

Keep Both Hands on the Wheel: Cities with the Bumpiest Rides and Strategies to Make our Roads Smoother

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Founded in 1971, The Road Information Program (TRIP)® of Washington, DC is a nonprofit organization that researches, evaluates and distributes economic and technical data on highway transportation issues. TRIP is supported by insurance companies, equipment manufacturers, distributors and suppliers; businesses involved in highway engineering, construction and finance; labor unions; and organizations concerned with an efficient and safe highway transportation network.

Executive Summary

The nation's major urban roadways – highways and major streets that are the main routes for commuters and commerce – are a critical link in the nation's transportation system and play an important role in providing homeland security. These major arterial routes carry 78 percent of the 1.7 trillion miles driven annually in urban America.

From commuters heading to work and children riding the school bus to people driving to stores, church or the doctor's office, Americans depend on good roads in their communities. But there are problems on our nation's major urban streets and highways. Continued increases in travel by cars and trucks are putting significant wear and tear on these aging city roads.

In this report, The Road Information Program (TRIP) examines the condition of major roads in the nation's most populous metropolitan areas, recent trends in urban travel, and the latest developments in repairing and building roads to last longer. Pavement condition data is based on the Federal Highway Administration's (FHWA) 2001 annual survey of state transportation officials on the condition of major state and locally maintained roads, based on a uniform pavement rating index. Although there may be some variance in how transportation officials apply this index, the FHWA survey is the only national source of pavement condition ratings based on a consistent criteria. The major findings of the TRIP report are:

The nation's most critical metropolitan area roads have significant deterioration and motorists are paying a hidden tax in increased vehicle operating costs as a result of driving on roads that provide an unacceptable ride quality

- One out of four (25 percent) of the nation's major metropolitan roads – interstates, freeways and other principal arterial routes – provide drivers with an unacceptable ride quality and are in need of resurfacing or reconstruction. An acceptable ride is provided by 43 percent of major urban roads while 32 percent of major urban roads provide a good ride.
- The average urban motorist in the U.S. is paying \$396 annually in additional vehicle operating costs as a result of driving on roads in need of repair. Driving on roads in disrepair increases consumer costs by accelerating vehicle deterioration, increasing the frequency of needed maintenance and increasing fuel consumption.
- The ten urban regions with at least one million people, which includes the city and its surrounding suburbs, where motorists pay the most annually in additional vehicle maintenance because of roads with poor ride quality are: Los Angeles - \$706, San Jose - \$705, San-Francisco-Oakland - \$674, San Diego - \$667, Detroit - \$621, New Orleans - \$617, Baltimore - \$612, Sacramento - \$609, Boston - \$606 and Oklahoma City - \$578.

- While a desirable goal for state and local governments is to maintain 75 percent of its roads in good condition, only three of the nation's urban areas of one million people or more – Atlanta, Orlando and Phoenix – achieve this goal. In fact, only 14 major urban areas have at least 50 percent of their major roads in good condition.

The high level of pavement deterioration on major metropolitan roads is a result of a significant increase in urban traffic, particularly from large trucks, which increases wear on key roads. Further significant increases in travel in the years ahead will put further wear and tear on roads and make it even more costly to improve and maintain them.

- Overall travel on urban roads increased by 30 percent between 1991 and 2001. But travel by large trucks (combination trucks and vehicles with at least two axles and six tires) increased 46 percent from 1991 to 2001. Large trucks place significant stress on road surfaces.
- Vehicle travel is expected to increase by approximately 42 percent by 2020, and the level of heavy truck travel nationally is anticipated to increase by approximately 49 percent by 2020, putting greater stress on our nation's urban roadways.

A 2002 U.S. Department of Transportation (DOT) study prepared for Congress found that urban road and highway pavement conditions are likely to get worse at current funding levels.

- The DOT study found that all levels of government are spending \$13.6 billion annually in preserving the physical condition of urban roads and highways. The report estimates that the annual investment needed to maintain urban roads, highways and bridges in their current condition is \$16.4 billion and that the needed annual investment to improve urban roads, highways and bridges is \$20.2 billion annually.
- The study found that keeping urban roadways in their current condition would require a 21 percent increase in annual funding and improving the physical condition of urban roadways would require a 49 percent increase in annual funding.

The level of federal road and bridge funding approved as part of a new federal transportation program will have a significant impact on the future condition of urban roads and highways. The current six-year federal surface transportation program, which provides state and local governments with funds to improve urban roads and highways, expires on September 30, 2003.

- The leadership of the U.S. House of Representatives' Committee on Transportation and Infrastructure has proposed that federal funding of roads and bridges from 2004 to 2009 be \$300 billion.
- The Congressional budget resolution approved in 2003, which Congress annually prepares to set funding targets, calls for federal spending of \$218 billion on roads and bridges from 2004 to 2009.
- The Administration's proposal for surface transportation calls for federal spending of \$190 billion for roads and bridges from 2004 to 2009.
- The U.S. DOT reported that the federal investment necessary to maintain the current physical condition and traffic congestion levels of roads and bridges from 2004 to 2009 is \$270 billion.
- Federal funding of road and bridge improvements from 2004 to 2009 in excess of \$270 billion would allow overall road and bridge conditions to improve and traffic congestion levels to be reduced.

New materials and techniques offer the opportunity of building and reconstructing roads and highways that provide a smoother ride to the public and remain smooth for longer periods, delaying the need for road repairs. Additional research on improved materials and techniques is needed to assist transportation agencies in providing the public with smoother roads and highways.

- Transportation agencies are requiring that roads and highways be built or reconstructed to higher surface smoothness standards, to insure that they provide the public with a smoother ride.
- The use of thicker pavements, and pavement mixes selected to best provide durability for a particular roadway segment, are being used to increase the lifespan of road and highway surfaces and delay the need for significant repairs.
- The Federal Highway Administration reports that the percentage of state road construction projects using high-performance paving techniques and materials increased from 4 percent in 1997 to 47 percent in 2000 and increased to 61 percent by 2002.

- Some regions are increasing the use of preventative pavement maintenance on roads while they are still in good condition to delay the need for significant repairs. These preventative maintenance treatments include sealing a road surface to prevent moisture from entering cracks in the pavement or thin pavement overlays, which improve ride quality, correct small surface irregularities and improve surface drainage and friction.
- If inadequate maintenance allows potholes to form, using patching material that is more durable and less susceptible to moisture significantly increases the life-span of a minor road repair.
- The timing of road maintenance and rehabilitation is critical to insure that it occurs before a road deteriorates to unacceptable condition. Repairing a road in unacceptable condition is approximately four times more costly than repairing a road in acceptable condition.

