Technical Memorandum #3: The Benefits and Costs of Healthy Design

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Introduction

One of the first issues planners addressed in the early 1900s was the problem of public health. Cities were growing in population and becoming increasingly dense, which meant that residents were coming in direct contact with substances that negatively affected public health, such as pollutants from industries. City planners started separating land uses so that people had less interaction with the causes of public health problems. As public health improved, planners were able to focus their efforts in other areas.

Recently, the subject of public health has reemerged as an important topic for urban planners, though this time for different reasons. As the number of vehicles on the road has increased, air quality has deteriorated causing respiratory illnesses. When residential areas are located in separate areas from community services, people are forced to drive their cars as their form of transportation, which has led to inactivity and a subsequent rise in obesity rates. With streets designed primarily to accommodate the automobile, the potential for conflicts between motorized vehicles, pedestrians, and bicyclists has increased.

Healthy design practices address these modern issues of public health at a policy and design level. If a community requires designs that encourage active transportation, healthy behavior, and sustainable practices, it is likely to have residents with improved physical and mental health.

This memorandum presents the benefits and costs of implementing healthy design principles, practices and treatments. It first discusses the benefits that healthy design can have, including health, public safety, environmental, economic, and quality of life benefits. It then presents the costs of healthy design, comprised of capital, construction, and maintenance costs, as well as anticipated impacts on the development community. The memorandum concludes with a brief discussion of the anticipated impacts to Los Angeles County Departments of Regional Planning, Public Works, Parks and Recreation, Fire, and Public Health.

Benefits of Healthy Design

Neighborhoods that are designed around the automobile are often not well designed for walking and biking as a form of transportation and for recreation. Bicycling and walking, however, have many proven benefits, which include health, public safety, environmental, economic, and quality of life benefits. This section discusses each of these benefits, which can be associated with healthy design principles, practices and treatments.

Health Benefits

Automobile-oriented development has contributed to a growing level of inactivity amongst Americans. The lack of physical activity has led to increasingly high obesity rates, which is paired with high medical costs and

lower life expectancies. Healthy design has the potential for reducing obesity rates by encouraging active transportation and thus lowering associated medical costs and increasing life expectancies. This section presents the results of studies that provide evidence of these benefits.

Obesity rates

Over the past half-century, the United States has been faced with a growing obesity epidemic. This is in part due to increased inactivity from the way neighborhoods have been designed. People now commute predominantly by driving, thus leading to sedentary lifestyles. By increasing the infrastructure for active transportation and reducing the need to drive, healthy design can be part of the solution to reducing obesity rates.

In a study conducted by Ryan T. Edwards in 2007, Edwards analyzed the effect of walking to transit stops on obesity rates by converting average minutes spent walking to transit to energy expenditures to determine how many calories on average people spent while commuting. He used travel diaries from 2001 National Household Travel Survey data to estimate that people who commute by transit on average walk about 8.3 additional minutes per day. He also found that people on average walked an extra 4.5 minutes to access a train rather than to get to a bus stop. When people walk they burn anywhere from 3.1 to 4.7 kcal/min depending on the level of intensity (Morabia and Costanza, 2004), which translates to the potential to burn between 25.7 to 39.0 kcal associated with transit use and to store between 12.9 and 19.5 fewer kcal assuming a 50 percent efficiency rate. In a separate study completed in 2003, Hill et al conclude that burning an additional 100 kcal per day will stop the increase of obesity in 90 percent of the population. Using Edwards' calculations, this would mean by simply increasing walking, weight gain could be halted in 43 to 60 percent of the population.

Another study published in the *American Journal of Preventive Medicine* in 2004 by Frank et al looked at the relationship between the built environment and obesity rates. One aspect of the study was to compare the difference in obesity rates of those who commuted predominantly by driving and those that primarily commuted by walking. Frank et al used travel survey data in the Strategies for Metro Atlanta's Regional Transportation and Air Quality (SMARTAQ) study, which included household data throughout 13 counties in the metropolitan region of Atlanta, Georgia. The study looked specifically at the minutes spent in a car and the number of kilometers walked to indicate transportation-related activity levels and the BMI of participants. The study analyzed the commute mode information spatially by identifying the type of urban form of each household in order to estimate the impact of the built environment on likelihood of driving and walking. The study estimated that for each kilometer walked there was a 4.8 percent reduction in the odds of a person being obese and for each extra 60 minutes spent in a car there was a 6 percent increase in the chance of being obese. The study also found that an increased mix of land use also translated to a reduction in the odds of being obese because more participants that lived in mixed-use areas walked more often than those that lived in environments with only one land use.

In 2006, Heath et al studied the impacts that urban design and policies had on increasing physical activity as a means of reducing obesity. The study reviewed policies and design practices in the following three specific areas: 1) community-scale urban design and land use policies and practices to increase physical activity, 2) street-scale urban design and land use policies to increase physical activity, and 3) transportation and travel policies and practices. At the community level, design and policy strategies included everything from building codes and zoning regulations to street layout and development densities. At the street scale, policies and designs included pedestrian scale lighting and landscaping, traffic calming, and bicycle infrastructure. With

respect to transportation and travel policies and practices, designs and policies included improved access to public transit and treatments that increased rates of non-motorized transportation. The results of the study determined that land use and transportation design and policies significantly impacted the level of physical activity people engaged in. For example, people walked and biked more in environments that had services located closer together as they were viable transportation alternatives to driving. Safe, connected, and aesthetically pleasing pathways also contributed to increased physical activity and adding on-street bicycle infrastructure was associated with increased bicycling rates.

Life expectancy

Approximately 280,000 adults in the United States die prematurely due to obesity-related illnesses every year (Allison et al, 1999). Health disorders, such as diabetes, high blood pressure, high cholesterol, asthma, and arthritis are just some of the contributors to shorter life expectancies of the obese population (Mokdad et al, 2001). If obese persons increased their physical activity, such as through active transportation, obesity-related health problems would likely decrease dramatically. Healthy design can contribute towards increasing life expectancy rates and improve overall quality of life by making it easier for people to participate in walking and bicycling.

In a 2009 study published in the *American Journal of Lifestyle Medicine*, Heath reported his findings on the causes of modern illnesses. His research focused on the reasons that modern human diseases are predominantly chronic illnesses, whereas in the first half of the 20th century diseases were mainly infectious. Heath noted that though the human genotype has not changed much in the last half-century, the human lifestyle has changed substantially. People now live very inactive lifestyles, spending much of their time driving and working in front of computers. Many of the fatal diseases of today are directly related to physical inactivity. Heath discussed inactivity and its relationship to specific diseases, such as type 2 Diabetes, coronary heart disease, and risk of metabolic syndrome, by reporting the findings of several studies that concluded these diseases are more prevalent among people with sedentary lifestyles. In his conclusion, Heath referenced Metzler's study of Community Health Status Indicators, which determined that a community is healthier when young people recreate outside and adults participate in active recreation and transportation. Heath noted that "these types of indicators have been shown to be successfully implemented in communities where there is strong advocacy for active living environments."

In a 2008 study published in the *Journal of Planning Education and Research*, Boarnet, Greenwald, and McMillan looked at the relationship between walking and health. They studied travel diary data from Portland Metro in Oregon to see if the built environment had an affect on how much people walked. The study used a regression analysis to determine which neighborhood characteristics contributed to walking more. The regression analysis considered several environmental characteristics, such as retail density and proximity to a light rail station. The study determined that an increase in the number of neighborhood characteristics that deem a location walkable did, in fact, increase walking. Depending on the concentration of the variables, people walked between 0.0019 and 2.51 more miles each day in walkable neighborhoods. Using data from the United States Environmental Protection Agency, the study demonstrated that increased walking was directly related to increased health and thus longer life expectancies due to the reduction in health-related diseases, such as coronary heart disease. This translated into significant savings in medical costs, which is discussed in the next section.

