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### **Ecological Footprints and Alternatives for Lehigh Transportation**

It took more than 200 million years to form all of the oil beneath the surface of the earth. It has taken 200 years to consume half that endowment. If current rates of consumption were to continue, the world's remaining resources of conventional oil would be used up in 40 years (EPA, Automobile Emissions). The Lehigh community, including students, faculty, and staff, are all major contributors to this problem. Transportation at Lehigh consists of an over abundance of automobiles, a seldom used bus system, and a handful of walkers. The ecological footprints of buses, trucks, and cars create too many hazardous effects; alternatives are essential for the health of the environment and humanity.

As society continues to consume non-renewable resources at an alarming and unsustainable rate, the environmental and human health impacts are devastating. Scientists have shown that the surface temperature of the earth has risen by 0.6 degrees Celsius over the past one hundred years. There was also a warming trend that started in the 1890s and continued until the 1940s. Cooling occurred from the 1940s to the 1970s, and sharply rising temperatures were prevalent from the 1970s until today (Sierra Club, Global Warming). The earth's temperature is maintained by a constant heating process from the sun. As the sun's solar radiation strikes the earth's surface, seventy percent is

deflected, while thirty percent is absorbed. As this heat is reradiated into space greenhouse gases retain some of the heat. Such gases include carbon dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), Water Vapor (H<sub>2</sub>O), Nitrous oxide (N<sub>2</sub>O), and Ozone (O<sub>3</sub>) (EPA, Mobile Source). The National Academy of Sciences has concluded that the increase in global average temperature is largely due to human activity.

By examining the discharge contained in tailpipe emissions we are able to observe the anthropocentric influence on the earth's level of greenhouse gases and overall temperature. Carbon dioxide is a major component of tailpipe emissions and is the primary global warming gas. Levels of CO<sub>2</sub> in the atmosphere have steadily increased over the past 100 years by 30 percent (Sierra club) (See exhibit E). This increase in the level of heat trapping gas is believed to increase the earth's average temperature, which is referred to as global warming. The reaction of hydrocarbons and nitrogen oxides in the presence of sunlight will form ozone, a greenhouse gas that also causes global warming. The United States is the world's largest emitter of manmade greenhouse gases, emitting over twenty percent. Two-thirds of the oil we consume powers transportation vehicles, half of which goes to passenger cars and light trucks. Diesel-powered vehicles and engines contribute to more than half the mobile source particulate emissions (EPA, Automobile Emissions).

Through tailpipe emissions, pollution is created as a by-product of engine combustion and fuel evaporation. Such discharges include unburned hydrocarbons (HC), nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO), particulate matter (PM), and carbon dioxide (CO<sub>2</sub>). Hydrocarbon tailpipe emissions are formed when fuel is partially burned,

or not burned at all during the combustion process (See exhibit B). Nitrogen oxides are formed at high temperatures that cause their airborne atoms to react (See exhibit C). These oxides will also react with hydrocarbons in the presence of sunlight to form ground-level ozone, a major component of smog. Carbon monoxide, a colorless, odorless gas, is formed when the carbon in fuel is not burned completely due to a lack of oxygen. Levels are generally highest when conditions for combustion, such as cold weather and high elevations, are inadequate (See exhibit A).

Another form of tailpipe emission is particulate matter. It is made up of tiny particles or droplets suspended in the air that contain several chemical components. Based on size, particulate matter is classified into two separate categories. The larger particles are simply “Particulate matter (PM),” while the finer particles, less than 2.5 microns in diameter, are categorized as “Particulate matter 2.5 (PM<sub>2.5</sub>)”. PM can be seen by the naked eye as smoke or dust, while the smaller particles are relatively invisible. Particulate matter 2.5 can travel long distances on air currents and is also a major cause of haze, which can reduce visibility (See exhibit D).

Finally, although a product of perfect combustion, carbon dioxide is a pollution concern. Carbon dioxide is viewed as a “Green House” gas that contributes to warming the earth by trapping the reradiated heat from the sun. Although this compound has allowed life to exist on this planet it is believed that, when emitted through tailpipes, it will trap too much of the sun’s heat, and will result in global warming.