The increased use of more durable, long-lasting pavement materials and the use of pavement preservation techniques to prolong pavement service life is consistent with a recent public opinion poll, which found that motorists want smoother pavements and fewer travel delays caused by work zones.

- A poll taken in 2000 by the Federal Highway Administration found that 37 percent of people were dissatisfied with current pavement conditions. The poll taken of more than 2,000 people, also found that 67 percent favored the use of more durable pavements; 66 percent wanted roads fixed during non-rush hours and 52 percent wanted highways and streets repaired in less time.

TRIP offers the following recommendations for insuring a smooth drive:

- Build and rebuild roads and highways with the highest level of smoothness.
- Insure that foundation for roads and highway pavements is built and maintained in good condition.
- When critical routes are constructed or reconstructed, consider using pavement designs that will provide a longer-lasting surface.
- Implement and adequately fund a pavement preservation program that postpones the need for significant rehabilitation by performing initial maintenance on road surfaces while they are still in good condition.

- Resurface roads in a timely fashion using pavement material that is designed to be the most durable given local climate and the level and mix of traffic on the road.
- Maintain an aggressive pothole repair program that uses the best patching material available.
- Invest adequately to insure that 75 percent of local road surfaces are in good condition.

Introduction

The nation's urban and suburban road system is the backbone of our transportation system, allowing Americans the freedom to pursue their chosen lifestyles and for the tremendous movement of goods and services upon which our modern lives depend.

From commuters heading to work and children riding the bus to school to people driving to stores, church or the doctor's office, Americans depend on smooth roads and highways in their communities.

But the tremendous pounding that urban roadways take daily from cars and trucks and particularly from large commercial trucks has taken a toll. From coast to coast, major streets and freeways in most U.S. communities are showing significant signs of distress. The result of this continued pounding is that one-quarter of urban streets and highways have rough pavements that provide a ride that most Americans find unacceptable. And the result of driving on these rough roads and highways is that the cost to own and maintain a vehicle increases because cars and trucks wear out more quickly, require more maintenance and consume more fuel.

This report looks at the level of smoothness of the major roads in the nation's metropolitan areas of at least one million people and the costs to motorists of driving on roads that provide an unacceptable ride quality. Pavement condition and driver cost data for urban areas between 500,000 and one million population are included in the appendix.

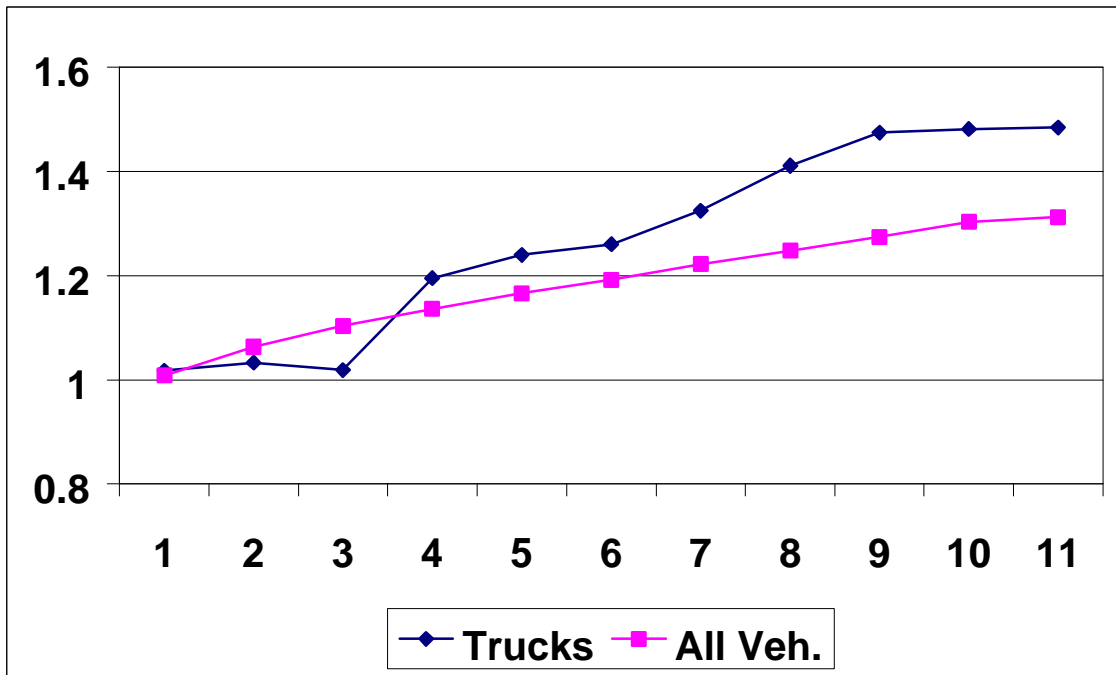
Data on pavement conditions was obtained from the Federal Highway Administration, which annually gathers data on the condition of the nation's major roads. This data is submitted annually to the Federal Highway Administration (FHWA) by state departments of transportation. Although the data is gathered by the states, the urban roads and highways for which condition data is provided in this report may be maintained by state or local governments.

The report also looks at the current level of annual investment being made in maintaining urban roads and highways, the amount needed annually to keep urban roads and bridges in their current condition and the amount needed annually to improve their condition. The study concludes with a series of recommendations for improving the condition of the nation's urban and suburban roads.

Travel on Urban Roads

One simple measure of the nation's economic growth is the tremendous volume of cars, trucks and buses that take to our streets on a daily basis as the nation's growing population conducts their daily lives. And while this growing traffic is a result of increased population and economic growth, it has resulted in a significant increase in wear and tear on our urban roads. This is particularly true because urban travel by large commercial trucks has increased by 46 percent over the last decade.¹ Overall urban vehicle travel has increased by 30 percent during the last decade.²

Chart 1. The Increase in urban travel by all vehicles and by large commercial trucks from 1991 to 2001 (1 = 100 percent of 1990 total)



Source: TRIP analysis of FHWA data

Wear and tear on urban roads is expected to continue to increase at a substantial rate, making it even more difficult to keep urban roads in good condition in the future. Overall vehicle travel is expected to increase by approximately 42 percent by the year 2020 and the level of heavy truck travel nationally is anticipated to increase by approximately 49 percent by the year 2020, according to FHWA projections.³

Why Roads Deteriorate

Most drivers first notice that a road is deteriorating when they are jarred by driving over a surface that is rutted or uneven or the pavement has cracked and a pothole has formed. But these visible signs of pavement distress are usually the final event in a process of deterioration.