Medical expenses

Increased medical expenses are also a result of obesity due to the many health issues associated with obesity. In a 1999 study published in *Medicine and Science in Sports and Exercise*, Colditz et al conducted an examination of scientific studies and determined that the United States spent $24 million on the treatment of diseases associated with a lack of physical activity in 1995. Illnesses included coronary heart disease, hypertension, Type II diabetes, colon cancer, depression and anxiety, and osteoporotic hip fractures. In a 2004 study published in the *Annals of Behavioral Medicine*, Wang et al determined that national health care costs specifically from cardiovascular disease as a result of low physical activity cost $23.7 billion in 2001 in the United States. Healthy design practices and policies can contribute towards reducing these medical expenses by decreasing the obesity rate, thereby reducing the number of people who need treatment for obesity related diseases.

As part of his 2007 study of the effect of walking to transit on obesity, Edwards also estimated the potential reductions in medical costs due to fewer diseases associated with sedentary lifestyles. Edwards estimated the incidence of obesity for each remaining year of life of the average U.S. citizen by using the obesity prevalence rate to determine the extra spending per person associated with obesity. He then calculated the future value of medical costs using a 3 percent increase in cost per year of life expectancy. He also divided the costs by public and private spending by assuming that money spent prior to age 65 (retirement age) would be private funding and money used after age 65 would be a public cost. Edwards calculated that obesity would produce $34,200 (2007 dollars) in healthcare costs per capita, about 70 percent of which will be public costs, such as Medicare. Using the additional 8.3 minutes he computed that people on average walk to commute to transit, he projected a savings of between $4,800 and $6,600 per person depending on the level of intensity. This would save pubic sources 80 percent of what they would be spending without this increased amount of walking.

In a 2011 study published in the *Journal of Physical Activity and Health*, Thomas Gotschi assessed the reduction in medical costs that Portland will experience from its investments in bicycling. His study included a review of the past monetary investments in bicycling infrastructure, as well as Portland's planned investments through 2040. Past estimated costs included an estimated $57 million dollars to rebuild the City's 274 mile bicycle network and $7.2 million through 2012 to implement the "Smart Trips" program that promotes active transportation. Future costs ranged from $100 million to $773 million based on three different investment options which may be implemented by Portland – a basic plan, an 80% plan, and a world class plan. Gotschi compared these costs to healthcare cost savings that would result from increased bicycling. He assumed a bicycle mode share of between 15 and 25 percent in 2030 based on the level of investment and the goals of the City, which he converted into miles of bicycling using bicycle counts and a traffic demand model, and subsequently determined the amount of medical costs savings that would result from the increase in physical activity. Assuming a 3 percent inflation rate, if Portland invests between $138 and $605 million, Gotschi projects that the City can expect to save $388 to $594 million in healthcare costs by 2040. He estimated that a half hour of bicycling everyday will reduce medical costs by $544 per person per year. The study also calculated the break-even year for each of the three investment plans. For the two cheaper plans, the break-even year was projected as 2015, whereas the break-even year was projected as 2032 for the world class plan.

Public Safety Benefits

Since healthy design increases the provision and bicycle and pedestrian facilities, there are many public safety benefits associated with it. This section discusses the effects of healthy design on crime rates and traffic collision rates, as well as how safe people perceive their environments to be, which can be an equally important variable influencing people's decisions to walk and bicycle in their communities.

Crime rates

Crime is a social problem that has persisted throughout societal history. There are many theories, as well as empirical evidence that evaluate methods of reducing crime. Some of these approaches are the same elements found in healthy design and thus positive benefits of a HDO.

In 1961, Jane Jacobs introduced the concept that mixed-use, walkable neighborhoods can reduce crime in her greatly influential book, *The Death and Life of Great American Cities*. Jacobs wrote that high density neighborhoods with a variety of land uses encourage the use of public space and thus bring more people to take an interest in them, creating what she called "eyes on the street." Pedestrians using the public spaces, as well as those who live and work in the neighborhoods, act as "natural proprietors" by watching the area more than they would if the streets were not active. She postulated that this increased monitoring would reduce crime because the opportunity to commit crime would be limited.

In a 2002 study published in *Cities*, Cozens reported on the relationship between sustainable design and the concept of Crime Prevention Through Environmental Design (CPTED). Sustainability is generally defined as meeting the needs of the present without compromising the needs of the future. From a design standpoint, this means that neighborhoods are designed to encourage sustainability, such as by reducing fuel consumption and promoting local equity, aspects that also can be found in healthy design. The study suggested that elements of sustainable design could work to reduce crime in neighborhoods. People protect their personal space through territoriality and thus elements of design believed to reduce crime are those that show ownership and defend space. These features can include signs of active maintenance of communities, such as landscaping and pavement treatments, to elements that encourage natural surveillance by attracting people to the streets, as discussed by Jane Jacobs.

In a 1996 study published in *Landscape and Urban Planning*, Kate Painter investigated the effects of street lighting on crime, a feature commonly associated with healthy design. Painter evaluated the impacts of upgraded street lighting on three streets that were notorious for being unsafe. The streets included in the study were in mixed-use areas that were poorly lit and had indications of social incivilities, such as loitering and graffiti. She interviewed survey respondents before and after the installation of the improved lighting to evaluate if the lighting had an affect on crime. In "before" and "after" interviews, Painter asked survey participants to record specific crime that had happened in the study area after dark. After analyzing the survey results, Painter reported that the improved lighting did, in fact, result in reduced crime on two of the three streets. She also found that crime was reduced on streets that were adjacent to the newly lit streets.

Traffic Collision Rates

Since elements of healthy design encourage walking and bicycling by providing additional facilities, healthy design practices should reduce the rates and seriousness of collisions involving pedestrians and bicyclists by providing safer facilities. By increasing the numbers of bicyclists on the road, drivers are also more aware of

bicyclists and learn how to interact with them. This section presents treatments associated with healthy design that reduce the frequency of traffic collisions involving bicyclists and pedestrians.

In a 2009 study published in *Environmental Health*, Reynolds et al investigated transportation infrastructure that reduced injuries and crashes of bicyclists. They reviewed and synthesized the current literature to determine which elements of infrastructure were proven to increase bicyclist safety. On-street bicycle facilities that separated vehicles and bicyclists, mainly bicycle lanes, reduced the number of collisions between bicyclists and motorists. Pavement markings, such as intersection crossing markings, and marked bicycle routes also minimized crashes as they alerted motorists to the presence of bicyclists. Certain roadway characteristics, including wide streets and lack of lighting, increased the severity of injury collisions. The study also looked at literature involving bicyclists riding on the sidewalk. Reynolds et al found that the opportunity for injuries of bicyclists on the sidewalk was significantly higher than on the street due to conflicts with pedestrians.

In a 2003 study in the *American Journal of Public Health*, Retting et al evaluated the traffic engineering countermeasures that were found to reduce the frequency of collisions involving pedestrians and motor vehicles. The study reviewed the literature to find design treatments that had been proven to reduce the opportunity for crashes involving pedestrians. The main three categories of design strategies to reduce the risk of crashes were 1) separating pedestrians from vehicles, 2) increasing the visibility of pedestrians, and 3) reducing vehicle speeds. **Table 1** shows the specific countermeasures found to reduce crashes associated with each of the three categories.