The ecological impacts of tailpipe emissions do not only affect the temperature of our world; they also have harmful implications on human health. Carbon monoxide

reduces oxygen delivery to the body's organs and tissues. It is most harmful to those who suffer from heart and respiratory disease. Symptoms may include visual impairment, headache, and reduced work capacity. Hydrocarbons are considered toxic air pollutants that can cause serious health problems, and are associated with some cancers. Ozone, resulting from hydrocarbon emission, causes health problems such as difficulty breathing, lung damage, and reduced cardiovascular functioning. On smoggy days, an individual might notice difficulty breathing or trouble seeing objects in the distance because of Nitrogen Oxides. Particulate matter is a health concern because very fine particles can reach the deepest regions of the lungs. Health effects include asthma, difficult or painful breathing, and chronic bronchitis, especially in children and the elderly. Fine particulate matter associated with diesel exhaust is also thought to cause lung cancer (EPA, Mobile Source).

Clearly, the tailpipe emissions of our automobiles have a direct effect on both our environment and our individual health. Therefore, it is paramount that all must act as stewards to the environment and reduce individual pollution. By simply choosing a vehicle that gets 25 miles per gallon (mpg) rather than 20 mpg, it will prevent the release of roughly 15 tons of greenhouse gas pollution over the lifetime of the vehicle. Global warming, as well as local pollution, is a very real environmental concern. We have observed the health effects associated with our automobile usage, yet levels continue to rise. We must act to reduce tailpipe emissions before environmental catastrophe occurs. New technology and new systems of personal transportation must be considered.

Creating alternatives for the Lehigh community is essential in changing the ecological footprints of transportation. The demographics of the Lehigh Campus provide

students an incentive to actively use a car around campus. Due to the climbing elevation, the Lehigh University terrain is especially brutal in harsh weather conditions. These restraints require that we identify the core incentives of having a car at school and offer alternatives, which gratify student's needs.

Providing a new campus park lot for carpool students encourages students to condense driving to around 1/3 of the amount. This parking location, behind Chandler-Ulman, will offer new parking in the central location of campus. Currently, this area is nearly impossible to park in for students due to the limited space primary dedicated to teacher parking. Regulated by a Lehigh University parking authority employee, the parking lot will operate between the hours of (7:30 am to 4:00 pm), Monday through Friday. By providing students with this new option at its central location, it will hopefully aid students in seeking other driving options.

Complementing a new parking garage with a more adequate bus system will supplement student's daily needs and desires. By taking advantage of a new carpool parking lot, some students with conflicting schedule to their respective driver will benefit from new bus measures that adequately fill their transportation needs. By adding two addition bus stops to the schedule, this will complete the route to serving all parts of the campus. The first stop, at the Rauch Business center on the corner of East Packard and Taylor Street, will aid business students, whom classes are all usually limited to Rauch. This would aid in the availability of many occupied all day parking spots. This would also reduce the amount of congestion on campus in the peak class hours. Adding a second bus stop to the Ulrich Center, on University Avenue, would also accommodate more students in their daily activities. Due to most of Lehigh University's campus being

occupied by students, the Ulrich center provides students a social location to meet, as well as facilities for food and mail. Boarding students require these amenities in order to fulfill their daily needs. These areas are most often used during the class hours when students have an interval of time between classes. Providing a bus stop on University drive will assist student in making the treacherous trek up the back stairs of the Ulrich building, hopefully even avoiding injury due to bad weather conditions.

## Diana

Regarding the reduction of emissions and pollution for the Lehigh community, a walking only campus would be the ideal situations. Due to the geographic strains of the university, students need incentives to encourage them not to drive. First, offering a one percent reduction in undergraduate tuition as a reward for not bringing and registering a car on campus would create an economic incentive. The resulting savings would most likely influence the majority of parents, due to the decrease in costs of gasoline, insurance, and car matinees.

A second approach would be to offer students actual incentives as they walk to class. Perhaps a contract with multiple food vendors, which could be strategically located in a walking only area, would encourage students to walk to class. The vendors would accept gold and gold plus, depleting the daily costs of a college student. While new food options are always an attractive option for college students, it is also possible that bringing other Lehigh departments to walking only areas would decrease driving on campus. For example, if the Lehigh bookstore were to open a stand in a location only accessible by foot, such as a stand on the UC lawn or on the grass in front of Lewis Lab,

students would be able to buy things from the bookstore without waiting in the long lines at the actual store, and more importantly, without the use of a car.

The Sasaki plan, which is Lehigh's long-range plan spanning the next twenty years, will eventually implement a walking only campus. The plan will restrict vehicles from driving between University Drive and Broad Street, in addition to restricting cars between the Admissions building and Taylor Street. In short, the purpose of the plan is to eliminate all vehicular traffic on Lehigh University's campus. The plan includes building various additional parking garages on the outskirts of campus to increase the availability of all day parking. Even though the main goal of this plan is safety, vast proportions of car emissions released on campus will be reduced.