Pavement failure is caused by a combination of traffic and moisture. Moisture from rain or snow often works its way into road surfaces and the materials that form the road's foundation. Heavy traffic, particularly from heavier vehicles, puts stress on the road surface, increasing the likelihood that cracks or potholes may form. This process is enhanced during periods of freezing and thawing, which peak in the late-winter and early spring, expanding and contracting road surfaces, which increases the likelihood of pavement failure. Road surfaces at intersections are even more prone to deterioration because the slow-moving or standing loads occurring at these sites subject the pavement to higher levels of stress.

Metropolitan Pavement Conditions

Every year the FHWA gathers data on the condition of the nation's major roads. This includes roads that are maintained by federal, state or local governments. For this report, TRIP included condition data for all arterial routes, which include all Interstates and limited-access freeways as well as other major city streets and routes within an urban

area. Most routes that are at least four-lanes are arterial routes, although some key two-lane roads are also classified as arterial routes. Urban pavement conditions were rated by states using the International Roughness Index (IRI). While there may be some variance in how transportation officials apply the IRI index, the FHWA data is the only national source of pavement condition ratings based on a consistent criteria.

TRIP then breaks down a region's road conditions into either providing a good, acceptable or unacceptable ride quality, based on categories established by the FHWA. The FHWA has found that that a road surface with an IRI below 95 provides a good ride quality, a road with an IRI from 95 to 170 provides an acceptable ride quality and that a road with an IRI above 170 provides an unacceptable ride quality.⁴ The FHWA determined that an IRI of 170 or above provided an unacceptable ride quality based on a study that measured driver reactions to various road conditions to determine what level of road roughness was found to be unacceptable to most drivers.⁵

Pavement data for each of the nation's most populous urban areas was obtained from the FHWA to allow TRIP to assess the condition of major roads in the nation's largest cities. The data is for the year 2001.

The FHWA data allowed TRIP to determine how many miles of major roads in each urban region provide either good, acceptable or unacceptable ride quality. Drivers on roads rated as providing an unacceptable ride quality should notice that they are driving on a rougher surface, which puts more stress on their vehicle. Roads rated as providing an unacceptable ride quality may have cracked or broken pavements. These

roads often show significant signs of pavement wear and deterioration and may also have significant distress in its underlying foundation. Roads rates as providing an unacceptable ride quality are in need of resurfacing and some need to be reconstructed to correct problems in the underlying road deck. Roads rated as providing an acceptable ride quality may also show some signs of deterioration and may be noticeably inferior to those of new pavements, but can still be improved to good condition, with cost-effective resurfacing or other surface treatments, which will extend the roads' service life.

A desirable goal for state and local organizations that are responsible for road maintenance is to keep 75 percent of their major roads in good condition.⁶ But only three of the nation's largest urban areas: Atlanta, Orlando and Phoenix achieve this goal.⁷

Although road deterioration is often accelerated by freeze-thaw cycles found most often in the nation's northern states, the urban areas with the highest share of poor pavement conditions in the nation actually include urban areas from a variety of regions. The 10 major urban areas with the highest percentage of major streets and highways in poor condition are Los Angeles, San Jose, San Diego, San Francisco-Oakland, New Orleans, Sacramento, Baltimore, Detroit, Kansas City and Oklahoma City.⁸

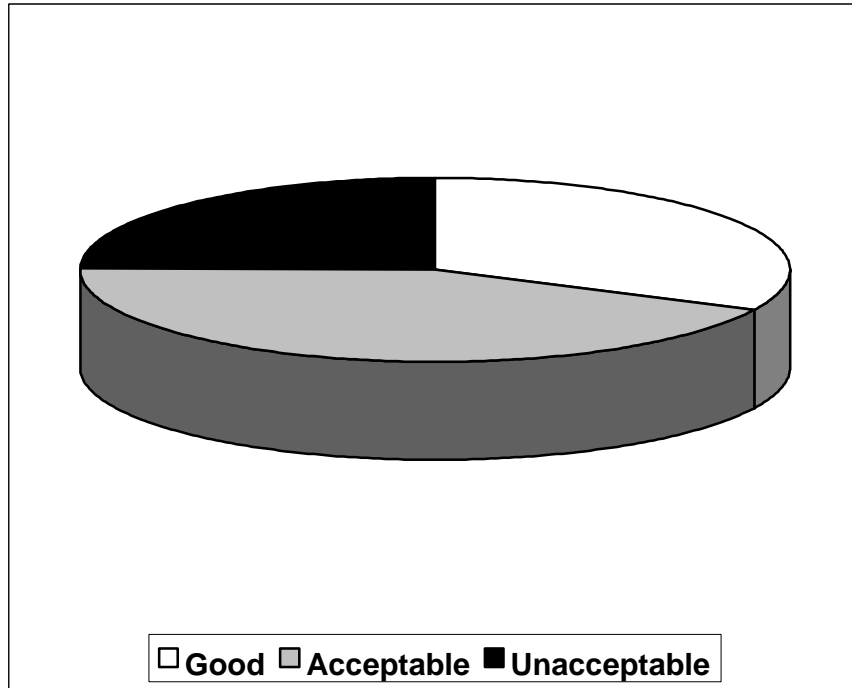
Chart 2. Urban areas (population one million or more) with highest share of major roads and highways with pavements providing an unacceptable ride quality

URBAN AREA	PERCENTAGE UNACCEPTABLE
Los Angeles	67
San Jose	67
San Diego	61
San Francisco-Oakland	61
New Orleans	51
Sacramento	50
Baltimore	49
Detroit	49
Kansas City	44
Oklahoma City	41

Source: TRIP analysis of Federal Highway Administration data

One in four (25 percent) of the nation's major urban roads – interstates, freeways and other main arterial routes – have pavements that provide an unacceptable ride and are in need of resurfacing or more significant repairs. TRIP's analysis of federal highway data also found that 43 percent of these major urban routes provided an acceptable ride quality. The remaining 32 percent of major urban highways and roads were found to provide good ride quality. These condition ratings were gathered in 2001. A listing of each urban area's road conditions and additional vehicle operating costs per driver can be found in appendices A and B for area's of at least one million population and in appendices C and D for regions with populations between 500,000 and one million.