Table 1: Countermeasures Found to Reduce the Risk of Vehicle vs. Pedestrian Collisions

Category	Countermeasure
Separating pedestrians from vehicles	• Extending the crossing time allocated to pedestrians at intersections • In-pavement flashing lights at crosswalks • Pedestrian overpasses and underpasses
Increasing the visibility of pedestrians	• Increased lighting • Less on-street parking
Reducing vehicle speeds	• Roundabouts • Multi-way stop sign control • Narrowing lanes • Pedestrian refuge islands • Additional traffic calming

Not only have elements of healthy design been found to decrease actual collision rates, they have also been proven to minimize factors that increase the opportunity for collisions, such as high vehicle speeds. In a 2007 study published in the *Journal of Planning Education and Research*, Day et al examined the impacts of urban design on pedestrian safety by looking at the before and after effects of a revitalization project on Minnie Street in Santa Ana, CA. Minnie Street is a two block segment, which consists of 48 apartment buildings. Before the revitalization efforts, Minnie Street experienced high vehicle speeds. Due to a lack of nearby parks, children frequently played in the street resulting in the death of a child in a motor vehicle collision in 2001. In response to complaints from Minnie Street residents, the City of Santa Ana funded various street improvements, which

included traffic calming, pedestrian scale lighting, and landscaping and fencing improvements. After the improvements were complete, Day et al evaluated the effects of the renovation on vehicular traffic to evaluate benefits to pedestrian safety. They found that mean vehicle speeds reduced from about 19 miles per hour to about 17 miles per hour, which was statistically significant. The number of vehicles also decreased significantly from 48 vehicles per 15 minutes to only 30 vehicles per 15 minutes on Minnie Street. By reducing the vehicle volumes and speeds, the study concluded that pedestrian safety improved through the renovation of Minnie Street.

Perception of Public Safety

The way a neighborhood looks has a significant impact on a person's perceived safety. For example, design elements that encourage social order, such as maintained buildings, and components that make neighborhoods look "defended", including aesthetically pleasing landscaping and clear delineations of public space, make people feel more secure and less vulnerable to crime. On the other hand, environments that are not maintained and have considerable vacant land generally elicit feelings of insecurity and a lack of safety. The components of healthy design are among those elements that improve perceived safety, and thus healthy design treatments have considerable potential to create communities where people are less concerned about crime.

In a 2010 study published in *Health and Place*, Foster, Giles-Corti, and Knuiman studied the effect of walkability on perception of safety. They defined walkable neighborhoods as those that were within a 15-minute walk from services. Foster et al asked people to participate in a survey after they moved into a new, walkable location that analyzed how safe they felt living in the given place. The survey included questions regarding their perception of crime, such as if they felt like they were going to be robbed, their thoughts on the social environment, and if they trusted their neighbors. Overall, the study found that residents felt safer in walkable neighborhoods that encouraged the use of public space. The sense of safety was due to a combination of various land use and urban design elements, such as proximity to a transit stop and reduced building setbacks.

Kate Painter's study of street lighting in relation to reduced crime also evaluated the effect of street lighting on perceived crime. 90 percent of survey respondents reported that they felt safer in the dark after the installation of the lighting improvements, although many of them could not identify why. Women, more often than men, noticed the new lighting and felt safer. Interviewers noted that women generally walked at a slower pace and did not look as intimidated as before. The study also evaluated the number of pedestrians that used the streets before and after they had upgraded lighting. There was an increase in pedestrian traffic at night after the improvements, which suggests that people felt safer and were more willing to be there in the dark.

In a 2000 study published in *Geoforum*, Koskela and Pain investigated the impact of the built environment on women's fear of crime. The study focused on two locations: Edinburg, Scotland and Helsinki, Finland. In both locations, women participated in interviews and answered questions about their perceived safety in public spaces. In Edinburgh, more than two-thirds of the women said they were fearful of being attacked by someone they didn't know, and over one-half of the women said that they were more afraid when there was a lack of street lighting. Isolated places and blank walls also contributed to respondents' sense of fear. In Helsinki, women stated that the most frightening places to them were forests, parks, and recreation paths. They also noted tunnels, shopping centers, stations, and bridges as being unsafe. These are locations that can be isolated and thus be more susceptible to criminal activity. These are all important considerations that should shape

healthy design in Los Angeles County such that it improves perceived safety, especially for women, by providing streets that are active, well lit, and inviting.

Environmental Benefits

Along with health and public safety benefits, healthy design principles and practices can dramatically improve the natural environment due to a variety of reasons, including a reduced need to drive, creating less impervious, paved surfaces, and integrating more sustainable, green infrastructure concepts and practices. This section discusses how healthy design can improve air quality, reduce water pollution, and lower a community's carbon footprint by reducing energy and fuel consumption.

Air Quality

In the past decades, air quality has increasingly become an issue of concern due to the well documented impacts of poor air quality on people's health. In Los Angeles County, stricter vehicle emission standards have resulted in improved air quality in the past 20 years. Many communities today are designed around the automobile and encourage its use for transportation. These areas are more likely to see lower air quality due to increased vehicles on the road and, consequently, more polluting vehicle emissions. Bicycling and walking, on the other hand, produce no emissions apart from the emissions associated with the production of bicycles and shoes.

In a 2005 study published in *International Regional Science Review*, Frank and Engelke investigated the impacts of non-motorized transportation on air quality. The study found that the form of a neighborhood has a significant impact on whether walking and bicycling is feasible. Communities that lack connectivity due to cul-de-sacs, for example, are much more challenging to walk or bike in than a neighborhood with streets on a grid because people have to travel much farther to get to their destinations. Since walking and bicycling is more challenging in communities with poor street connectivity, more people drive and thus produce more vehicle emissions. Increased emissions typically result in reduced air quality as emissions contain pollutants, such as nitrogen oxides, volatile organic compounds, and carbon dioxide, among others. Cities that are designed to encourage healthy lifestyles improve air quality by reducing vehicular travel and emissions.

In a 2000 study published in *Transportation Research*, Frank, Stone, and Bachman evaluated neighborhood design and travel behavior in Seattle, WA to determine if urban form had an impact on vehicle emissions. They modeled the emissions of nitrous oxide, carbon monoxide, and volatile organic compounds by using emission estimates calculated from travel survey data. Frank et al included density and connectivity variables into their model, which are associated with higher levels of walking and biking. The study concluded that density and connectivity variables reduced emissions of all three pollutants, which was largely due to these environments producing fewer vehicle miles traveled due to the proximity of services to residential areas.

Water Pollution

Vehicles require paved surfaces to drive on and when there are more vehicles on the road the amount of paved area needed consequently increases. Paved surfaces are often non-permeable, thus creating runoff that makes its way into groundwater, oceans, lakes, and streams. The runoff carries with it pollutants from the ground, like oils and road salts. By reducing the number of vehicles on the road, healthy design practices can minimize the number of paved areas needed, which typically results in improved water quality.

In a 2009 study published in *Progress in Physical Geography*, Sutton et al investigated the extent of impervious surfaces throughout the world. They estimated the number of global hectares of paved areas for 149 countries and found that the United States had the second largest portion of paved land per person at 9.6 GHA/person, following the United Arab Emirates at 11.9 GHA/person. Much of the paved surfaces were in the form of roadways. This has a large impact on water quality, as stated above, because of the storm water runoff of non-permeable surfaces into the water supply.

