areas for all NAAQS.

Requirements for Non-Attainment Areas

The requirements and deadlines for non-attainment areas are shown in Figure B-3.

Figure B-3
Non-Attainment Requirements and Deadlines

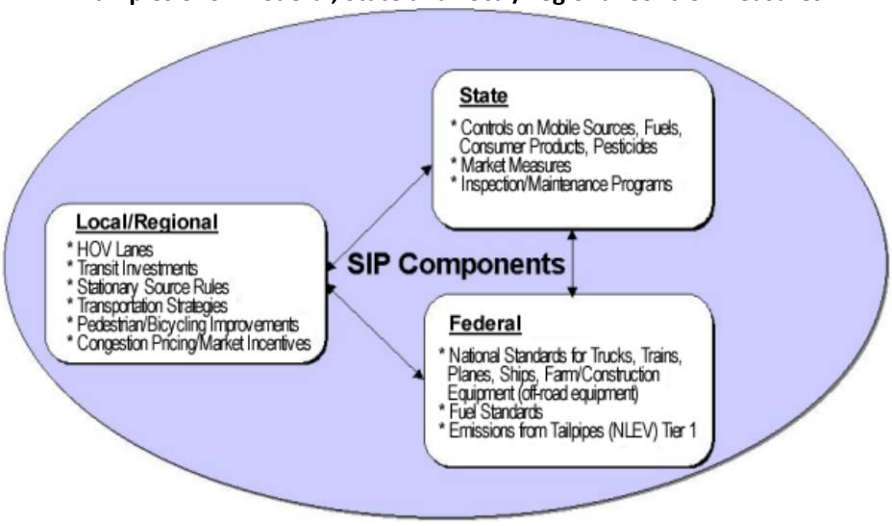


If a new NAAQS or new monitoring data indicate that an area does not comply with the air quality standard, the state is responsible for recommending to EPA the areas of the state that should be designated as attainment, non-attainment, or unclassifiable based on available data. (Areas without monitoring data may be designated as unclassifiable.) EPA reviews the state's recommendations and makes the final designation.

If any area in a state is designated as non-attainment, the state must update the SIP to include an attainment plan for the pollutants that no longer comply with the standards. A SIP attainment plan is required to include the following elements:

- Emissions inventory – States are periodically required to submit emissions inventories to EPA. Emission inventories are based on a combination of actual monitoring data (e.g., for large stationary sources) and modeling (e.g., on-road vehicle emissions are calculated based on modeled vehicle miles traveled and emission factors). The most recent emissions inventory, currently the 2005 inventory, is usually the baseline emissions inventory for the SIP.
- Emissions budgets – Modeling analyses, based on the emissions inventory and predicted growth, are used to forecast future emissions and determine the amount of emission reductions needed to achieve the NAAQS. This is a challenging exercise for ozone and fine particulates, given that distant emission sources and weather conditions can also contribute to local pollutant levels. It is not currently possible to accurately predict that a specific amount of emissions reductions will result in the needed improvement in air quality. However, a non-attainment area can only control the amount of local pollutant emissions, so emission budgets focus on reducing pollutants from local sources. The total emissions reductions needed are then allocated to source categories (i.e., point sources, area sources and mobile sources) to form emission budgets. Because feasibility and cost-effectiveness of controls vary for the source categories, the allocation of emissions reductions may not be equally shared by the source categories. The motor vehicle emissions budget (a subset of the mobile source emissions budget) is important for transportation planning in non-attainment areas.
- Emission control strategies – The SIP identifies the emission control measures that will be implemented to reduce emissions, as well as an implementation schedule for these controls. Inclusion in the SIP makes these emission control measures legally enforceable. Industry sources will be affected by requirements for Reasonably Available Control Technologies (measures that are reasonably available, considering technical and economic feasibility). Transportation Control Measures (TCMs) are emission control strategies specifically intended to reduce motor vehicle emissions. Examples of TCMs include transit, ridesharing arrangements, telecommuting and parking management. Figure B-4 shows examples of enforceable emission control strategies that might be included in a SIP.

Figure B-4
Examples of SIP Federal, State and Local/Regional Control Measures



Source: FHWA

When monitoring data demonstrates that air quality has improved to again meet the NAAQS, a non-attainment area can be re-designated as a "maintenance area." The SIP is then revised again to include a plan to ensure that the area can maintain compliance with the standard. A maintenance area must sustainably meet the standard for at least 10 years before it can be re-designated as an attainment area.

Transportation Conformity

The Clean Air Act establishes a process, called transportation conformity, to ensure that federally-funded and approved transportation plans, transportation improvement programs (TIPs) and projects are consistent with the air quality goals in the SIP. Transportation conformity applies to non-attainment and maintenance areas. Because conformity review is effective one year after an area is designated as non-attainment, conformity review is required to be done even before the updated SIP and the emissions inventory is prepared. The transportation conformity process is depicted in Figure B-5.