Chart 3. Pavement Conditions of Major Urban Roads and Highways, 2001



Source: TRIP analysis of Federal Highway Administration data

The Cost to Motorists of Deteriorated Roads

When road surfaces deteriorate they tax motorists in the form of additional operating costs, which are incurred by driving vehicles on roads that provide a less than good ride quality.

Additional vehicle operating costs have been calculated in the Highway Development and Management Model (HDM), which is recognized by the U.S. DOT, and in more than 100 other countries, as the definitive analysis of the impact of road conditions on vehicle operating costs. The HDM report is based on numerous studies

that have measured the impact of various factors, including road conditions, on vehicle operating costs.

The HDM study found that road deterioration increases ownership, repair, fuel and tire costs. The report found that deteriorated roads accelerate the pace of depreciation of vehicles and the need for repairs because the stress on the vehicle increases in proportion to the level of roughness of the pavement surface. Similarly, tire wear and fuel consumption increase as roads deteriorate since there is less efficient transfer of power to the drive train and additional friction between the road and the tires.⁹

TRIP's additional vehicle operating cost estimate is based on taking the average number of miles driven annually by a region's driver, calculating current vehicle operating costs based on the Automobile Association of America's 2002 vehicle operating costs and then using the HDM model to estimate the additional vehicle operating costs being paid by drivers as a result of substandard roads.¹⁰ Additional research on the impact of road conditions on fuel consumption by the Texas Transportation Institute (TTI) is also factored into the TRIP vehicle operating cost methodology.¹¹

TRIP estimates that driving on roads in need of repair costs the average urban driver nationally an average of \$396 annually in extra vehicle operating costs.¹² A driver's individual additional vehicle operating costs may vary. Individual driver operating costs may be somewhat higher or lower depending on the type of vehicle

driven, as larger vehicles tend to have greater increases in operating costs due to substandard roads, and the amount of travel by an individual driver.

The urban area in which drivers incur the greatest annual extra vehicle operating costs due to driving on rough roads is Los Angeles, where the average driver pays an additional \$706 annually because of substandard roads. The other cities that cost drivers the most because of rough roads are San Jose, San Francisco-Oakland, San Diego, Detroit, New Orleans, Baltimore, Sacramento, Boston and Oklahoma City.

Chart 4. Urban Areas (population of one million or more) with highest annual additional vehicle operating cost per motorists as result of driving on roads with unacceptable ride quality

URBAN AREA	ADDITIONAL VEHICLE OPERATING COSTS PER DRIVER
Los Angeles	\$706
San Jose	\$705
San Francisco-Oakland	\$674
San Diego	\$667
Detroit	\$621
New Orleans	\$617
Baltimore	\$612
Sacramento	\$609
Boston	\$606
Oklahoma City	\$578

Source: TRIP analysis based on Federal Highway Administration data

Strategies for Smooth Roads

Improving the smoothness of the nation's highways and roads is a key priority for transportation agencies. Significant progress has been achieved over the last decade in improving construction practices and in the design of materials used to surface roads to achieve a smoother driving surface.

A solid, stable and consistent foundation below the surface of a road or highway is critical in maintaining a smooth driving surface.¹³ When constructing or reconstructing a roadway, it is critical that the routes' sub-base be adequate to support the roadway surface that cars and trucks will be driving upon. If a roadway's foundation is deficient, it will reduce pavement smoothness and increase the rate of pavement deterioration.

It is also critical that roadway surfaces be built or rebuilt initially as smooth as possible. A recent Federal Highway Administration report concluded "All other things being equal, the smoother a pavement is built, the smoother it will stay over time. The smoother it stays over time, the longer it will serve the traveling public, thereby benefiting the public in terms of investment and vehicular wear costs, as well as comfort and safety."¹⁴ The Federal Highway Administration has developed specifications for measuring pavement smoothness at initial construction and has been working with states to insure that new and reconstructed roadway surfaces be built with practices that will insure high levels of initial smoothness¹⁵.

States are increasingly also using new pavement mixes to achieve more durable road surfaces. By using pavement surfaces that are often thicker and that may use different mixtures of materials in different layers of the surface, states are increasingly able to provide more durable roadway surfaces. In fact, the FHWA reports that the percentage of state road construction projects using high-performance paving techniques and materials increased from 4 percent in 1997 to 47 percent in 2000 to 61 percent by the year 2002.¹⁶

Once a smooth, new pavement has been built, some transportation agencies are putting greater emphasis on doing early preventative maintenance on these pavements, to extend the lifespan of roadway surfaces and to delay the need for more significant pavement rehabilitation. These initial surface treatments include sealing a road surface to prevent moisture from entering cracks in the pavement or thin pavement overlays, which improve ride quality, correct small surface irregularities and improve surface drainage and friction. For pavement preservation strategies to be effective, they must be applied while the pavement surface is still in good condition, with no structural damage.

The timing of the maintenance and rehabilitation of road surfaces is critical, affecting the cost-effectiveness of the repairs and ultimately the overall quality of a regional road network. The wear-out rates of pavement surfaces are generally predictable, based on local climate and the level and mix of traffic carried. New pavements usually decline from good to acceptable condition at between eight to ten years. After that point, their deterioration accelerates and road surfaces usually fall into

unacceptable condition at between 12 and 14 years.¹⁷ If pavements can be resurfaced while still in acceptable condition, repairs generally costs about one-fourth the cost of repairing roads in unacceptable condition, reducing the overall life-cycle costs of providing the public with a smooth ride on that road or highway.¹⁸

The Best Way to Repair Potholes

When a road or highway deteriorates to the point where potholes form, care should be taken to insure that the repair will last as long as possible, which will delay the need to again divert traffic while the road is repaired. Some pothole repairs quickly show signs of dishing, cracking or fail completely, creating the need for repeated repairs, causing continued traffic delays.

The Federal Highway Administration (FHWA) recently completed a study of a variety of pothole repair techniques to determine the best practice. The study was based on assessing 1,250 pothole patches at eight locations under varying weather conditions over a four-year period. The study found that 56 percent of the repairs were still functioning by the end of the study period¹⁹. The report also found that the most critical issue in pothole repair is the quality of the materials used to fill in the pothole. "The cost of patching the same potholes over and over because of poor-quality patching material quickly offsets any savings from the purchases of less expensive mix," the FHWA report concluded²⁰. Higher grades of pothole patching material typically have aggregate mixes that are less susceptible to moisture damage and are more durable.