In a 2007 study published in *Transportation Research*, Nixon and Saphores evaluated the impact of motor vehicles on water quality in the United States. The study focused on the increased public costs of water quality impacts related to motor vehicle use. The transportation industry creates many point and non-point source pollutants from both driving and the production of roadways and vehicles. Oil leakages spill onto the road from motorized vehicles, along with other pollutants from agriculture and manufacturing, and are carried into water sources during storms. Fuel for vehicles is stored in underground storage tanks and when these tanks leak they pollute groundwater. The study estimated that pollution cleanup costs between $3.7 billion and $17.7 billion on arterials every year, which is about 2.0-9.6 percent of yearly transportation expenditures nationwide, and 2.8-13.6 percent of transportation expenditures in California because of the higher number of urban arterials.

Energy Consumption and Carbon Footprint

One of the main pollutants from burning fuel for automobiles is carbon dioxide, which has been shown to have an effect on global climate patterns. Decreasing the number of vehicles on the road will result in less carbon dioxide being released into the atmosphere. Healthy design practices have the potential to reduce energy consumption and subsequent emissions from automobiles by creating environments where bicycling and walking are more viable transportation options and thus reducing the need to drive.

In a 2011 study published in *Energy Policy*, Lovelace et al evaluated the impact on energy consumption of replacing vehicle trips with bicycling in Sheffield, UK. The study used past growth rates in cycling in Sheffield, UK to determine the number of bicycling trips that could replace trips made by motorized vehicle under three scenarios: business as usual, hard pro-cycling policy, and integrated pro-cycling policy. The business as usual scenario assumed that cycling growth rates would increase at the same rate without any policy interventions. The hard pro-cycling policy scenario considered engineering changes to make bicycling safer while the integrated pro-cycling policy considered engineering, as well as education and encouragement interventions. The three scenarios respectively predicted an increase of 4.5, 9.0, and 13.6 million bicycle trips annually in Sheffield by 2050 and a decrease in fuel consumption by 3.5, 12.5, and 44.2 TJ/year by 2020. The study noted that more people bicycling would result in an increase in energy consumption in terms of food production as active people must eat more to sustain themselves. However, there would still be an overall net reduction in primary energy consumption due to the significant fuel savings.

In Gotschi's cost-benefit analysis of Portland's investment in bicycling infrastructure, he gave consideration to fuel savings and environmental benefits associated with bicycling. The study estimated that between 1991 and 2040, if Portland invested between $138 and $605 million, there would be cumulative fuel savings ranging from $143 to $218 million. To compute the savings, Gotschi assumed that bicycle trips three miles or less are utilitarian in nature and therefore would replace vehicle trips. For fuel savings calculations between 1991 and 2006, Gotschi used a fuel economy of 20.2 mpg, and from 2007 to 2030, a 35 mpg fuel economy rate was

assumed. The study also calculated that by reducing fuel consumption by these amounts, Portland will have avoided releasing between 540 to 830 million metric tons of CO2 into the atmosphere by 2040.

In a 2009 study published in *Transportation Research Part D*, Jacobson and King investigated the impact of the growing obesity epidemic in the United States on fuel consumption. People who drive a lot are statistically more likely to be overweight and vehicles with heavier loads require more energy to run. The study sought to determine if increased human weight had a significant impact on increased fuel consumption of all types of passenger vehicles by using vehicle data, passenger data, and weight data in their research. Vehicle data included the performance and use of cars and light trucks for noncommercial uses, passenger data was comprised of the gender and age of the vehicle's passengers, including the driver, and weight data consisted of the weight of each passenger. Jacobson et al used the three types of data to estimate the increase in the weight of vehicle passengers from the 1960s to the 2000s and the increase in fuel consumption that resulted from the increased weight, taking into account the improved fuel economies of the passenger vehicle fleet during this time period. The study concluded that every year an additional 1.137 billion gallons of fuel are consumed due to passenger weight gain, which is 0.8 percent of the gasoline consumed by passenger vehicles in 2005 (US Department of Transportation, Bureau of Transportation Statistics, 2007), and 1.104 billion of these gallons of fuel are approximated to be from overweight and obese people. 1.104 billion gallons of fuel yield 21.4 billion pounds (9.71 million metric tons) of CO2, which translates to 0.5% of the CO2 emissions released from fossil fuels used in the transportation industry in 2005 (US Environmental Protection Agency, 2007b).

Economic Benefits

Increasing fuel prices and the growing awareness of environmental sustainability has started to affect where people are choosing to live. Increasingly, people desire to be in walkable areas where they do not have to rely on a motorized vehicle and can walk or bike to their destinations. There are several economic benefits associated with walkable and bikeable neighborhoods, including increased property values, increased sales for local businesses, and lower household transportation expenses. This section discusses the economic benefits associated with healthy design.

Property Values

Transit Oriented Developments (TODs) are designed to encourage walking, bicycling, and use of public transit so that residents of these developments can be less dependent on motor vehicles. In a 2011 study published in *Urban Studies*, Michael Duncan studied the effects of TODs on condominium prices in San Diego, CA by looking at the property values of condos near the San Diego trolley stations. He chose to study condominium prices because they are medium-high density, which is generally the level of density of a TOD. Duncan used a hedonic price model to analyze the impact of pedestrian-oriented design. A hedonic price analysis takes into account that peoples' willingness to pay a given price is based on a set of criteria rather than one variable. In this case, the varying measures are the many amenities of a TOD, such as proximity to a transit station, a walkable neighborhood and nearby services such as restaurants and shopping. After running the model, Duncan found that condominiums located close to transit stations do, in fact, cost more than their counterparts farther from transit stations. He also found that condos had significantly higher impacts on the price when a shorter distance to a transit station was paired with a walkable environment, which suggests that TODs have a greater impact on property values than similar housing in non-walkable areas.

In 2009 paper written for CEOs for Cities, Cortight studied the relationship between housing prices and walkability in 15 metropolitan regions in the United States. He used the "Walk Score" algorithm (www.walkscore.com), which measures the number of commercial destinations within walking distance of a home. The Walk Score algorithm assigns a higher value to homes that are located within walking distance to a greater number of services as they are considered to be in more walkable neighborhoods. The scores range from 100 (very walkable) to 0 (auto dependent). Cortight then used a hedonic regression to determine how much more money people were willing to spend on homes in walkable areas. He ensured that the study controlled for other factors that influence home price, including house size and number of bedrooms and bathrooms. Cortight's study concluded that walkability scores were positively correlated with housing prices in 13 of the 15 studied metropolitan regions. In the typical market, an additional one point increase in Walk Score translated to a $500 to $3,000 increase in home values.

In a 2007 report, Colin Buchanan examined the effect of street design and maintenance on residential and retail property values in London by conducting case studies of 10 streets. Buchanan first assigned a score to each street based on its quality, which included variables such as lighting, maintenance, and personal security. He then applied a multiple regression analysis to the data to determine whether or not street design had an effect on home prices on the streets. The study determined that on streets with good walking conditions, property values were 5.2 percent higher for residences and 4.9 percent higher for retail establishments.

Local Business Impacts

Automobile-oriented shopping centers encourage people to drive to their destination, park, shop, and then leave. Typically, they do not facilitate walking around, which reduces the likelihood that people will casually enter retail stores or window-shop. This translates into fewer purchases, particularly for local businesses, which tend to rely more upon impulse purchases as compared to large chain retailers. Healthy design practices create attractive pedestrian environments in which people are more likely to casually shop, thus positively impacting local businesses.