Conformity determinations for transportation plans, TIPs and projects are made by the MPO (or the state and DOT in rural areas), and submitted to FHWA/FTA for approval, with input from EPA. The transportation conformity process includes documentation of the following requirements:

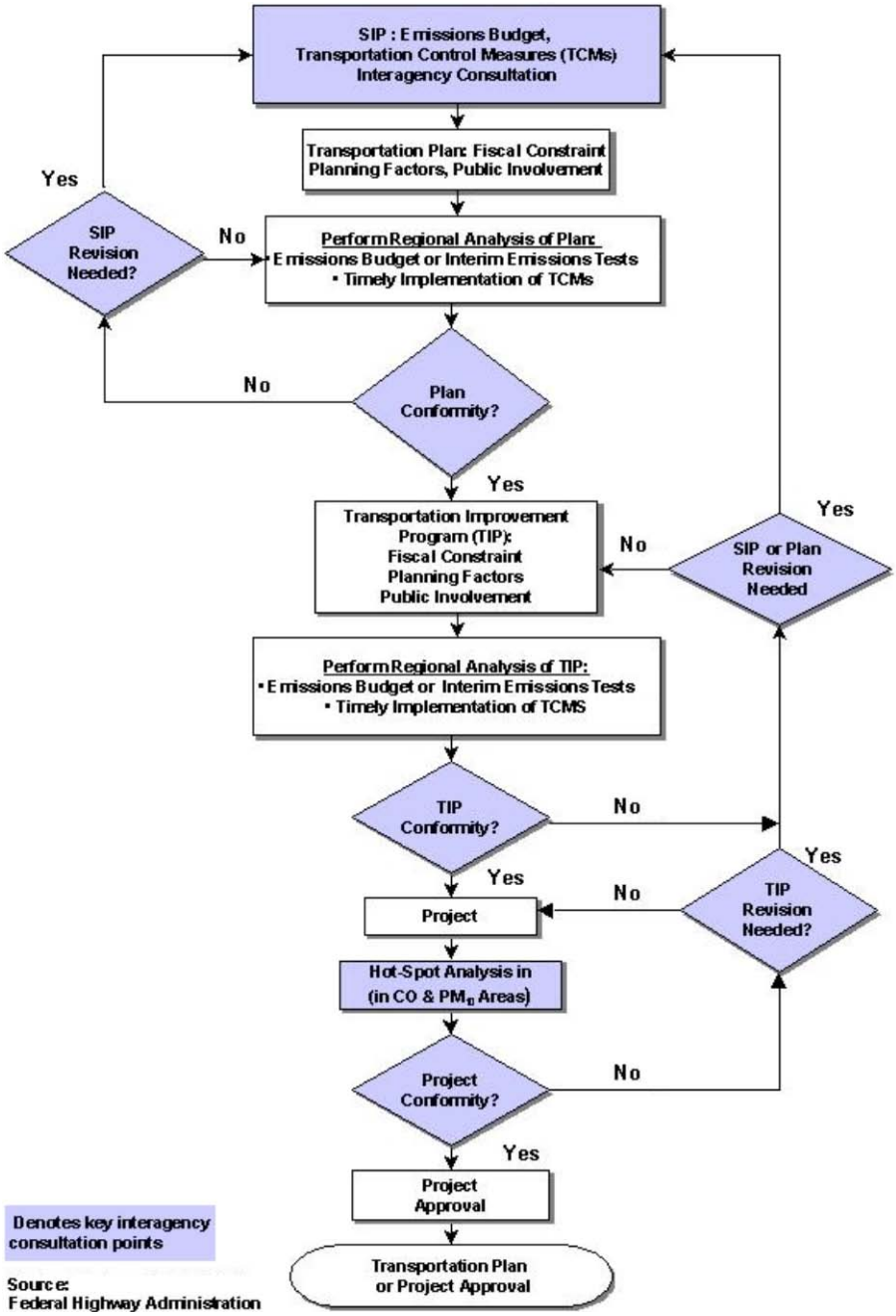
- Interagency consultation – Transportation conformity requires a formal and active interagency consultation process, along with a formal public comment process.
- Regional emissions analysis – Modeling is done to estimate vehicle miles traveled (VMT) and the grams of pollutant per mile traveled. The regional emissions analysis must demonstrate that the transportation plan and TIP are within the motor vehicle emissions budget. For transportation projects, the analysis must demonstrate that the region will still meet the motor vehicle emissions budget.
- Project level analysis – Transportation projects must be included in a conforming transportation plan and TIP, and the project's emissions must be included in the regional emissions analysis for the transportation plan and TIP. Localized emissions impact analysis is required for projects in carbon monoxide, PM_{10} and$PM_{2.5}$ non-attainment areas.
- TCM implementation – The transportation conformity review must include assurance that all transportation control measures identified in the SIP are being implemented on schedule. This is intended to ensure that TCMs are not postponed due to a lack of a funding commitment.

Transportation plans and TIPs in non-attainment and maintenance areas need to be re-evaluated for conformity every four years, or sooner if these plans are updated.

The Clean Air Act imposes penalties if SIP and transportation conformity requirements are not met. Two types of sanctions are imposed through an EPA rule-making process if a state do not submit an approvable SIP or implement the SIP on schedule.

- Offset sanctions – 18 months after the sanctions clock is started, a 2:1 offset sanction is imposed on new or modified major stationary sources. Each ton of emissions created by a new stationary source must be offset by a two ton reduction in existing sources.
- Highway sanctions – 6 months after offset sanctions are imposed, federal highway funding is withheld. Highway sanctions are used to enforce deadlines for SIP submittals and implementation of approved SIP measures. Only "exempt" transportation actions (e.g., safety projects) and projects already authorized may proceed.

Figure B-5
Transportation Conformity Process



Similar to highway sanctions, conformity lapse sanctions also restrict federal transportation aid. Exceptions from these restrictions include safety projects, transportation control measures in an approved SIP, and projects that are already authorized.

