planokc Comprehensive Plan

Health Impact Assessment

BRIEF

planokc

planning for a healthy future

HEALTH IMPACT ASSESSMENT

In an attempt gauge the effectiveness of the major planokc components as they relate to community health in Oklahoma City, a Health Impact Assessment (HIA) was completed to evaluate the potential for various city-wide development patterns to influence opportunities related to health. It is widely understood that how a city grows affects the people and businesses who call it home. The HIA evaluates whether one of those effects is health, and if so, which aspects of health.

The HIA identified 35 measures or indicators that have the potential to change based on how Oklahoma City grows over the next few decades. Each of these measures was analyzed for each alternative growth scenario being tested as part of the Growth Scenarios Analysis described in this chapter. Because it is tied to the Growth Scenarios Analysis, the HIA assumes the same population and job growth for each scenario.

KEY FINDINGS AND RECOMMENDATIONS

The HIA process resulted in numerous findings and recommendations related to improving health in Oklahoma City. The following strategies, if implemented, have important components that are very likely to have a noticeable positive impact on the community over the next several years.

Create more opportunities for walking and biking. The development pattern and variety of uses within and close to neighborhoods strongly influence people's desire to walk or ride a bike. If the environment feels safe to pedestrians and cyclists and there are useful destinations within a reasonable distance, many more people will opt to walk or bike, either frequently, or occasionally. This situation offers several key benefits to public health, including increased physical activity and reduced vehicle emissions.

Increase access to fresh healthy produce. Many neighborhoods in Oklahoma City have relatively poor access to healthy food choices. Increasing the variety of and access to healthy food through urban farms, community gardens, and better access to stores with healthy food will have direct health benefits for individuals and the community.

Improve and protect water quality. The development pattern Oklahoma City chooses for the next 5 to 15 years has the potential to affect water quality in two key ways 1) the number of individual septic systems that require regular maintenance; and 2) the amount of impervious and manicured surfaces (roofs, paving, and lawns) which contribute pollutants and nutrients to runoff.

Increase access to parks and schools. Having easy access to parks and/or schools and playgrounds provides a community with both gathering places and opportunities for physical activity. The pattern and design of neighborhoods can influence this access.

Increase safety and security. Many factors affect how safe people feel in a particular neighborhood or location. Typically places that are well-populated, well-lit, and have been designed with safety in mind feel inviting and safe.

Reduce occurrences of abandoned buildings. Abandoned buildings create a variety of negative consequences impacting the health of neighborhoods and their residents. Targeting redevelopment and revitalization efforts on areas with relatively high numbers of abandoned buildings has the potential to turn negative impacts into positive outcomes.

Increase the variety of housing types in and near the inner loop. People are attracted to the features and amenities found in more urban neighborhoods of Oklahoma City; however, there is not always desirable housing in those areas. Increasing the amount of high-quality small houses, townhomes, and condos will offer more households the options they are looking for as they consider relocating in Oklahoma City.

URBAN FARMS AND COMMUNITY GARDENS
Growing food throughout the city can be an important component of a healthy local food system.

INFILL DEVELOPMENT
Revitalizing older neighborhoods can help reduce occurrences of abandoned structures and increase housing choices throughout our community.

This chart displays indicators from the HIA and shows the predicted change from existing conditions to each alternative growth scenario.

↑ indicates a chance for a positive change in health outcomes

= indicates health outcomes would be about the same as they are now

↓ indicates a negative change in health outcomes compared to today

The estimated magnitude of change is indicated, where appropriate, by multiple arrows – e.g. air quality is predicted to decrease over time due to the increase in population; however, Scenario A would likely require much more vehicular activity than Scenario C. Therefore A shows three ↓ while C shows just one.