In a 2011 paper, Todd Litman reported on the effect of walking on economic development. He stated that people place high importance on retail and employment centers, such as shopping malls, and that creating a more pedestrian friendly environment has the potential to increasing the economic viability of these locations. Litman reported that people who walk in retail environments on average spend more than those who drive from one location to another. This is in part due to savings from lower transportation costs. The report also noted that wages are often higher in automobile-oriented areas because they need to cover transportation costs of commuting. In areas where walking and bicycling are more practical, employers could theoretically reduce wages on account of lower employee transportation costs. By enhancing the pedestrian environment to encourage more walking, Litman concluded that this healthy design practice typically results in increased sales at local businesses.

Bicycling can also impact the economy of a city by increasing bicycle-related jobs and services. In 2008, Alta Planning + Design reported on the impact of increased bicycling on the local economy of Portland, OR. Staff from Alta conducted research into Portland's bicycle-related businesses, events, tours, races, and rides. Staff identified relevant Portland businesses through web research, consultation with industry leaders, and widespread promotion of a web survey (notably through bikeportland.org). 67 businesses participated in a web survey and/or follow-up interviews. Alta found that there has been a 38 percent increase in the value of the bicycle-related industry sector in Portland since 2006. **Table 2** displays the annual revenues by each sector

in the bicycle-related industry in Portland in 2008. As shown, the retail, rental, and repair sector brought in the highest revenues in the bicycle-related industry, followed by the manufacturing and distribution sector.

Table 2: Annual Revenue by Bicycle-Related Industry Sector, 2008

Sector	Revenue
Retail, Rental, and Repair	$52,268,374
Manufacturing and Distribution*	$17,126,578
Races, Rides, Events, and Tours	$9,158,484
Professional Services**	$8,559,610

* Includes: frame/component/rack manufacturing, accessory and apparel production, distribution, etc.
** Includes messengers, frame painting, coaching, non-profits, etc.

Overall, the total number of companies in the bicycle-related sector rose from 95 in 2006 to 143 in 2008, a growth rate of 50 percent. New businesses are primarily small and locally-owned, with the notable exception of Rapha Performance Roadwear, a national company that relocated to Portland. The bicycle-related economy provides between 850 and 1,150 jobs in Portland. Between 2006 and 2008, hand-built bicycle manufacturers increased from 5 to 17, which was a 340 percent increase.

Household Savings

In addition to gasoline, automobiles have many other costs that people do not always think about, such as maintenance and insurance. There are significantly fewer costs associated with walking and bicycling. As such, if people chose to walk and bicycle more, they could save thousands of dollars a year in reduced transportation related expenses. Healthy design practices can result in household savings by providing environments with adequate bicycle and pedestrian facilities that are convenient and comfortable.

In 2011, Litman reported that consumers saved a significant amount of money from traveling by bicycle rather than a motor vehicle. Although bicycles cost money to purchase and maintain and people will need to buy shoes more often if they walk more, people save upwards of thousands of dollars per year by not owning a vehicle. There are many types of costs that can be avoided by using a bicycle instead of driving. For example, operating costs, which include fuel, oil, and tire wear, are significantly lower for bicycles. Bicycles are also used mostly for short trips, which are cheaper by bicycle because cold starts in motorized vehicles require a considerable amount of energy.

In 2009, Jim Motavalli posted an article in the New York Times comparing the costs of owning an automobile to a bicycle. He reported that in 2007, an average household with a yearly pretax family income of $63,091 and 1.9 vehicles put more money toward transportation expenses than it did on clothing, health care and entertainment costs, combined. This amount totaled $7,432 and included the purchase of the vehicle, fuel, maintenance, registration, and insurance costs. Paul Steely White, Executive Director of Transportation Alternatives in New York, NY, estimated that the cost of owning a bicycle is approximately $390 per year. This number includes $200 for maintaining the bicycle, $60 for replacing helmets and other accessories, $60 for the bike itself (which is calculated to be one-tenth of the cost of a $600 commuter bike that is projected to last ten years), and a $70 cushion for replacement of stolen or lost parts.

Quality of Life Benefits

On top of all of the previously mentioned benefits associated with healthy design, healthy design practices can also contribute towards a better quality of life for people. There are psychological benefits of being active and having higher levels of social interaction. Furthermore, residents develop a strong sense of pride when their communities are vibrant, walkable and bikable.

Psychological Benefits

Healthy design has the potential to produce psychological benefits by increasing exercise, access to nature, and social interaction, all of which have been shown to improve mental health. In 2007, Cavill and Davis published a study on the positive effects of bicycling on public health, which included a discussion on emotional wellbeing. They reported that physical activity is positively correlated with a person's emotional wellbeing and mood, regardless of socio-economic level or health condition. The study also reported that physical activity improves self-esteem and reduces anxiety, which can have a positive impact on the quality of sleep that a person gets. The authors also noted that a lack of exercise can lead to depression and suggested that people that are active are more likely to be happy.

In 2011, Todd Litman conducted a literature review to evaluate how walking and biking have mental health benefits. He noted that residents who live in more walkable neighborhoods tend to be more active, are happier, and have better mental health. Litman also suggested that children who bike and walk are more easily able to develop socially and emotionally. Litman concluded that both children and adults who do not have access to vehicles can be happier when they can walk and bike because it makes them more independent and they do not have to rely upon others for transportation.

Psychological benefits also come from walkable neighborhoods because being outdoors has been thought to improve mental health. In a 2008 study published in *Environment and Behavior*, Herzog and Strevey investigated the relationship between nature and mental health to determine if being outside reduced stress. The authors conducted surveys of college students to learn about their contact with nature and their emotional wellbeing. Herzog and Strevey determined that nature does, in fact, affect emotional wellbeing. They found exposure to nature to help with personal-development and effective-functioning, the latter of which helps with attention span.

Impact on Social Interaction

Walkable and bikable environments tend to encourage social interaction as they bring people out of their homes and cars, and onto the street. Design strategies to attract people include providing aesthetically pleasing public spaces, such as inviting streetscapes or well maintained park space. As discussed above, socialization can have a positive impact on mental health and thus increased socialization is desirable for a community. Healthy design strategies and concepts can create opportunities for bringing people together and fostering social interaction.

In a 2011 paper, Todd Litman wrote that a key aspect of the public realm is the pedestrian environment, which includes the sidewalk, pathways, and city streets. These areas offer many opportunities for socialization and interaction, particularly when there is a high density of shops and restaurants. Litman noted that the quality of pedestrian environments has a significant impact on the amount of socialization that can occur because people are more attracted to public places with adequate amenities and locations that are aesthetically pleasing. Litman concluded that when public spaces are more attractive, people generally think more highly of them, which breeds an environment for positive interactions amongst users of the space.

In a 2003 study published in the *American Journal of Public Health*, Howard Frumpkin conducted a thorough literature review on healthy environments. The study discussed the concept that some of the most important places are "third places," which are in the public realm and can include streets, sidewalks, parks, and cafes. These locations are important because they foster many types of social activities and interactions, which positively impact health. He argued that public health policies should take into account the concept of "place," as it is critically important to the public health of a community.

Impact on Sense of Place

Communities that provide a sense of place typically have features that make residents proud of their neighborhoods. Many of these design elements, such as landscaping and street furniture, are associated with healthy design.

In his book, *The Image of the City*, published in 1960, Kevin Lynch presented the concept that well planned and designed cities can promote a sense of place by creating an image that people will remember. Lynch discussed five key elements that evoke this image, specifically paths, edges, districts, nodes, and landmarks. Paths include the streets, sidewalks, and trails that people travel on. People use paths to reach landmarks, nodes, and districts. Nodes and landmarks are focal points, while districts are larger defined areas with regional identity. Edges mark the boundaries of the other elements and inform people of the place they are in. When these elements are oriented toward people, they evoke a sense of place. Because these elements enhance the environment for pedestrians, they are strongly correlated with healthy design. Therefore, Lynch's findings from over fifty years ago are still relevant today and directly applicable to healthy design because creating a sense of place encourages people to be more active.