Other key variables impacting the effectiveness of pothole repair include adequate compaction of pothole fill material following the repair, the preparation of the site for repair by removing loose material and underlying moisture and the subsequent levels of precipitation at the location and the amount of and vehicle mix of traffic on the road.

Motorists Want Roads in Better Shape and Longer-Lasting Repairs

The increased use of more durable, long-lasting pavement materials and the use of pavement preservation techniques to prolong pavement service life is consistent with a recent public opinion poll which found that motorists want smoother pavements and fewer travel delays caused by work zones.

A poll taken in 2000 by the Federal Highway Administration found that 37 percent of people were dissatisfied with current pavement conditions. The poll, taken of more than 2,000 people, also found that 67 percent favored the use of more durable pavements; 66 percent wanted roads fixed during non-rush hours and 52 percent wanted highways and streets repaired in less time.²¹

Funding Level Required to Improve Urban Road Smoothness

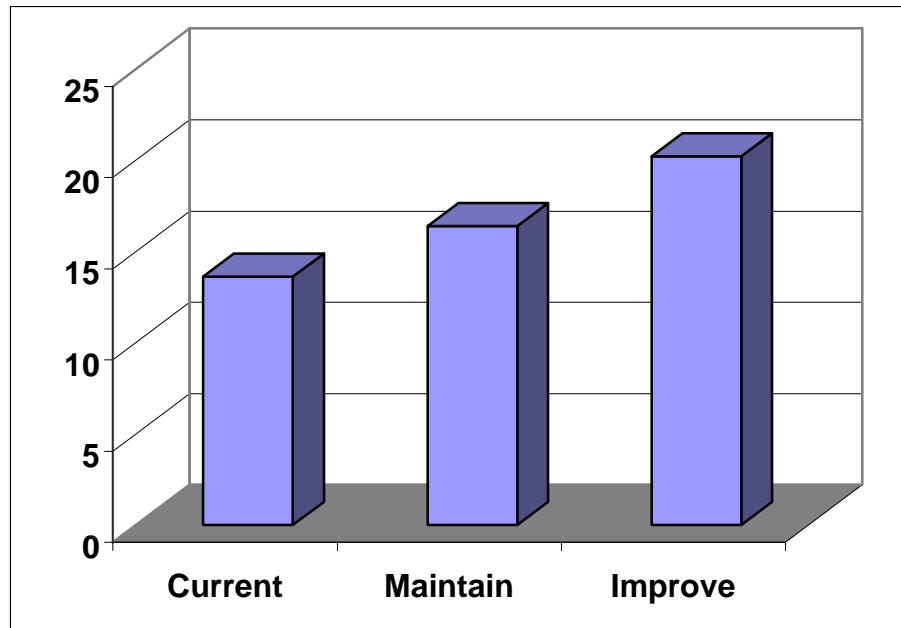
The U.S. Congress requires the U.S. Department of Transportation to provide semi-annually a comprehensive report on the condition, use and funding needs of the

nation's surface transportation program. The most recent report, the 2002 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, found that current levels of investment by all levels of government in maintaining the physical condition of urban roads is inadequate.

The DOT report estimated the current level of investment in preserving urban roads and highways and calculated what level of annual investment would be required through 2020 to either maintain physical conditions at their current level or to improve physical conditions.

The DOT study found that all levels of government are spending \$13.6 billion annually in preserving the physical condition of urban roads and highways, including bridges.²² The DOT estimates that the annual investment needed to maintain urban roads and highways in their current condition is \$16.4 billion and that the needed annual investment in urban roads and bridges to improve conditions is \$20.2 annually.²³ An annual investment of \$20.2 annually, adjusted in future years to account for inflation, would allow all necessary improvements to be done by 2020 to improve the physical condition of urban roads and highways, including providing future repairs that become necessary because of future deterioration.²⁴

Chart 5. Current annual funding, needed funding to maintain conditions and needed funding to improve conditions of urban roads, highways and bridges



Source: 2002 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, U.S. Department of Transportation

Thus, at the current level of investment in urban roads, overall pavement conditions can be expected to get worse, unless funding is increased, based on the findings of the 2002 U.S. DOT report to Congress. Keeping urban roadway conditions in their current condition would require a 21 percent increase in funding and making progress in improving the physical condition of urban roadways would require a 49 percent increase in funding, the 2002 U.S. DOT report found²⁵.

National Funding for Road and Bridge Improvements

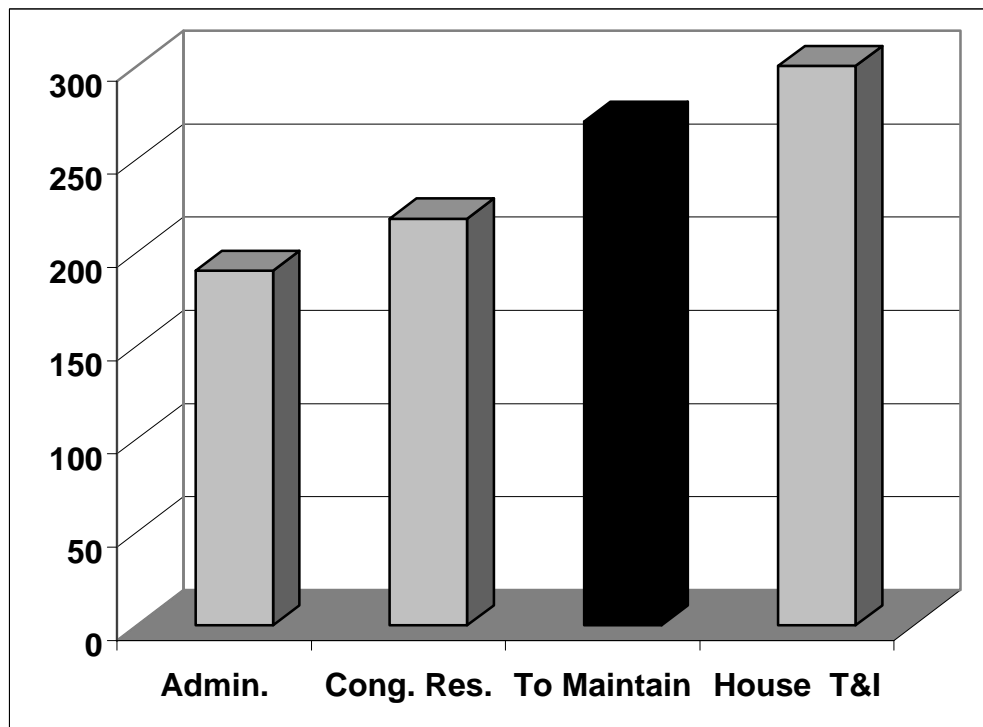
The federal government is a significant source of funding for urban road and bridge improvement projects. Federal funding for road and bridge improvements is distributed to state and local governments under the provisions of the Transportation Equity Act for the 21st Century (TEA-21), which expires on September 30, 2003. By the time TEA-21 expires, approximately \$168 billion will have been distributed during the six-years of the federal surface transportation legislation, including approximately \$32 billion in 2003.