Indicator Description		Scenario A Impact	Scenario B Impact	Scenario C Impact
sustainokc – Land Use				
Land Use Mix		↓	↑	↑↑
Regulatory impacts to walkability		↓	=	↑
connectokc – Transportation				
Reduction in Annual Vehicle Miles Traveled (VMT)	Total	↓↓↓	↓↓	↓
	per capita	↓	↑	↑↑
Time Available for Non-Commute Activities		=	↑	↑
Usage of Transit, Cycling, and Walking for Routine Trips		↓	↑	↑
Streets Access to Transit, Bike, and Pedestrian Facilities		↓	↓	=
Cyclist and Pedestrian Safety		↓	=	↑
Income Available for Non-Transportation Expenditures		↓	↑	↑↑
greenokc – Environment & Natural Resources				
Proportion of Land with Potential for Farming Use		↓↓↓	↓↓	↓
Proportion of Land Converted from Pervious to Impervious Surface		↓↓	↓	↓
Air Quality		↓↓↓	↓↓	↓
Surface and Groundwater Quality		↓↓	↓	=
Average Residential Energy Efficiency		↓	=	↑
Preservation of Dark Skies (Light Pollution)		↓	↓	↓
Quiet Environment (Noise Pollution)		↓	=	↑
Residential Uses Buffered from Oil or Gas Wells and/or Industrial Uses		↓	↓	↓
liveokc – Communities				
Proportion of Population with Easy Access to Schools		↓	↓	↓
Residential Density (net – residential parcels only)		↓↓	↓	↑
Proportion of Population with Easy Access to Healthy Groceries		↓	=	↑
Social Inclusion of Vulnerable Populations		↓↓	↓	↑
Proportion of Population with Easy Access to Healthcare Facilities		↓	↓	↑
enrichokc – Preservation, Appearance, & Culture				
Redevelopment Potential for Abandoned Buildings		↓↓	↓	↑
Proportion of Population with Easy Access to Cultural Elements		↓↓	↓	=
playokc – Parks & Recreation				
Proportion of Population with Easy Access to Public Parks		↓↓	↓	=
Proportion of Population with Easy Access to Private Parks		↓	=	↑
Proportion of Population with Easy Access to the Trails Network		↓	=	↑
strengthenokc – Economic Development				
Proportion of Jobs Paying a Living Wage		↓	↓	↑
Housing Affordability by Household Income Bracket		↓	↓	↓
Homelessness		↓	=	↑
serveokc – Public Services				
Police and Fire Service Efficiency by Zip Code		=	↑	↑
Safety from DUI Incidents		↓↓	↓	=
Public Utility Efficiency (water, sewer, solid waste)		↓	↑	↑↑

planokc Comprehensive Plan

Health Impact Assessment

SUMMARY

planokc

planning for a healthy future

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"We've got to get people out of their cars, out of those drive-thru windows, get them walking, get them in parks and get them more active."

- Mayor Mick Cornett

INTRODUCTION

Oklahoma City's comprehensive planning effort comes at a time when there is a great deal of interest in the overall health of the city, as well as the changes needed to improve health and promote healthy lifestyles. Comprehensive planning addresses the expected changes in population growth and how these changes will impact the economy, the environment, transportation, public infrastructure, public services, culture, housing, and much more. Each of these elements plays a role in the overall health of a community. Thusly, health – the term – is an overarching concept that has implications for all aspects of life.

For the purposes of this health impact assessment health refers to both individual health and community health. For individual health this includes, but is not limited to: physical health, mental health, mortality, disability, and behavioral health. For community health this includes, but is not limited to: environmental health, economic health, and social health. Nearly all aspects of health can be influenced by decisions made by governing bodies; therefore, it is of the utmost importance to look at what the implications of different possible futures composed through the comprehensive planning process may mean for the health of Oklahoma City.

HEALTH IMPACT ASSESSMENT

In partnership with the Oklahoma City-County Health Department (OCCHD), the City of Oklahoma City Planning Department participated in the Community Transformation Grant administered by the Centers for Disease Control and Prevention(CDC) to have the capacity to conduct a Health Impact Assessment as a part of the planokc comprehensive planning process.