A less drastic alternative to the elimination of cars on campus would be to provide environmentally friendly automobiles. Proof of a drive clean test should be required for anyone requesting to register his or her car. This test, originally started in Ontario, will ensure that the efficiency of a vehicle is at its highest level. Cars three to twenty years old are placed on a treadmill-like machine called a dynamometer. A probe is in the tailpipe, which is connected to a gas analyzer computer system. Its job is to measure the concentration of nitrogen oxides, hydrocarbons, and carbon monoxides that are emitted during acceleration. If levels do not meet the current emission standards for that vehicle's model and year, the engine needs to be tuned. Not only will this lower gas consumption by about ten percent, it will also prolong the life of the vehicle. Such a test is not feasible for anything except passenger cars and light trucks; however, such vehicles are Lehigh's main concern.

Until the amount of cars on campus is limited, there are gas alternatives as well.

Fuels such as propane, ethanol, and natural gas need to be advertised and available to the Lehigh community. Such fuels are less expensive, domestically abundant, and achieve a similar gas mileage as gasoline. Propane emits one third less reactive organic gases, and bi-fuel tanks are available for gasoline. Natural gas is non-toxic; it reduces carbon monoxide and dioxide by sixty six percent and sixteen percent, and has an extremely rapid rate of dissipation. Ethanol, a mixture of eighty five percent ethanol and fifteen percent gasoline, can be made from any starch free stock, such as corn, sugar cane, wheat, and barley. These fuel alternatives would dramatically reduce the amount of pollutants released into Lehigh's atmosphere. Pumps could be installed on Goodman campus, Mountaintop, and Packer campus. These self service stations would take payments of mountain gold plus, cash, and credit card. This system would be convenient and cheap for students and faculty, and it could bring in extra profits for Lehigh University as well.

Another remedy for reducing pollution is the introduction of electrically motored vehicles. Electric vehicles have engines that are powered by a rechargeable lead acid battery. Hybrid electrics have a self-charging battery that shuts down whenever the car is stopped. Both have emission rates of zero, but do have a limited driving range. However, most students have a short drive to class, and these cars do have the capacity to get the average person to and from work. Incentives would be necessary for these cars to become popular at Lehigh. Free parking passes could be issued to anyone owning an electric automobile, and certain parking facilities could be restricted only to those driving hybrid cars. These alternative vehicles could catch on and prove to be a great success among the Lehigh community.

Although these alternative provide satisfactory solutions to the ecological problems, major alternations need to be changed is in our cultural ideology. Despite the current fertile atmosphere of Lehigh University, preservation is necessary to ensure its beauty in the future. The most effective way in preserving the beauty of the campus requires the elimination of fuel emissions, or even a drastic reduction. Despite whether we reach these goals through alternative fuels, vehicles, walking, bus systems, or even alternative parking arrangements, changes need to be implemented immediately.

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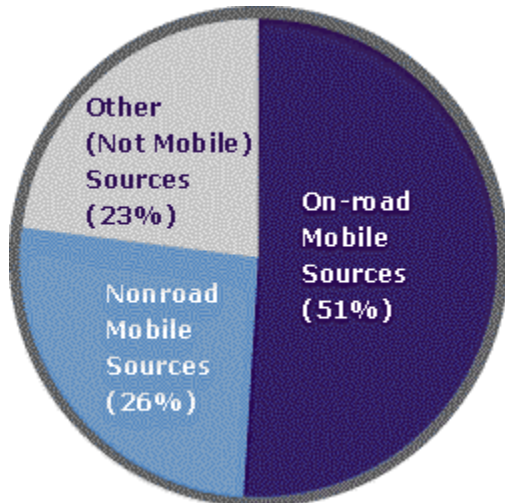
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## Exhibits:

**Source:** Any place or object from which pollutants are released, such as a power plant, factory, tractor, car, or other machines. Mobile sources move (e.g. , cars and buses), while stationary sources do not (e.g. factories).

A.