Congress has begun deliberations on reauthorizing new federal surface transportation legislation. The Bush Administration has also made its proposal for a six-year federal surface transportation program. The Administration's proposal calls for spending approximately \$190 billion for roads and bridges from 2004 to 2009.²⁶ The Congressional budget resolution approved in April 2003, which Congress annually prepares to set funding targets, calls for spending \$218 billion on roads and bridges from 2004 to 2009. The leadership of the U.S. House of Representatives' Committee on Transportation and Infrastructure has proposed that federal funding of roads and bridges during 2004 to 2009 be increased to \$300 billion.

The funding proposal of the House Transportation and Infrastructure committee, which will have the primary jurisdiction over the reauthorization of federal surface transportation legislation, is the only proposal that has adequate funding to result in an

improvement in the conditions of the nation's roads and bridges. In response to a request by the House Transportation and Infrastructure Committee, the U.S. DOT recently estimated the level of federal funding needed from 2004 to 2009 to maintain the current condition and performance of the nation's roads and bridges. The U.S. DOT reported that the federal investment necessary to maintain the current condition and performance of roads and bridges from 2004 and 2009 is \$270 billion²⁷. Federal funding of road and bridge improvements from 2004 to 2009 in excess of \$270 billion would allow overall road and bridge conditions and performance to improve.

Chart 6. Proposed road and bridge funding for new Federal surface transportation program (2004-2009) by the Administration, the Congressional Resolution and the leadership of the House Transportation and Infrastructure Committee and the U.S. DOT estimate for needed federal road and bridge funding to maintain current conditions and performance



Source: TRIP, U.S. DOT, American Road and Transportation Builders Association

Recommendations for Smooth Urban Roads

Increasing the smoothness of urban roads, thus reducing the additional vehicle operating costs paid by motorists for driving on deteriorated roads, requires that transportation agencies pursue an aggressive program of constructing and re-constructing roads to high smoothness standards, conducting maintenance before roadways reach unacceptable condition and using the best practices for repairing damaged pavements.

TRIP offers the following recommendations for insuring a smooth drive.

- ✓ Build and rebuild roads and highways with the highest level of smoothness.
- ✓ Insure that foundation for roads and highway pavements is built and maintained in good condition.
- ✓ When critical routes are constructed or reconstructed, consider using pavement materials and pavement designs that will provide a longer-lasting surface.
- ✓ Implement and adequately fund a pavement preservation program that postpones the need for significant rehabilitation by performing initial maintenance on road surfaces while they are still in good condition.
- ✓ Resurface roads in a timely fashion using pavement material that is designed to be the most durable given local climate and the level and mix of traffic on the road.

- ✓ Maintain an aggressive pothole repair program that uses the best patching material available.
- ✓ Invest adequately to insure that 75 percent of local road surfaces are in good condition.

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Endnotes

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- ¹ Highway Statistics 1991, 2001, VM-2. Federal Highway Administration. www.fhwa.dot.gov/policy/ohpi/hss/index.htm
- ² Ibid.
- ³ The VMT projection is based on an annual increase of 2.08 percent as forecast in the 2002 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, U.S. Department of Transportation. P. 9-10. The estimated increase in large commercial truck travel is based on the Freight Analysis Framework, developed by the U.S. Department of Transportation.
- ⁴ 2002 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, U.S. Department of Transportation. P. 3-6.
- ⁵ A Statistical Analysis of Factors Associated With Perceived Road Roughness by Drivers, K. Shafizadeh, University of Washington, F. Mannering, Purdue University, (2002).
- ⁶ Why We Must Preserve our Pavements, D. Jackson, J. Mahoney, G. Hicks, 1996 International Symposium on Asphalt Emulsion Technology.
- ⁷ TRIP analysis of 2001 Federal Highway Administration data.
- ⁸ TRIP analysis of Federal Highway Administration data.
- ⁹ Highway Development and Management: Volume Seven. Modeling Road User and Environmental Effects in HDM-4. Bennett, C. and Greenwood, I. 2000.
- ¹⁰ Your Driving Costs. American Automobile Association. 2002.
- ¹¹ Updated Fuel Consumption Estimates for Benefit-Cost Analysis of Transportation Alternatives, Texas Transportation Institute, 1994.
- ¹² The average additional vehicle operating cost among drivers in urban areas of at least 500,000 population.
- ¹³ T. Kuennen, Better Roads, March 2003. New Technologies Boost Pavement Smoothness. P. 37.
- ¹⁴ Wanted: A Smoother Ride, Focus, U.S. Department of Transportation. July 2002. P. 5.
- ¹⁵ Ibid.
- ¹⁶ SUPERPAVE Adoption by State Highway Agencies: Implementation Status, Assessment and Benefits. Center for Highway Materials Research. Prepared for the Federal Highway Administration. DTFH-02-104-1S. 2002.
- ¹⁷ Why We Must Preserve our Pavements, D. Jackson, J. Mahoney, G. Hicks, 1996 International Symposium on Asphalt Emulsion Technology.
- ¹⁸ Selecting a Preventative Maintenance Treatment for Flexible Pavements. R. Hicks, J. Moulthrop. Transportation Research Board. 1999. Figure 1.
- ¹⁹ Pothole Repair, FHWA-RD-99-202, Federal Highway Administration, www.tfhrc.gov
- ²⁰ Ibid.
- ²¹ On The Move: The American Public Speaks on Roadways and Transportation in Communities, 2001. The Federal Highway Administration.
- ²² 2002 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, U.S. Department of Transportation. P. 6-21
- ²³ Ibid. P. 7-7.
- ²⁴ Ibid. P. 7-6.
- ²⁵ TRIP estimate based on data in the 2002 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance, U.S. Department of Transportation.
- ²⁶ SAFETEA: Safe, Accountable, Flexible, and Efficient Transportation Equity Act of 2003, Key Information. U.S. DOT. 2003.
- ²⁷ "Financing Our Nation's Roads," testimony of the American Road and Transportation Builders Association, before the Joint Economic Committee, U.S. Congress, May 6, 2003. Based on U.S. DOT analysis provided at the request of the House Transportation and Infrastructure Committee.