In *The Image of the City*, Kevin Lynch also presented the idea of "imagability," which is the "quality in an individual object that gives it a high probability of evoking a strong image in any given observer." The qualities that Lynch discussed as creating a community with imagability were connectivity, landmarks, distinct neighborhoods, and city centers. In an article published in the *Journal of Planning Education and Research* in 1985, Michael Southworth readdressed Kevin Lynch's concept of imagability. Southworth wrote that the growth of privatized, automobile oriented shopping centers reduce the icons that Kevin Lynch noted as creating a sense of place because the focus is no longer on the street, but inward. When the streets are given less attention, they become blank and everywhere starts to look the same. People do not get attached to these types of places because they lack identity. Southworth stated that communities with imagability continue to become more important as public spaces have decreased. There are ways in which a city can recreate its image to be one that people will remember and identify with. These include many aspects of healthy design, such as pedestrian amenities, public parks, and attractive streetscapes. When streetscapes are more aesthetically pleasing, they attract people to them and create an image that people will remember.

Day et al's study of Minnie Street in Santa Ana, as discussed in the Traffic Collision Rates section of this report, also evaluated the effects of the Minnie Street renovation on residents' sense of place. Before the renovation, the street was neglected, landscaping was not maintained, and garbage littered the streets. Narrow sidewalks lined with cars created an unattractive pedestrian environment. Residents participated in surveys before and after the street improvements, which included traffic calming, pedestrian scale lighting, and landscaping and fencing. After the renovation, people perceived Minnie Street as a more enjoyable place to live and they were proud to live there. To quote Kevin Lynch, the renovated street had achieved imagability.

Social Equity

Automobile transportation is a luxury that not all people can afford. As discussed in the Household Savings section of this report, walking and bicycling are much more affordable alternatives to driving and thus those in lower income brackets rely on these forms for commuting. When inadequate walking and bicycling facilities are available, it is challenging for people who depend on these modes. Healthy design can improve social equity by ensuring that communities are designed with infrastructure for walking and bicycling, thus benefiting residents that rely upon these modes for their livelihood.

In 2011, Todd Litman reported that in an average community, about 20 to 40 percent of people are unable to drive either because of physical disability or poverty and must rely upon others to get around. Increasing the provision of walking and biking facilities gives this portion of the population an alternative to being "chauffeured" and gives them better access to jobs, retail, and other services.

In 2003, Sanchez, Stolz, and Ma published a report on the various aspects of equity as it relates to transportation. The study noted that as transportation costs increase, such as through increasing gas prices, lower-income households have to spend a larger proportion of their income on transportation related expenses. From 1992 and 2000, households that had incomes below $20,000, spent at least 36.5 percent of their income on transportation-related expenditures. Households with incomes between $5,000 and $9,999 spent 57 percent more on transportation expenses than they did in 1992, while households with incomes of at least $70,000 spent only 16.8 percent more. In suburban environments, housing is often located farther from jobs, shopping, and other community services and people must rely on vehicles to get around. However, low income populations cannot always afford to have a car. The report noted that more money is put toward road infrastructure than other modes, such as transit, so people who cannot afford to own vehicles have limited access to services and jobs. In conclusion, the report stated that healthy design practices can address the issue of social equity and access by providing infrastructure to enhance walking and bicycling, modes that are more affordable and accessible to lower income groups.

In a 2007 article published in *The Lancet*, Woodcock et al evaluated the effects of automobile oriented communities on lower-income people. Woodcock et al stated that walking is the primary mode of transportation for many low-income people and noted that low-income populations are often impacted the most from the problems associated with energy-intensive transport. Similar to Sanchez et al's findings, Woodcock et al noted that lower-income groups typically have decreased accessibility to the transportation system (i.e., roads) because they cannot afford to own a vehicle. The study noted that people who rely on walking and bicycling are often put at greater risk of injury due to a lack of adequate bicycling and walking facilities in automobile oriented communities. Woodcock et al concluded that promoting and facilitating active transportation improved social equity by creating a transportation system that is accessible to all income groups. Implementing healthy design in Los Angeles County will further promote social inclusiveness by providing infrastructure that benefits all income groups.

Costs of Healthy Design

As documented in the section above, there are numerous benefits to healthy design. However, healthy design practices can also be more expensive as compared to more traditional design treatments. This section investigates the costs associated with healthy design treatments, including consideration for capital, construction, and maintenance costs. This section also provides a cost comparison between more

conventional design practices and healthy design practices. Since many of the costs associated with healthy design will be borne by the development community, a discussion of the impact of healthy design practices on the development community is provided, including several case studies from other communities.

Capital and Construction

The following section summarizes planning-level cost estimates for design components typically associated with healthy design (i.e., pedestrian-scale, neo-traditional design features that emphasize pedestrian and bicyclist movement over automobile traffic circulation). The FHWA PEDSAFE manual served as the source for many of these unit costs. Tables 3A–3C also include notes on proper application depending on the neighborhood context. As shown in the table, facilities may have a wide range of cost depending on varying design features, and raw materials and labor cost variations by geographic location.

Table 3A: Healthy Design Feature Unit Costs, Pedestrian Features[1]

Improvement	Cost	Note
Sidewalks		5' minimum, recommended width depends on adjacent land use. Suburban neighborhoods – 6 to 8 feet Urban neighborhoods – 8-12 feet
Curbing	$15/linear foot	
Walkway	$11/square foot	
Curb ramps	$800 - $1500 ea, new or retrofit	HDO - Use 2 ramps (perpendicular alignment) at each corner rather than single diagonal ramp
Marked crosswalk		HDO - Combine crosswalk treatment with other measures. Align crosswalk to curb ramp
Regular striped	$100 / ea (installation)	
Ladder	$300 / ea (installation)	
Patterned concrete	$3000 / ea (installation)	
Bus shelter	$1000-$10,000 / ea	Cost depends on amenities and existing ROW on sidewalk
Pedestrian lighting	$3500 / ea	150 feet apart / side (70 lights / mile)
Solar powered	$10,000 / ea	
Street furniture	Varies - depends on fixture	
Bench	$800 - $1200 / ea	2 / block, assume 8 blocks / mi / side (32 features / mi)
Trash receptacle	$600 -$800 / ea	
Bike rack	$500 - $1000 / ea	
Curb radius reduction	$2000 - $20,000 / ea	Cost depends on drainage and utilities
Curb extension	$2000 - $20,000 / ea	Cost depends on drainage and utilities
Crossing island	$4000 - $30,000	May require additional improvements such as crosswalk striping and pedestrian beacons
Raised crosswalk	$2000 - $15,000 / ea	
Landscaping		Varies based on landscaping type
Street Trees	$500-$1000 / ea	Root patterns vary by tree species. Selectappropriate tree species to reduce the potential for root damage to sidewalks and buildings.
Tree well covers	$200-$1000 / ea	
Shrubs and plants	$10-25 / SF	

[1] Federal Highway Administration (2004) *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System.* Washington DC. FHWA-SA-04-003.