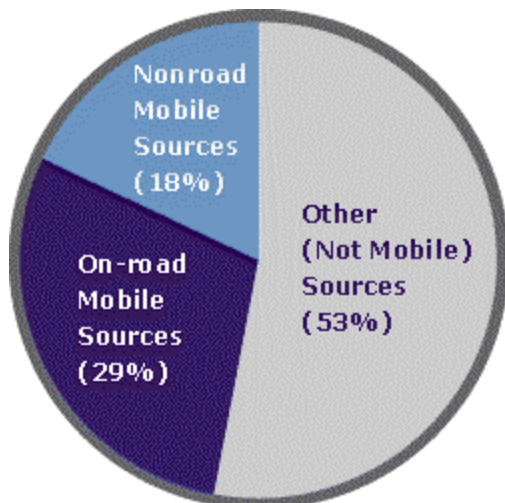
**1999 National Emissions by Source:  
Carbon Monoxide**



<http://www.epa.gov/otaq/invntory/overview/pollutants/index.htm>

B.

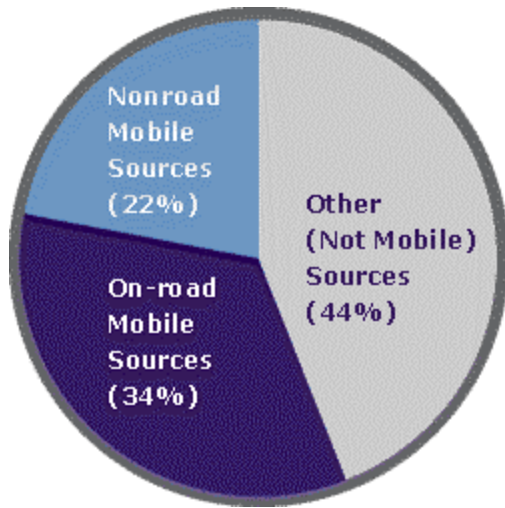
**1999 National Emissions by Source:  
Hydrocarbons**



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C.

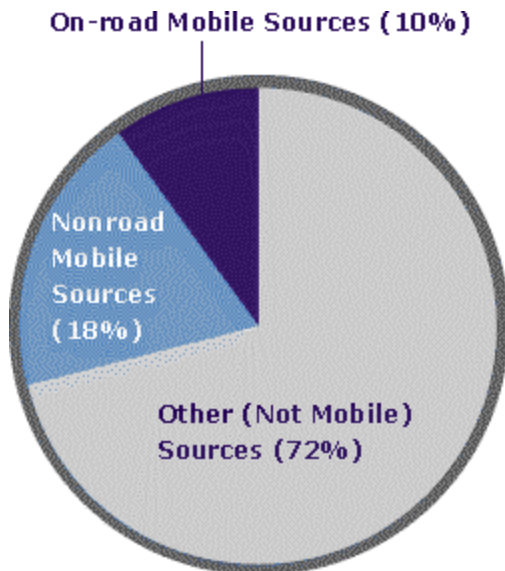
**1999 National Emissions by Source:  
Nitrogen Oxides**



<http://www.epa.gov/otaq/invtory/overview/pollutants/index.htm>

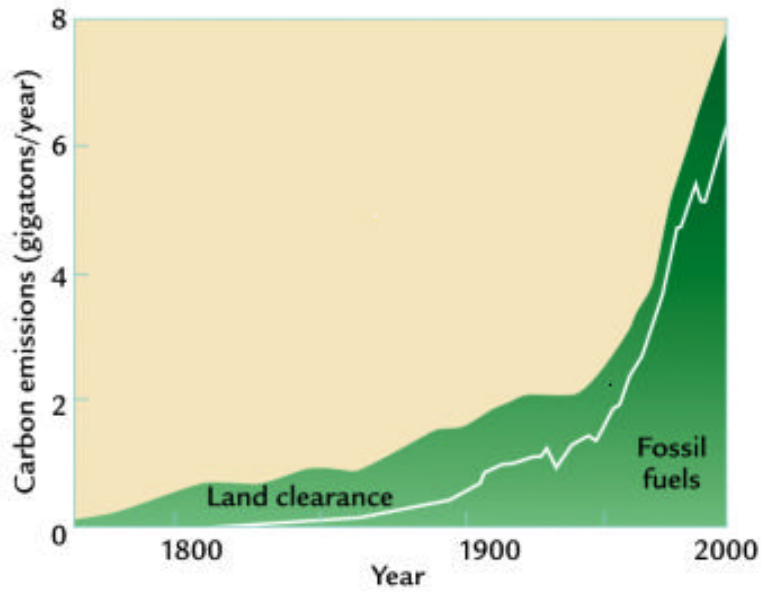
D.

**1999 National Emissions by Source:  
Fine Particulate Matter (PM<sub>2.5</sub>)**



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E.



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