Appendix A

URBAN AREA	Percent	Percent	Percent
1 million or above	Unacceptable	Acceptable	Good
ATLANTA	2%	12%	86%
AUSTIN	32%	38%	30%
BALTIMORE	49%	31%	19%
BOSTON	42%	53%	5%
BUFFALO	17%	46%	37%
CHARLOTTE	10%	40%	51%
CHICAGO	20%	42%	38%
CINCINNATI	12%	54%	34%
CLEVELAND	22%	55%	23%
COLUMBUS	6%	41%	53%
DALLAS-FORT WORTH	24%	60%	16%
DENVER	22%	40%	38%
DETROIT	49%	30%	21%
FT LAUDERDALE-HOLLYWOOD	3%	32%	64%
GRAND RAPIDS	35%	36%	29%
HARTFORD	17%	64%	18%
HOUSTON	32%	43%	25%
INDIANAPOLIS	42%	28%	31%
JACKSONVILLE	5%	24%	70%
KANSAS CITY	44%	34%	23%
LAS VEGAS	11%	39%	50%
LOS ANGELES	67%	31%	2%
LOUISVILLE, KY	16%	62%	22%
MEMPHIS	14%	32%	54%
MIAMI-HIALEAH	10%	29%	60%
MILWAUKEE	18%	53%	28%
MINNEAPOLIS-ST PAUL	9%	53%	38%
NASHVILLE	6%	30%	64%
NEW ORLEANS	51%	26%	23%
NEW YORK-NE NJ	33%	44%	23%
NORFOLK-VIRGINIA BEACH	26%	56%	18%
OKLAHOMA CITY	44%	35%	22%
ORLANDO	2%	20%	77%
PHILADELPHIA	36%	52%	12%
PHOENIX	0%	22%	77%
PITTSBURGH	21%	64%	15%
PORTLAND, OR	10%	54%	36%
PROVIDENCE	21%	58%	21%
RALEIGH	9%	34%	57%
ROCHESTER	36%	25%	39%
SACRAMENTO	50%	48%	2%
SALT LAKE CITY	15%	56%	30%
SAN ANTONIO	30%	45%	25%
SAN BERNARDINO-RIVERSIDE	42%	55%	3%
SAN DIEGO	61%	35%	5%
SAN FRANCISCO-OAKLAND	61%	39%	1%
SAN JOSE	67%	31%	1%
SEATTLE	15%	54%	31%
ST LOUIS	31%	36%	33%
TAMPA-ST PETERSBURG	4%	27%	69%
WASHINGTON, DC	27%	41%	31%
WEST PALM BEACH	7%	22%	72%

Source: TRIP analysis of Federal Highway Administration data

Appendix A (Page 2)

URBAN AREA	Miles	Miles	Miles	Total
1 million or above	Unacceptable	Acceptable	Good	Miles
ATLANTA	31	251	1,751	2,033
AUSTIN	130	152	122	404
BALTIMORE	615	389	241	1,246
BOSTON	930	1,190	109	2,229
BUFFALO	156	421	343	920
CHARLOTTE	39	164	208	412
CHICAGO	910	1,893	1,698	4,501
CINCINNATI	114	495	313	922
CLEVELAND	267	662	280	1,209
COLUMBUS	43	300	394	738
DALLAS-FORT WORTH	572	1,445	382	2,399
DENVER	268	484	465	1,217
DETROIT	1,291	798	548	2,637
FT LAUDERDALE-HOLLYWOOD	19	172	345	536
GRAND RAPIDS	178	178	146	502
HARTFORD	96	361	103	560
HOUSTON	766	1,052	606	2,424
INDIANAPOLIS	286	193	210	689
JACKSONVILLE	28	123	361	512
KANSAS CITY	588	454	303	1,344
LAS VEGAS	57	206	265	529
LOS ANGELES	4,421	2,031	132	6,585
LOUISVILLE, KY	106	397	141	644
MEMPHIS	107	236	397	740
MIAMI-HIALEAH	75	211	431	717
MILWAUKEE	235	690	367	1,292
MINNEAPOLIS-ST PAUL	179	1,060	761	2,000
NASHVILLE	38	194	406	637
NEW ORLEANS	280	143	130	553
NEW YORK-NE NJ	2,551	3,346	1,740	7,638
NORFOLK-VIRGINIA BEACH	226	488	159	874
OKLAHOMA CITY	452	358	227	1,037
ORLANDO	18	151	574	743
PHILADELPHIA	966	1,408	321	2,696
PHOENIX	2	179	618	800
PITTSBURGH	330	1,016	244	1,590
PORTLAND, OR	85	464	303	852
PROVIDENCE	165	455	163	784
RALEIGH	32	122	200	353
ROCHESTER	199	135	212	546
SACRAMENTO	354	337	16	706
SALT LAKE CITY	59	225	120	404
SAN ANTONIO	279	420	230	929
SAN BERNARDINO-RIVERSIDE	398	527	32	957
SAN DIEGO	798	454	61	1,312
SAN FRANCISCO-OAKLAND	1,224	781	17	2,022
SAN JOSE	594	279	13	885
SEATTLE	151	557	324	1,032
ST LOUIS	458	526	490	1,475
TAMPA-ST PETERSBURG	38	249	637	924
WASHINGTON, DC	517	779	594	1,890
WEST PALM BEACH	26	88	287	401