Table 3B: Healthy Design Feature Unit Costs, Roadway Features[2]

Improvement	Cost	Note
Bike lanes	$5000 - 50,000 / mi	Cost varies based on pavement condition, moving adjacent lane lines, adjusting signal detectors, etc. Most efficient to construct during street resurfacing projects.
Bike route signage	$100-200 ea $1600 - $3200 / mi	2 / block @ 8 blocks / mi
Shared Roadway Bicycle Markings	$200-300 ea $8000 – $12,000 / mi	MUTCD recommends 250' spacing 20 / mi / direction
Lane reduction (4 lane undivided to 3 lane divided with bike lanes)	$5000 - $20,000 / mi	Cost for painted delineation only
Lane width reduction	$5000 - $10,000 / mi	Cost includes adding bike lanes and/or on-street parking
Raised median	$15K - $30K / 100'	
Pedestrian-friendly driveway (level walkway)	See sidewalk reconstruction cost	No cost if part of new construction
Chokers (curb exts)	$5000 - $20,000 / ea	Cost depends on drainage and landscaping
Speed humps	$1000 / ea	
Speed tables	$2000 - $15,000 / ea	
Paved shoulders (4')	$70K+ / mi	Cost depends on area and material prices

Table 3C: Healthy Design Feature Unit Costs, Intersection Features[3]

Improvement	Cost	Note
Roundabouts		Costs do not include ROW acquisition
Neighborhood	$45-$150K	Roundabouts have lower operation and maintenance costs than traffic signals
Arterial	$250K+	
Mini-circles	$6000-$12,000 / ea	
Raised intersection	$25K - $75K / ea	Cost depends on size of roadway

[2] Ibid.
[3] Ibid.

Maintenance

Tables 4A-4B present example maintenance costs for various bikeway and pedestrian facilities that may be a part of a particular community's strategy to implement healthy design principles. Specific maintenance costs will vary based on the type of facility, the expected lifecycle based on use, and geographical variations in material and labor cost. The bikeway maintenance cost uses capital cost estimates within the range provided in Table 3B and assumes maintenance schedules of two years for in-pavement features (e.g. paint and stencils), and ten years for signage. The pedestrian maintenance costs presented in Table 4B are average costs from maintenance reports for cities within or near the Southern California region.

Table 4A: Maintenance Costs: Bikeways

Item Description	Unit	Qtty/ mile	Unit Price	Total	Notes
Bicycle Boulevard					
Sign replacement	EA	2.6	$250	$660	26 signs every 10 years
Pavement markings	EA	21	$175	$3675	Repaint every 2 years, both directions
Cost per mile				$4335	
Annual maintenance cost per LF				**$0.82**	
Shared Lane Marking					
Shared Lane Markings	EA	21	$175	$3675	Repaint every 2 years, both directions
Sign replacement	EA	2.6	$250	$660	26 signs every 10 years
Patching	LF	10,560	$0.04	$400	Twice per year
Cost per mile				$4735	
Annual maintenance cost per LF				**$0.90**	
Bike Lane					
Re-striping	LF	5,280	$1.50	$7,900	2 lanes, every 2 years
Sign replacement	EA	2.6	$250	$660	26 signs every 10 years
Patching	LF	10,560	$0.04	$400	Twice per year
Street Cleaning	WK	1	$70	$3640	
Cost per mile				$12,620	
Annual maintenance cost per LF				**$2.40**	
Shoulder Bikeway					
Sign replacement	EA	2.6	$250	$660	26 signs every 10 years
Patching	LF	10,560	$0.04	$400	Twice per year
Cost per mile				$1,060	
Annual maintenance cost per LF				**$0.20**	

Table 4B: Maintenance Costs: Pedestrian Facilities, Parks, and Open Space

Item Description	Unit	Unit Cost	Source	Notes
Parks	Acre	$4800 $6200 $5700	San Diego CA Palmdale CA Pismo Beach CA	FY 2006 Average Rate[4] 2008-2009 Budget Summary[5] 2009 Fiscal Analysis[6], Table A-14
Open Space	Acre	$30	San Diego CA	Brush control and maintenance
Street Cleaning	MI LF	$9000 $0.40	Palmdale CA Pismo Beach CA	Equivalent to $1.70 / LF Equivalent to $2100 / MI
Landscaped Parkways	SF	$0.66	Palmdale CA	Annual average cost
Medians Hardscape Landscape	 SF SF	 $0.11 $0.28	 San Diego CA San Diego CA	 Annual average cost
Sidewalks	LF EA	$30-$50 $1000-$1500	Los Angeles CA	Citywide estimate for 4600 miles at $1.2 billion [7]
Streetlights	EA	$750	Inglewood CA	FY 2004 analysis[8] 50% of cost for utilities Remaining cost for personnel (20%), overhead (20%), replacement, equipment, and misc.

[4] http://www.sandiego.gov/fm/annual/pdf/fy06/01v6overview.pdf

[5] http://www.cityofpalmdale.org/city_hall/budget/08-09/budget_summary.pdf

[6] Stanley R. Hoffman Associates. Report Memorandum: City of Pismo Beach – Price Canyon Planning Area Fiscal Analysis. January 28, 2009. www.pismobeach.org/DocumentView.aspx?DID=4736

[7] Shoup, Donald (2010) *Fixing Broken Sidewalks.* **Access.** Spring 2010, Vol. 36. www.uctc.net/access/36/access-36brokensidewalks.pdf

[8] www.cityofinglewood.org/agendastaffreports/06-22-04/lighting.pdf

Cost comparison

This section presents cost estimates for several corridor designs that demonstrate the difference in initial and maintenance costs between conventional suburban design and healthy design. While capital and maintenance costs will vary based on the specific project, the unit and maintenance costs used for this exercise (**Tables 5A-5B**) are within the range of costs presented in the previous sections. The examples illustrate how incorporating bicycle and pedestrian-oriented design features can occur relatively inexpensively within conventional design rights-of-way.

Table 5A: Cost Comparison Examples: Bikeways

Conventional Design	Healthy Design	Cost Difference
Collector	**+ Class II Bike Lanes**	
60′ ROW	60′ ROW	**Capital**
Auto parking 2x8′	Auto parking 2x8′	Additional Bike Lane Striping - $10,000 / mi
Auto travel lane 4x11′	Auto travel lane 2 x 10	
	Bike lane 2x5.5′	**Maintenance**
	Median/turn lane 12′	Re-striping, signage replacement, patching, and cleaning - $12,500 / mi / yr
Arterial	**+ Class II Bike Lanes**	
76′ ROW	77′ ROW	**Capital**
Auto parking 2x8′	Auto parking 2x7.5′	Additional Bike Lane Striping - $10,000 / mi
Auto travel lane 4x12′	Auto travel lane 4x10′	
Median/turn lane 12′	Median/turn lane 12′	**Maintenance**
	Bike lane 2x5′	Re-striping, replacing signs, patching, and cleaning - $12,500 / mi / yr
Residential Road	**+ Class III Bike Route**	
35′ ROW	35′ ROW	**Capital**
	Shared Roadway Bicycle Marking (Sharrows)	Additional Roadway Marking - $10,000 / mi
	Signage	Signage - $3200 / mi
		Maintenance
		Repainting markings, replacing signs, and patching - $4800 / mi / yr

Bike lanes on new arterial and collector facilities will require additional right-of-way width. Roadway standards could mitigate this concern by allowing narrow travel lanes to reduce the overall right-of-way. Retrofitting an existing roadway to include bike lanes generally requires narrowing existing lanes, and occasionally requires removing parking or travel lanes. The extra cost for including bike lanes generally comes from extra pavement striping work.

Class III shared lane facilities have little to no impact on vehicular rights of way since bike routes do not receive exclusive roadway right of way for bicycles. The additional cost for Class III bike routes comes from additional pavement markings and signage.