Planning staff had already convened a group of community stakeholders deemed the Healthy Communities Oversight Group (HCOG) by the time the Health Impact Assessment was begun. From the HCOG, a group of interested individuals became a steering committee for the HIA process. This committee was instrumental in determining what health indicators were studied throughout the assessment phase of the HIA. The steering committee was also responsible for the approval of policy recommendations made as a result of the research coducted during the assessment phase of the HIA. Additionally, a partnership with the University of Oklahoma College of Public Health provided graduate student practicum research, ensuring that the concepts of public health addressed in the HIA were valid and rigorously vetted.

planokc

Begun in 2008, planokc will be the City's new comprehensive plan, guiding decision-making that will help to ensure that the City is able to manage the impending population growth, while also creating the possibility for a healthier, more sustainable, and overall improved standard of living. planokc consists of planning and policies that will help Oklahoma City to best meet the needs of the existing population (599,199) and the 300,000 new residents projected to live inside of the city limits within the next 40 years.

planokc is segmented into eight major elements:

1. sustainokc – Future Land Use
2. connectokc – Transportation
3. greenokc – Environmental and Natural Resources
4. liveokc – Communities
5. enrichokc – Preservation, Appearance & Culture
6. playokc – Parks and Recreation
7. strengthenokc – Economic Development
8. serveokc – Public Services

In addition to these eight elements, a scenario analysis consisting of three different possible futures for Oklahoma City was conducted. Each of these alternatives serves to evaluate what would happen if different decisions were made in regard to development patterns.

WHAT IS A HEALTH IMPACT ASSESSMENT?

A Health Impact Assessment is a collaborative effort, requiring a breadth of knowledge of public health concerns, the potential for policy decisions to impact these concerns, and unfettered insight into the details of the particular project for which the HIA is being conducted. An HIA combines procedures, methods and tools to evaluate a policy, program or project as to its potential impacts on the health of a population and the distribution of those impacts within the population. Typically, there are six main procedural phases that make up the HIA process:

1. SCREENING

This phase is characterized by the determination of the feasibility and applicability of an HIA. This phase primarily asks the question, "What value will be added to this project by including a health impact assessment?"

2. SCOPING

This phase is characterized by the creation of a plan and timeline to complete the HIA. Priorities are defined in this phase, and play a key role in the prodution of a list of health indicators to be explored throughout the HIA process. Additionally, the role of each person or group involved with the HIA is established as a part of the scoping phase.

3. ASSESSMENT

This phase is characterized by the creation of an existing conditions profile for each of the indicators decided upon in the scoping phase. Additionally, quantitative and qualitative analyses are completed to determine what the potential health impacts of the project will be relative to the existing conditions of each health indicator.

4. RECOMMENDATIONS

This phase is characterized by the formation of recommendations that could help to mitigate health risks associated with the project. These recommendations come as a result of the research and findings of the Assessment phase.

5. REPORTING

This phase is characterized by the compilation and creation of a final document to house all of the indicator research and recommendations. Other forms of presentation, whether visual or written, are a part of this phase.

6. MONITORING

This phase is characterized by the observation of each indicator studied within the HIA process to determine the actual results relative to the impact of the project. This phase is on-going and can be continued perpetually.

GROWTH SCENARIO ALTERNATIVES

The three scenarios present a range of realistic alternative growth patterns that are likely to result in different fiscal impacts for the City. The Planning Department developed the scenarios in-house using the Envision Tomorrow + tool and market research provided by Fregonese Associates. Economic & Planning Systems performed a housing market study that was used for the Scenarios B and C to provide control totals for the appropriate location and mix of housing. Each scenario assumes the same increase in population and employment. Additionally, the proportion of retail, office, and industrial jobs is consistent across scenarios.

SCENARIO A
(Trends)

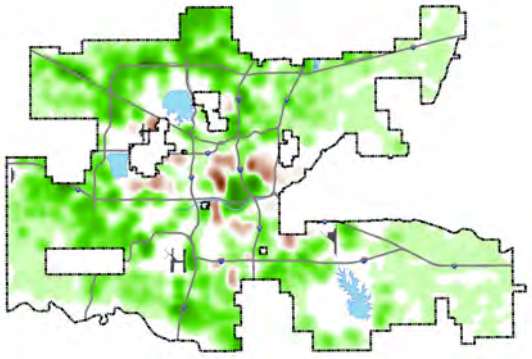
This scenario is based on land consumption rates and a housing mix that is consistent with observed trends over the past two decades. A market study was not used. Rather, the mix of new housing was calibrated to match the mix of housing built over the last 20 years. A geographically subdivided age-cohort model constrained by developable land was used by the Planning Department to project and allocate population. Employment projections were based on the model used by ACOG. Characteristics of this scenario include new, non-contiguous development (i.e., development full of gaps or "leapfrog" development), continuation of decline and abandonment in areas currently challenged, and little focus on providing City services efficiently.