Economic Impacts of Non-Attainment

Appendix A describes the environmental and health impacts of non-attainment. The previous sections of Appendix B describe the regulatory impacts of non-attainment. In addition to these impacts, non-attainment status has direct economic impacts to the area.

State and local agencies are likely to require additional financial resources to implement the planning and regulatory requirements imposed on non-attainment and maintenance areas. Projects will take longer and cost more. Failure to implement these requirements results in federal sanctions and the loss of federal transportation funds.

Employers with major facilities will be directly impacted by additional regulatory burdens and emission restrictions. New and modified stationary sources are subject to RACT requirements, and have to quantitatively demonstrate that the new emissions won't worsen air quality. Otherwise, air emission permits will be denied and the new facility or expansion will be blocked. Businesses may decide not to consider a new facility or expansion in a non-attainment area in order to avoid the additional regulatory costs. Some of Chittenden County's larger facilities, such as Burlington Electric's McNeil Generating Station, IBM and the Burlington Airport, may be particularly affected if they need to expand.

Smaller commercial sources may also be impacted economically. For example, depending on the control strategies in the SIP, more gas stations might be required to install vapor recovery controls on gas pumps.

Agriculture and forestry may be economically impacted by lower yields. Tourism, which is highly dependent on Vermont's green image, may also suffer.

Individuals may also be affected economically if their car or truck requires repairs or replacement in order to meet inspection.

Other Rules and Programs to Help States Meet the Standards

The EPA has several other national initiatives intended to help states meet the air quality standards. These rules and programs are important because they recognize that not all air quality problems can be solved by actions at the state or local level.

- National emission standards for cars and trucks – These national standards reduce emissions of several pollutants, including precursors of ozone and fine particulate matter.
- Heavy Duty Highway Rule – This national program requires heavy duty engines in trucks and buses to meet stringent emission standards for particulate matter, VOCs and NOx. Highway diesel fuel is also required to have low sulfur content, so that the catalytic emission control devices on diesel vehicles will work properly. Together, these initiatives will reduce ozone and fine particulate matter pollution.
- Clean Air Non-Road Diesel Emissions Rule – This national rule sets stringent emission controls on diesel engines used in boats and construction, agricultural and mining equipment, thus reducing fine particulate matter pollution.
- Clean Air Visibility Rule – This national rule reduces emissions from sources that affect fine particulate matter air quality in national parks and wilderness areas.
- Clean Air Interstate Rule – This rule mandates that power plants in the eastern US reduce NOx and sulfur dioxide emissions. The rule will help reduce the amount of fine particulate matter and precursors of ozone and $PM_{2.5}$ that can blow into an area from other states.
- NO_x SIP Call – This regional strategy caps NO_x emissions from major stationary sources in certain Ozone Transport Region states, requiring emissions to be reduced from the 1990 baseline year. Unused emission allowances can be traded, providing a market incentive for industry to

further reduce emissions. The strategy is primarily designed to reduce ozone levels in the Ozone Transport Region, but also helps reduce emissions of $PM_{2.5}$ precursors.

Conclusions

The impacts on non-attainment on a region are immediate, sustained and significant. Although health and environmental impacts are reduced once the air quality improves to meet the NAAQS, regulatory impacts and their associated economic impacts can last for 20 years after the region is designated as a maintenance area.

Given the extent of these impacts, it is highly desirable to prevent Chittenden County from becoming a non-attainment area. If the county does become a non-attainment area, it is also important to return to attainment status as quickly as possible.

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[1] Information in this section is based on personal communication from Paul Wishinski, December 20, 2008.

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Appendix C
Energy Use, Climate Change and Air Quality

Air quality is closely interconnected with energy use and climate change issues. Fuel combustion for transportation and heating emits pollutants that cause ozone and fine particulate air quality problems. The same fuel combustion is a major source of greenhouse gases contributing to climate change.

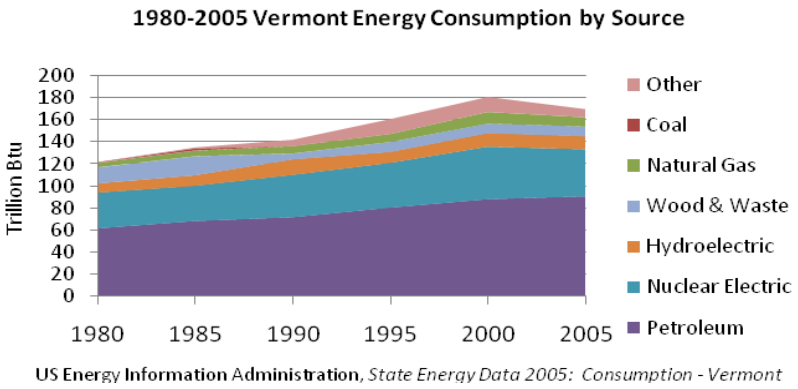
Energy Use

We use energy everyday to heat our homes, light our workplaces, and power our transportation. The US Energy Information Agency provides state-level data on where we get energy from and how we use it (Figure C-1).