Table 5B: Cost Comparison Examples: Pedestrian Corridors

Conventional Design	Healthy Design	Cost Difference
5′ sidewalk, no buffer	7′ sidewalk, 5′ landscaped buffer (12′ total)	**Capital** 7′ additional ROW Sidewalk width - $11 / SF x 2′ additional width $500-$1000 for street tree (spaced 50′-100′) Landscaping - $10-$25 / SF x 5′ buffer Street furniture - $800 / feature x 32 features / mi **Maintenance** Landscaping - $0.20 / SF / yr x 5′ buffer Street furniture - $800 / feature x 3.2 features / mi / yr (replace features every 10 yrs)
Diagonal curb ramps	Perpendicular curb ramps	**Capital** $800 - $1500 for one additional curb ramp **Maintenance** – NA
Sloped driveway	Unsloped driveway	**Capital** NA if part of original design and construction $11 / SF x 5′ sidewalk width x 10′-30′ driveway **Maintenance** - NA

A project or community can incorporate pedestrian-friendly design on a network, corridor, and point basis. For networks and corridors, pedestrian-friendly walkways will require additional right-of-way for wider sidewalks, planting strips, and amenities. The cost difference will depend on the level of amenities, which would vary based on zoning (e.g. residential, commercial, or other) and land use (e.g. density and setbacks).

Impact on Development Community

Incorporating additional features into the public realm beyond "conventional design" may require additional right of way and capital costs. Developers may incur additional expenses when incorporating such design features into their construction plans. To mitigate these additional expenses, Los Angeles County may want to examine other development standards to determine whether changes can also serve to reprioritize healthy design principles and practices.

For instance, healthy design features such as reduced parking standards, narrower roadway standards, and shorter building setback standards not only contribute towards creating more pedestrian and bicyclist-friendly communities, but they also typically result in reduced construction costs for developers. Accounting for active transportation within environmental analyses can allow developers to avoid costly traffic, noise, and environmental mitigation measures based on conventional, auto-centric analyses. The following section presents several case studies on how other communities adopted healthy design principles and how such policies affected the development community.

Montgomery County, MD[9]

Montgomery County, MD adopted a Pedestrian and Bicyclist Impact Statement (PBIS) to encourage developers to integrate pedestrian improvements into new and existing projects. The PBIS became a required part for all construction projects to ensure that developers will maximize pedestrian safety and access. By explicitly requiring developers to consider pedestrian and bicyclist safety issues as part of all development projects, the County expects to build significantly more pedestrian and bicyclist-friendly projects. The County collaborated with developers in creating the PBIS. Most of the developers within the County were conducting similar assessments independently, and most welcomed the new policy. The County officially adopted the PBIS in May 2004. Building on the PBIS, Montgomery County adopted development guidelines in 2008 allowing the Planning Board to reduce automobile traffic mitigation measures in exchange for facilities that enhance pedestrian safety or encourage walking, bicycling, and use of public transit.[10]

Cornelius, NC[11]

Cornelius, NC adopted a Land Development Code as a development guideline emphasizing pedestrian health and safety, and traditional neighborhood design. City staff reached out to developers and builders during the process to explain how the code could offer flexibility and benefits to developers. The Code, adopted in October 2006, states that "streets shall be designed as the main public space of the Town and shall be scaled to the pedestrian." The code encourages narrow roads with on-street parking, requires street landscaping, and requires sidewalks on both sides. It prohibits closed or gated streets and requires network connectivity. The code offers specific guidelines for trees, planting strips, street crossings, and curb cuts that specifically

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[9] Active Living By Design (2006) *Pedestrian Impact Statement.* http://www.activelivingbydesign.org/sites/default/files/Montgomery_Co.pdf

[10] Montgomery County (MD) Planning Department (2008) *Local Area Transportation Review and Policy Area Mobility Review Guidelines* . http://www.montgomeryplanning.org/transportation/documents/LocalAreaTransportationReviewandPolicyAreaMobilityReviewGuidelines.pdf

[11] Active Living By Design (2006) *Land Development Code.* http://www.activelivingbydesign.org/sites/default/files/Cornelius.pdf

account for pedestrian needs. Although Cornelius was successful in adopting a development code with a pedestrian focus, a similar effort in a neighboring community was unsuccessful due to severe developer opposition. Staff emphasized early stakeholder involvement among their lessons learned with Cornelius's success.

Flexible Bicycle Parking Requirements in New York City, NY and Pittsburgh, PA[12][13]

Several cities that adopted bicycle parking requirements worked with developers to ensure the requirements are flexible. New York City, NY passed its bicycle parking requirements in 2009 as part of a citywide effort to encourage active transportation. The requirements allow developers to exclude bicycle parking from calculations of floor area, and to locate and configure the bicycle parking in whatever way works best. This allows developers to employ the most space-efficient bicycle parking for their situation, from vertical racks to hanging systems. New York's code also allows small developments and affordable housing to waive the bicycle parking requirement.

Pittsburgh, PA went further to make bicycle parking requirements work for developers. Pittsburgh's code allows developers to swap required car parking spaces for bicycle parking. Because bicycle parking spaces are smaller and cheaper to build than car parking spaces, the swap reduces the cost of development.

The City of Los Angeles is currently reviewing a similar ordinance.[14] Real estate developers expressed their support for a bicycle parking swap in the *Los Angeles Business Journal.*[15] Flexible bicycle parking requirements provide an excellent example of a healthy design feature that is less expensive to provide than the corresponding conventional design feature.

Impact on Los Angeles County Departments

The Los Angeles County Departments of Regional Planning, Public Works, Parks and Recreation, Fire, and Public Health will experience varying costs and benefits associated with the implementation of healthy design principles and practices. At this point in time, it is not possible to quantify the costs and benefits of adopting a Healthy Design Ordinance due to numerous uncertainties involved. Nevertheless, **Table 6** presents a qualitative assessment of the potential costs and benefits of the HDO on each Los Angeles County department. Although the Los Angeles County Office of the Assessor is not listed in this table below, it is worth mentioning that property tax revenues are likely to increase over time with the adoption of an HDO, as was documented in the Economic Benefits section above.

Table 6: HDO Impacts on Los Angeles County Departments

Department	Potential Costs	Potential Benefits
Regional Planning	• Ordinance development • Ordinance Implementation	• Codifies and clarifies goals related to sustainability and healthy communities • Streamlined design review process
Public Works	• Maintenance of bicycle and pedestrian facilities	• Decreased total roadway maintenance resulting from narrower roadway width

[12] http://www.nyc.gov/html/dcp/html/bicycle_parking/index.shtml
[13] http://bike-pgh.org/blog/2010/03/17/city-council-unanimously-passes-bike-parking-requirement-ordinance/
[14] http://lacbc.files.wordpress.com/2011/02/bicycle-parking-public-notification-packet-1.pdf
[15] http://www.labusinessjournal.com/news/2010/apr/26/putting-parking-its-place/

		and increased percentage of public right-of-way allocated to pedestrians and bicyclists • Reduced watering requirements by using drought tolerant landscaping
Parks and Recreation	• Increased capital and construction costs of building new parks and open space • Maintenance from increased landscaping and park space and from having more dispersed facilities • Park maintenance and monitoring due to an increase in usage	• Improved countywide health • Improved quality of life from recreation opportunities • Smaller urban parks can serve more residents with less intense uses
Fire	• Purchasing new fire trucks that can traverse narrower streets	• Shorter emergency response times on account of having a well connected grid street pattern • Smaller coverage area per station on account of high population densities • Reduced traffic collision rates from roadways designed for all users translates to few traffic incidents to respond to
Public Health	• NA	• Improved countywide health • Reduced medical expenses

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