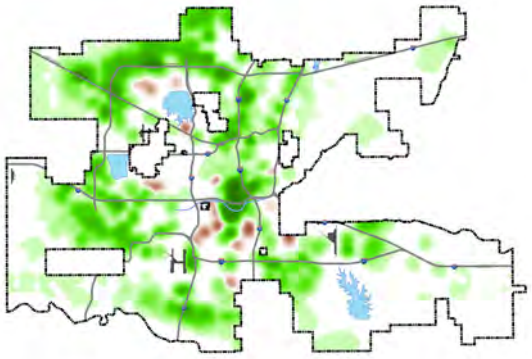
SCENARIO B
(Trends + Market + Efficiency)

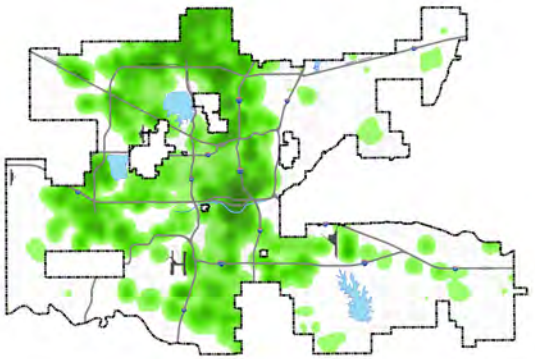
This scenario deviates from historical trends to reflect current and expected market demand and quality of life priorities (as captured by recent citizen and stakeholder input), as well as public service costs. In essence, it seeks a balance between providing a high quality of life, with housing options reflective of market demand (per the Housing Market Study), and a development pattern that lends itself to efficient provision of public services. Characteristics of this scenario include new, continuous development focused around nodes and corridors, modest transit improvements, and a limited amount of infill development in areas with excess service capacity. Housing mix and location information was provided by the Housing Market Study. Some areas still lose population.

SCENARIO C
(Market + Efficiency + Revitalization)

This scenario illustrates the most efficient growth scenario for providing public services. It is based on the extensive body of research into cost-effective development patterns, which supports the central principle that more compact development is more efficient to serve. The scenario is not purely abstract, as it is tied to consumer preferences as identified in the Housing Market Study. It presents the most compact development scenario that can be justified, given the results of that study. Likewise, the scenario is still reflective of citizen priorities for quality of life amenities. Characteristics of this scenario include even more infill, and more focus around fixed-guideway transit and nodes and corridors than in the Scenario B. The housing mix is consistent with the housing market study; however, some liberty was taken with location of new housing in order to enhance efficiency. No population loss is shown.







METHODOLOGIES

INDICATOR LIST

In order to develop a list of indicators, recently completed HIAs were examined and evaluated for their applicability and relevancy to Oklahoma City. A list of 57 potential indicators was assembled; through in-house discussions in the Planning Department this list was trimmed to 40 potential indicators before being brought to the HIA Steering Committee for discussion and changes. Over two meetings, the HIA Steering Committee removed indicators that were deemed unnecessary, added indicators that needed to be included, and tweaked indicators to be more representative of meaningful community outcomes. This process resulted in 35 fully-vetted indicators.

HEALTH-BASED RATIONALE

This section of the Assessment Phase required academic research and writing. Literature reviews of medical journals, healthcare publications, online databases and more were studied to justify the importance of researching each indicator.

EXISTING CONDITIONS

A diverse set of methodologies was required to determine the existing conditions for each of the 35 indicators:

- GIS was used a great deal to determine residential proximity to various land uses, networks, and amenities throughout the city.
    - The Network Analyst extension was very important to determine real access and proximity as it enabled accurate models of the existing streets, sidewalks, and transit system.
    - Model Builder was used to capture technical details and improve replicability.
- Data from the 2010 Census and the 2012 American Community Survey rolling 5-year average were used often.
- Data and statistics were acquired from various agencies and departments including the Oklahoma City Public Works Department, Utilities Department, Police Department, Fire Department, and Parks and Recreation Department, As well as the Oklahoma Department of Transportation and the Oklahoma City-County Health Department.
- Other statistics and information were sourced from various City-sanctioned and unaffiliated studies.