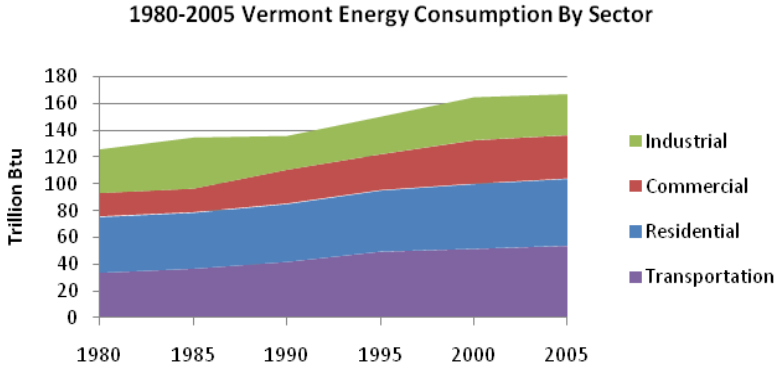
- Vermont is highly dependent on non-renewable energy sources. Over half of the energy we use is based on petroleum fuels.
- Transportation is the largest use of energy, closely followed by residential energy use. The commercial and industrial sectors are smaller users of energy in Vermont, but are still significant.
- Petroleum used for transportation fuels and residential use accounts for over 80% of Vermont's energy use.

The combustion of fossil fuels and wood emits air emissions that contribute to ozone and fine particulate pollution.

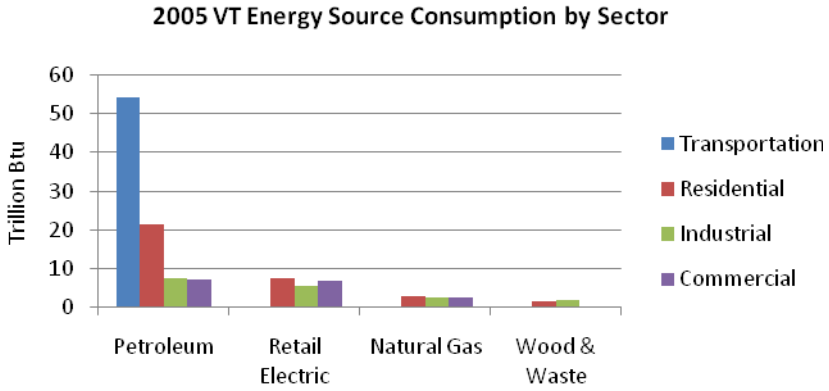
Figure C-1
Vermont Energy Consumption



US Energy Information Administration, *State Energy Data 2005: Consumption - Vermont*



US Energy Information Administration, *State Energy Data 2005: Consumption - Vermont*



US Energy Information Administration, *State Energy Data 2005: Consumption - Vermont*

Non-combustion energy sources (wind, solar, hydroelectric and nuclear electric) generate less pollution, but there are costs involved in switching to these energy sources.

Improving the efficiency of energy use – so that less energy is used – is the most effective way to control energy costs in the near and intermediate timeframe, and will reduce emissions that contribute to air pollution. Efficiency Vermont

The Vermont Transportation Energy Report[1] notes that there are two ways to reduce vehicular fuel consumption:

1) Increase vehicle fuel economy; and

2) Decrease the total distance or miles traveled.

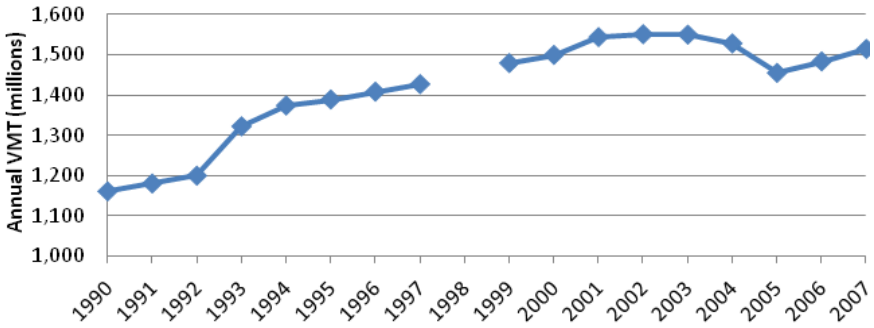
Individuals and businesses can increase fuel economy by choosing to drive more fuel efficient vehicles. Possibly in response to the dramatic increases in fuel prices, Vermonters changed their vehicle purchase preferences in 2008: more basic economy cars were purchased than any other new vehicle segment. Since 2004, purchases of new full-size pick-ups and sport utility vehicles have decreased by a third.

Technology advances, such as hybrid vehicles and the development of plug-in hybrid electric vehicles, can improve vehicle fuel economy. While still a small percentage of vehicles registered in Vermont, the number of registered hybrid electric vehicles in Vermont has increased over 200%.

Vehicle maintenance can help all vehicle types operate at optimum efficiency levels. Changes in driving behavior, such as driving at slower speeds and reducing unnecessary vehicle idling, can also increase vehicle fuel economy.

The other way to reduce transportation fuel consumption is to drive less.

Figure C-2
Chittenden County Annual Vehicle Miles Traveled



Source: VTrans, *Highway Performance Monitoring System*

As Figure C-2 shows, the average annual vehicle miles traveled (VMT) in Chittenden County increased steadily between 1990 and 2002, declining slightly through 2005 before increasing again.