Source: TRIP analysis of Federal Highway Administration data

Appendix B

Additional vehicle operating costs for urban areas with a population 1 million or more	Annual additional vehicle operating cost per driver
ATLANTA	\$54
AUSTIN	\$454
BALTIMORE	\$612
BOSTON	\$606
BUFFALO	\$326
CHARLOTTE	\$242
CHICAGO	\$358
CINCINNATI	\$320
CLEVELAND	\$419
COLUMBUS	\$204
DALLAS-FORT WORTH	\$454
DENVER	\$366
DETROIT	\$621
FT LAUDERDALE-HOLLYWOOD	\$144
GRAND RAPIDS	\$508
HARTFORD	\$414
HOUSTON	\$482
INDIANAPOLIS	\$540
JACKSONVILLE	\$148
KANSAS CITY	\$567
LAS VEGAS	\$240
LOS ANGELES	\$706
LOUISVILLE, KY	\$375
MEMPHIS	\$278
MIAMI-HIALEAH	\$215
MILWAUKEE	\$376
MINNEAPOLIS-ST PAUL	\$261
NASHVILLE	\$169
NEW ORLEANS	\$617
NEW YORK-NE NJ	\$497
NORFOLK-VIRGINIA BEACH	\$453
OKLAHOMA CITY	\$578
ORLANDO	\$97
PHILADELPHIA	\$556
PHOENIX	\$71
PITTSBURGH	\$445
PORTLAND, OR	\$289
PROVIDENCE	\$420
RALEIGH	\$213
ROCHESTER	\$473
SACRAMENTO	\$609
SALT LAKE CITY	\$323
SAN ANTONIO	\$476
SAN BERNARDINO-RIVERSIDE	\$564
SAN DIEGO	\$667
SAN FRANCISCO-OAKLAND	\$674
SAN JOSE	\$705
SEATTLE	\$346
ST LOUIS	\$455
TAMPA-ST PETERSBURG	\$131
WASHINGTON, DC	\$438
WEST PALM BEACH	\$149

Source: TRIP analysis of Federal Highway Administration data

Appendix C

	Percent	Percent	Percent
URBAN AREA	Miles	Miles	Miles
	Unacceptable	Acceptable	Good
AKRON	13%	34%	53%
ALBANY	29%	48%	24%
ALBUQUERQUE	40%	43%	17%
ALLENTOWN-BETHLEHEM	17%	61%	22%
ANN ARBOR	22%	44%	33%
BAKERSFIELD, CA	7%	77%	16%
BATON ROUGE	50%	40%	10%
BIRMINGHAM	2%	42%	56%
CHARLESTON, SC	21%	52%	27%
COLORADO SPRINGS	12%	43%	45%
COLUMBIA	17%	46%	37%
DAYTON	11%	44%	46%
EL PASO	31%	58%	11%
FORT WAYNE, IN	18%	42%	40%
FRESNO	29%	60%	11%
GREENSBORO, NC	18%	42%	39%
GREENVILLE, SC	32%	41%	26%
HARRISBURG	10%	67%	23%
HONOLULU	32%	57%	11%
KNOXVILLE	4%	27%	69%
LITTLE ROCK	52%	27%	20%
MCALLEN-EDINBURG, TX	21%	51%	28%
MOBILE	5%	39%	55%
OMAHA	29%	47%	23%
RICHMOND	26%	54%	20%
SARASOTA, FL	4%	30%	66%
SCRANTON--WILKES-BARRE	28%	54%	18%
SPRINGFIELD, MA	20%	71%	9%
STOCKTON, CA	34%	53%	13%
SYRACUSE	20%	28%	51%
TACOMA	17%	35%	48%
TOLEDO	14%	50%	36%
TUCSON	5%	28%	68%
TULSA	39%	48%	12%
WICHITA	33%	34%	34%
WILMINGTON	25%	47%	28%
WINSTON-SALEM	14%	55%	32%
WORCESTER, MA	51%	37%	12%
YOUNGSTOWN	16%	61%	23%

Source: TRIP analysis of Federal Highway Administration data

Appendix C (Page 2)

URBAN AREA				
500,000 to 1 million	Miles	Miles	Miles	Total
	Unacceptable	Acceptable	Good	Miles
AKRON	66	166	257	488
ALBANY	148	248	124	520
ALBUQUERQUE	160	169	66	394
ALLENTOWN-BETHLEHEM	51	185	66	302
ANN ARBOR	54	108	81	243
BAKERSFIELD, CA	24	270	55	350
BATON ROUGE	186	151	38	376
BIRMINGHAM	14	275	361	650
CHARLESTON, SC	55	139	71	265
COLORADO SPRINGS	44	160	165	369
COLUMBIA	55	147	120	322
DAYTON	56	225	236	518
EL PASO	127	241	44	413
FORT WAYNE, IN	37	86	81	204
FRESNO	133	269	50	452
GREENSBORO, NC	45	105	96	247
GREENVILLE, SC	77	99	63	239
HARRISBURG	33	214	72	318
HONOLULU	60	105	20	185
KNOXVILLE	11	79	203	293
LITTLE ROCK	194	102	76	372
MCALLEN-EDINBURG, TX	52	126	71	249
MOBILE	13	94	132	239
OMAHA	125	201	100	427
RICHMOND	173	354	130	657
SARASOTA, FL	8	54	121	183
SCRANTON--WILKES-BARRE	111	213	71	395
SPRINGFIELD, MA	140	493	61	694
STOCKTON, CA	55	85	21	162
SYRACUSE	76	105	189	371
TACOMA	76	155	209	440
TOLEDO	55	193	137	386
TUCSON	17	97	240	354
TULSA	254	314	79	648
WICHITA	104	108	108	320
WILMINGTON	81	152	91	323
WINSTON-SALEM	21	86	50	157
WORCESTER, MA	217	159	50	426
YOUNGSTOWN	48	183	70	301

Source: TRIP analysis of Federal Highway Administration data

Appendix D

Additional vehicle operating costs for urban areas with a population 500,000 to 1 million	Annual additional vehicle operating cost per driver
AKRON	\$269
ALBANY	\$451
ALBUQUERQUE	\$566
ALLENTOWN-BETHLEHEM	\$380
ANN ARBOR	\$410
BAKERSFIELD, CA	\$327
BATON ROUGE	\$647
BIRMINGHAM	\$156
CHARLESTON, SC	\$392
COLORADO SPRINGS	\$251
COLUMBIA	\$346
DAYTON	\$263
EL PASO	\$507
FORT WAYNE, IN	\$366
FRESNO	\$503
GREENSBORO, NC	\$339
GREENVILLE, SC	\$468
HARRISBURG	\$337
HONOLULU	\$549
KNOXVILLE	\$135
LITTLE ROCK	\$635
MCALLEN-EDINBURG, TX	\$383
MOBILE	\$203
OMAHA	\$468
RICHMOND	\$455
SARASOTA, FL	\$144
SCRANTON--WILKES-BARRE	\$479
SPRINGFIELD, MA	\$481
STOCKTON, CA	\$546
SYRACUSE	\$318
TACOMA	\$316
TOLEDO	\$307
TUCSON	\$139
TULSA	\$572
WICHITA	\$478
WILMINGTON	\$422
WINSTON-SALEM	\$312
WORCESTER, MA	\$656
YOUNGSTOWN	\$380

Source: TRIP analysis of Federal Highway Administration data