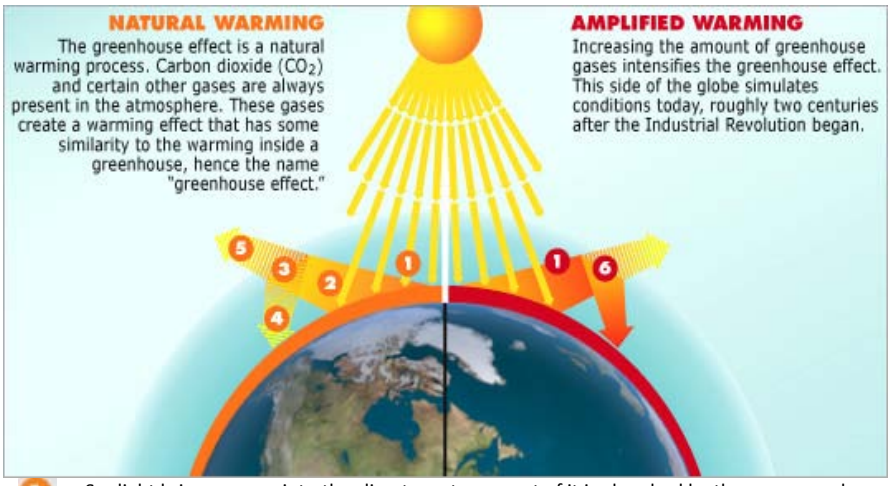
In a rural state like Vermont, ways to reduce VMT include rideshare programs, programs and infrastructure improvements to increase biking and walking, targeted transit, and land use patterns that encourage less driving.

The *Vermont Comprehensive Energy Plan*[2] includes strategies that address both vehicle fuel economy and VMT reduction.

Efforts to reduce vehicular fuel consumption will also result in decreased emissions of pollutants that cause ozone and fine particulate pollution.

Climate Change

Figure C-3
Greenhouse Effect



1. Sunlight brings energy into the climate system; most of it is absorbed by the oceans and land.

THE GREENHOUSE EFFECT:

2. Heat (infrared energy) radiates outward from the warmed surface of the Earth.
3. Some of the infrared energy is absorbed by greenhouse gases in the atmosphere, which re-emit the energy in all directions.
4. Some of the infrared energy further warms the Earth.
5. Some of the infrared energy is emitted into space.

AMPLIFIED GREENHOUSE EFFECT:

6. Higher concentrations of CO_2 and other "greenhouse" gases trap more infrared energy in the atmosphere than occurs naturally. The additional heat further warms the atmosphere and Earth's surface.

Source: Marian Koshland Science Museum, Natural Academy of Sciences

Our climate is a function of natural factors and, increasingly, human factors. Heat from the sun is naturally trapped by the earth's atmosphere, much the way heat is captured within a greenhouse (Figure C-3). Certain gases in the atmosphere, known as greenhouse gases, are particularly effective in trapping the sun's heat.

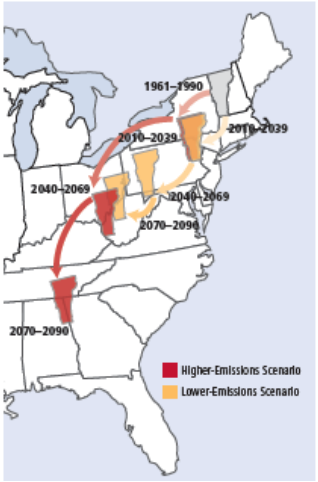
The most common greenhouse gases are carbon dioxide (found in the air we exhale), methane (the major component of natural gas) and nitrous oxide (N_2O).

Human activities, particularly fuel combustion, have increased the atmospheric concentration of carbon dioxide and other greenhouse gases. The current scientific consensus is that this increase in greenhouse gases is the cause of temperature increases observed over the past 50 years and continuing today.

Climate models are used to project how the climate may change in the future. These projections typically include a range of outcomes, because it is difficult to predict how the human population will grow, use energy and manage resources.

Most climate projections predict that Vermont's climate will become generally warmer and wetter. Figure C-4 shows what Vermont's climate may be like if greenhouse gas emissions are allowed to continue at the current rate (higher emissions scenario) and if clean energy technologies replace fossil fuels and greenhouse gas emissions are largely curtailed (lower emission scenario). If current emission trends continue, Vermont is predicted to have summer temperatures that feel like Tennessee.[3]

Figure C-4
Vermont Climate Change Predictions



Migrating State Climate

Changes in average summer heat index—a measure of how hot it actually feels, given temperature and humidity—could strongly affect quality of life in the future for residents of Vermont. Red arrows track what summers in Vermont could feel like over the course of the century under the higher-emissions scenario. Yellow arrows track what summers in the state could feel like under the lower-emissions scenario.

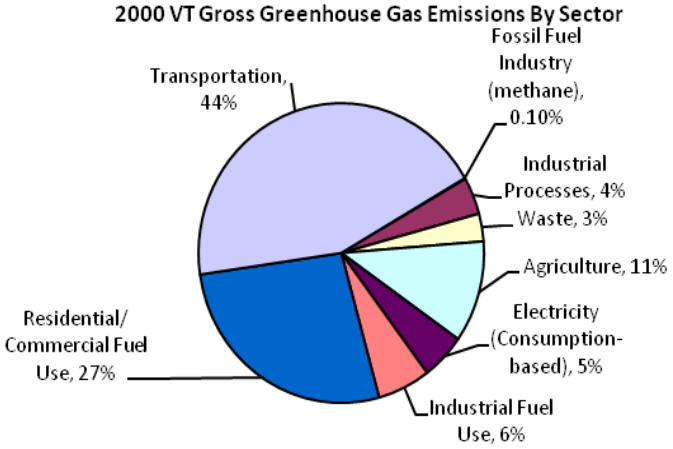
Source: Northeast Climate Impact Assessment, *Confronting Climate Change in the U.S. Northeast, Science, Impacts, and Solutions*

Probable impacts of climate change for Vermont would include:

- Warmer summers could dry up wetlands and increase the need for agricultural irrigation.
- The fall foliage season would be shorter and less colorful.
- The ski season would be shorter.
- Warmer temperatures could reduce the length of the maple sugaring season and the quality of maple syrup.
- Maple, beech and birch forests would be replaced by oak and hickory forests better adapted to warmer, wetter conditions.
- Warmer wetter days would make it easier for insects and diseases to migrate and survive in Vermont.
- Warmer temperatures promote the formation of smog, increasing the concentration of ozone and fine particulate pollution.

Mitigating the predicted climate change impacts for Vermont requires reduction in greenhouse gas emissions.

Figure C-5
2000 VT Gross Greenhouse Gas Emissions By Sector



Source: Center for Climate Strategies, *Final Vermont Greenhouse Gas Inventory*

As shown in Figure C-5, transportation is the single largest source of greenhouse gas emissions in the state (44%). Transportation and fossil fuel combustion sources combined account for 77% of Vermont's greenhouse gas emissions. These sectors provide the greatest opportunities for greenhouse gas emission reductions.

In 2005, Governor Douglas established goals for reducing Vermont's greenhouse gas emissions by 25% from 1990 levels by 2012; 50% by 2028; and, if practical, 75% by 2050. These goals were subsequently ratified by the General Assembly.

The Governor's Commission on Climate Change was established to look at the sources of greenhouse gas emissions, the impacts of climate change on the state, and to evaluate a broad range of ways to reduce greenhouse gas emissions and make specific policy recommendations. The Commission issued its final report and recommendations in October 2007.[4] Since then, several state agencies have issued plans evaluating strategies the state can implement to help accomplish the greenhouse gas emission reduction goals.[5-8] The Climate Neutral Working Group, composed of state agency heads, recently released its third biennial report on the progress of state agencies in meeting the state climate change goals.[9]

In its *Policy Guide on Planning and Climate Change*, the American Planning Association notes:

> Planning can play an important role in influencing societal actions that can slow the pace of climate change, mitigate the effects that do occur and allow adaptation to the ultimate impacts of global warming. [10]

Most strategies for mitigating climate change focus on reducing greenhouse gas emissions. Many of these approaches also mitigate the impacts of air pollution. Some strategies that reduce emissions of both greenhouse gases and air pollution include: encouraging higher-density development to reduce

the number and length of auto trips and support other modes of transportation; using energy-efficient building techniques to reduce heating fuel consumption; and supporting renewable energy sources.

Conclusions

Ground-level ozone and fine-particulate matter pollution are linked to energy and climate change through common pollution sources. Fuel combustion for motor vehicle transportation and heating buildings is a major portion of the energy we consume, and a major source of greenhouse gases emissions. Strategies that focus on improved energy efficiency overall, and more energy-efficient transportation options particularly, will improve air quality and help mitigate climate change. It makes sense to coordinate initiatives that address common root causes to multiple public concerns.

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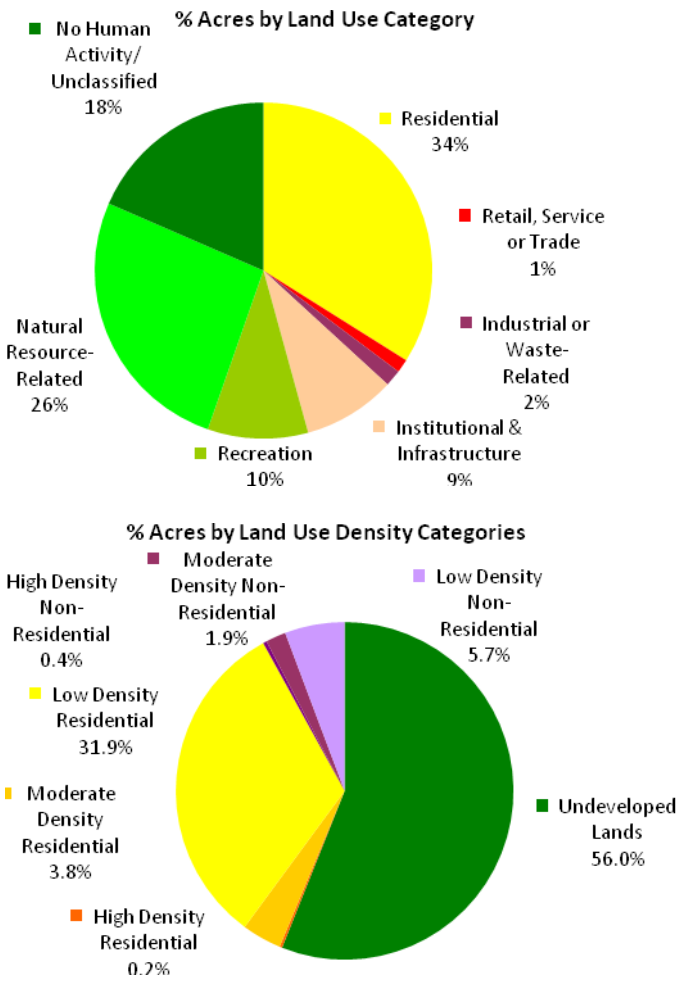
Appendix D

The Connections Between Land Use, Transportation and Air Quality

Land use and transportation are closely intertwined. The development choices we make have transportation consequences. Likewise, the transportation choices we make influence land development. This appendix explores the connections between land use and transportation, and how both affect air quality.

Chittenden County Land Use

Figure D-1
Chittenden County Land Use



Source: *2006 Chittenden County Regional Plan*

Land use can be evaluated by considering land use types, intensity and connectedness.

Chittenden County has a wide range of land uses, from natural landscapes, to rural areas, to urbanized areas.

Figure D-1 shows that residential land uses, including all types of housing, are the most widespread type of land use (about 34%). Combined, commercial and industrial development account for about 3% of land use. Institutional and infrastructure development, which includes educational, public safety, military, public safety and transportation facilities, consumes about 9% of land use. The three types of land use that typify "open space," recreation, natural resource-related and no human activity, account for approximately 54% of county land uses.

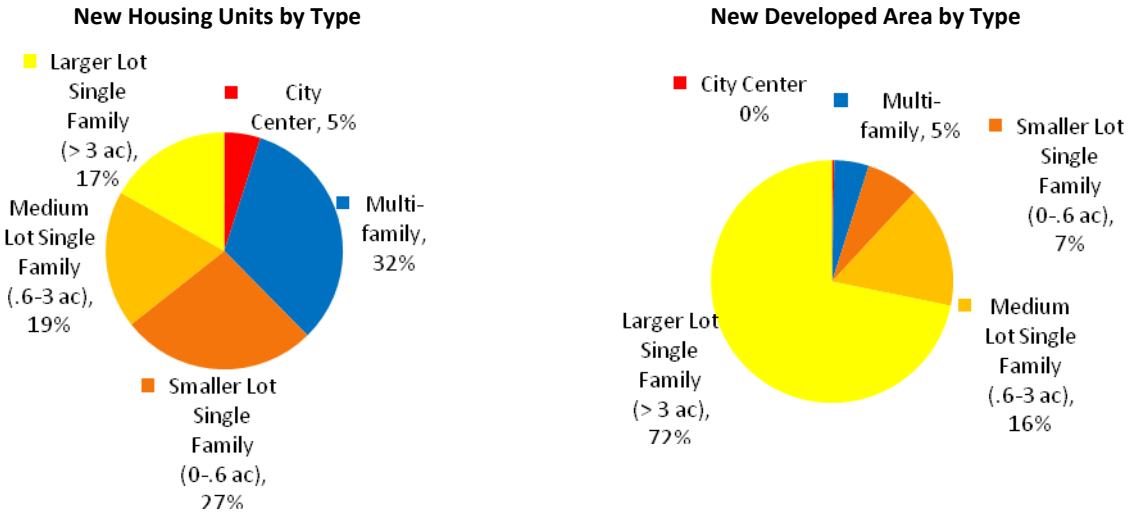
By area, most residential development in the County is low-density (less than one dwelling unit per acre). A smaller amount is moderate density residential (1-8 dwelling units per acre). Less than 1% is high density residential development (more than 8 dwelling units per acre).

Similarly, most non-residential development is low density (less than one employee per acre). Moderate density non-residential development (1-20 employees per acre) is less than 2% of County land use. High density non-residential development (over 20 employees per acre) is less than 1% of county land use.

Existing land use patterns reflect a long history of land development. With the widespread availability of the automobile in the mid-20th century, the traditional Vermont development pattern of compact settlements surrounded by rural areas started to shift increasingly to low density development.

Figure D-2, shows the distribution of recent residential development in Chittenden County.

Figure D-2
1990-2008 Distribution of New Housing Units and Area by Type



Source: CCMPO and Smart Mobility

The greatest number of new housing units were multi-family construction, consuming 5% of the developed land area. Smaller lot single family homes accounted for 27% of new units, consuming 7% of the developed area. By contrast, larger lot single family homes accounted for 17% of new units, but consumed 72% of the developed area. Despite the number of housing units developed in more compact patterns, Chittenden County still has a large amount of new, low density development.

The Land Use and Transportation Connection

The intensity of how land is used is important for transportation: dispersed, low-density land use favors automobile transportation, while compact, mixed-use development shortens trip lengths and makes walking and transit viable alternatives. By influencing transportation patterns and choices, land use indirectly influences pollutant emissions and air quality.

Recent national studies[1-6] have concluded that compact land use actually does decrease vehicle miles traveled (VMT). VMT is a function of trip length, trip frequency and travel mode choice. The studies have shown that compact land use patterns reduce trip length and increase use of transit, walking and bicycling. The studies have not shown a strong link between compact land use patterns and trip frequency; when making a trip is more convenient, people may actually make more trips.

Research on sprawl[7] has found strong correlations between compact land use and travel and transportation outcomes. Density is linked to lower average vehicle ownership, lower VMT per capita, reduced traffic fatality rates, increased walking and use of public transportation. The relationship between density and air quality was pronounced: higher density urban areas were found to have lower peak concentrations of ozone than lower density urban areas.

The studies have shown a correlation between land use patterns and travel behavior, but this does not prove causality. Self-selection may be involved: people who would rather walk or take transit than drive may choose to live in pedestrian-friendly neighborhoods with transit services. Their travel choices may be more of a reflection of their desire to drive less, rather than a reflection of compact growth.

However, it safe to conclude that compact development can reduce VMT, at least to the degree that it helps address an unmet demand for neighborhoods where it is possible to drive less.

At the same time, transportation systems influence land development patterns. New roadways add road capacity and decrease travel times, encouraging vehicle travel and enabling development to disperse further from the urban center. Transportation investments in public transit, sidewalks and bicycle facilities make non-automobile transportation more convenient and attractive, which in turn makes compact, mixed use development more attractive to residents and employers.

Figure D-3 (on next page) depicts the interrelationships between land use, transportation and air quality.

Land Use, Transportation and Physical Activity

Motor vehicle use is an underlying cause of air quality problems. Motor vehicle use also contributes to physical inactivity and obesity. People who drive to a destination are not getting exercise by walking or bicycling there. People who use public transportation have been found to walk more than people who drive.

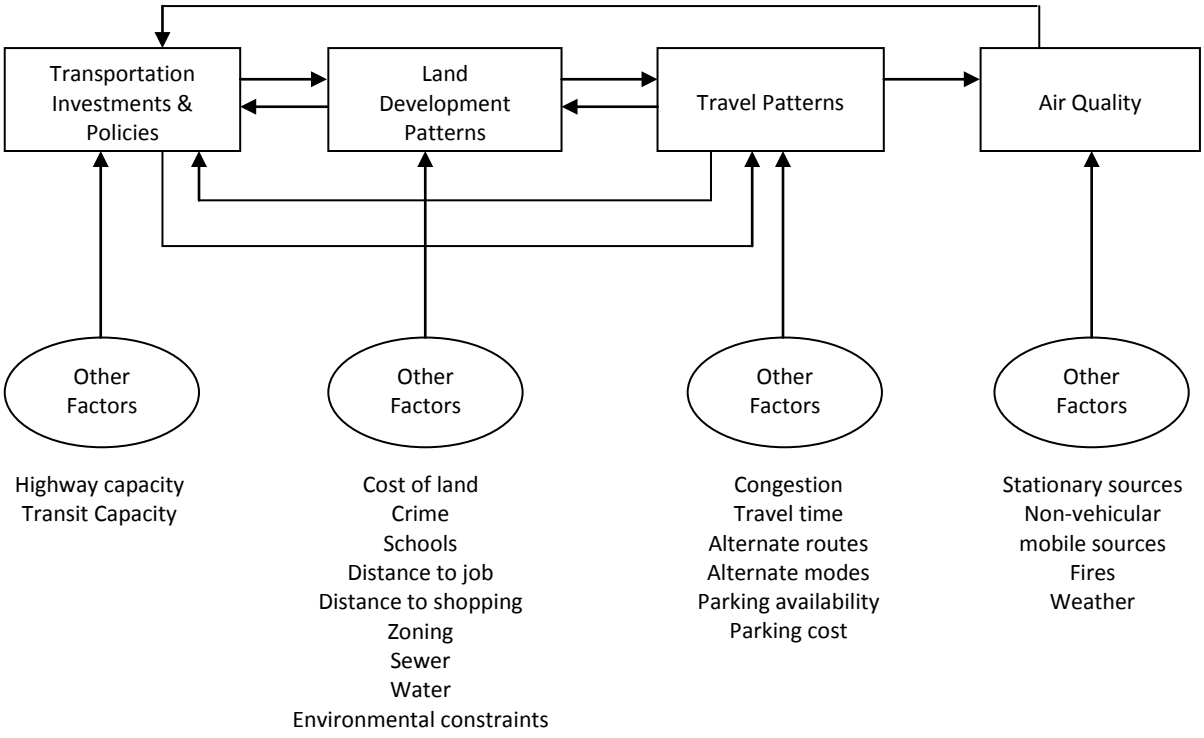
Physical inactivity, along with unhealthy eating, contributes to weight problems. And, being overweight substantially increases the risks for many chronic diseases, including diabetes, high blood pressure, osteoarthritis, heart disease and stroke, gallbladder disease, and certain cancers.

Being overweight or obese is a problem that affects both Vermont adults and youth:

- 59% of Vermont adults are overweight or obese[8]
- 22% of Vermont adults are obese, weighing more than 30 pounds above a healthy weight. The Healthy Vermonters 2010 goal is 15%.[9]
- The prevalence of obesity among Vermont adults has doubled between 1990 and 2007.[10]
- 11% of Vermont youth, grades 8 – 12, are overweight. The Healthy Vermonters 2010 goal is 5%.[11]
- 26% of Vermont youth, grades 8 – 12, engage in regular moderate physical activity. The Health Vermonters 2010 goal is 50%.[12]
- Overweight adolescents have a 70% chance of becoming overweight or obese adults[13]

Vermont's Blueprint for Health is a statewide initiative to improve the health of persons with, and at risk of, chronic diseases and the quality of their health care[14]. Chronic conditions are serious illnesses that are not easily controlled or quickly resolved. Common chronic conditions include: arthritis, asthma, cancer, depression, diabetes, heart disease, high blood pressure, high cholesterol, lung disease, obesity and osteoporosis. The Blueprint for Health includes goals and strategies to improve provider care, information technology, self management, and community support for healthy lifestyles. Infrastructure improvements, such as trails and sidewalks, and workplace and community support for physical activity programs are specifically identified as strategies in the Blueprint for Health.

Figure D-3
Linkages Between Land Use, Transportation and Air Quality



Source: Adapted from Handy, 2005

Based on the relationships shown, strategies to improve air quality can address factors that directly affect air quality, or they can address factors that indirectly influence air quality.

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Public Health

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Chittenden County Metropolitan Planning Organization

Chittenden County Regional Planning Commission