These methodologies provided information for maps, tables and graphs that help to illustrate the existing conditions for each of the 35 indicators as well as could be accomplished.

SCENARIO ANALYSIS

The Planning Department utilizes the Envision Tomorrow + scenario planning tool, created by Fregonese Associates Inc. and the University of Utah Metropolitan Research Center. This tool generates spreadsheets full of statistical data, and was available for all three of the scenarios in the planokc scenario planning section. This, in addition to the GIS mapping of each scenario, served as the greatest resource of information to inform the scenario analysis. Some indicators were not directly addressed by the Envision Tomorrow + tool, but were able to be addressed quantitatively by making predictions using other plans, including the Parks Master Plan, adopted in 2013. Other indicators were qualitative in nature and required assumptions based upon research.

POLICY REVIEW

In order to integrate the HIA into planokc, a study of all of the policies to be included in the comprehensive plan was conducted for each of the indicators. All relevant policies were summarized and listed with each indicator to provide the ability to cross-reference between the main policy section of the comprehensive plan and the HIA.

RECOMMENDATIONS

Draft recommendations were vetted by City employees with expertise and knowledge of the concepts of specific indicators. These draft recommendations were then reviewed, modified and approved by the HIA Steering Committee as the final step of the recommendation process. Several iterations between HIA indicators and recommendations and planokc policies were completed so that each informed the other.

sustainokc

future land use

OVERVIEW

This section of the HIA addresses the mix of land uses in relation to one another, as well as the implications of this mix on active transportation options. Future growth and development of the City will inevitably have a very important impact upon individual and public health. The establishment of sustainable land-use patterns to provide direction for infrastructure needs, capital improvement planning and priority redevelopment areas will ensure public health concerns are considered as the city grows. Location, type, intensity and form of development patterns must be coordinated to ensure a healthy city.

HEALTH INDICATORS

Land use patterns in Oklahoma City have continued to push the limits of the urbanized area out into rural areas, degrading the rural quality that is a major constituent of the spirit of the city. The ability for the City to serve all of its residents has also been strained, weakening the City's ability to provide utilities, public safety, and infrastructural improvements. planOKC represents an opportunity to reverse the patterns that have left portions of Oklahoma City unwalkable, increasingly homogenous, and environmentally indifferent. The following health indicators are evaluated in this section to determine what different directions in terms of land-use planning could mean for the overall health of the population:

Su.1 Land-Use Integration (Mixed-Use)

Su.2 The Effect of Regulation on Walkability

HEALTH IMPLICATIONS

- Cities that are strongly dependent on motor vehicles have higher rates of obesity and are less likely to have strong communities[i].
- Low density suburban development generally indicates a poor walking environment[ii].
- Greater amounts of driving cause higher amounts of pollutants in the air. This can lead to respiratory disease and cardiovascular disease[iii].
- Lack of land-use integration can negatively impact water quality. Runoff can contain harmful chemicals from motor vehicles, or pesticides and fertilizer from lawns and farms[iv].
- Poor land-use integration reduces the amount of open land available for farming. This causes higher levels of air pollution as foods must be brought in from greater distances. Also, the quality of food is degraded[v].
- Poor land-use integration and connectivity can contribute to higher rates of social and physical isolation. Populations that experience high levels of isolation have less access to healthy food and jobs, and are more prone to poverty, violence, HIV/AIDS, weather-related deaths, mental health concerns, as well as other negative health outcomes[vi].

EXISTING CONDITONS

Land-Use Integration

When looking at land-use integration at varying scales (i.e. a walkable distance, a bikeable distance, a driving distance) the current environment differs in terms of diversity of land uses. Some areas of the city that score well in terms of land-use diversity at the walkable or bikeable scale do not have sufficient infrastructure to support active transportation. Uses are predominantly spread out at distances most suitable for automobile travel, though several locations are potentially quite usable for pedestrians and cyclists (Downtown, Brittontown, S. 29th Street at Western Avenue).

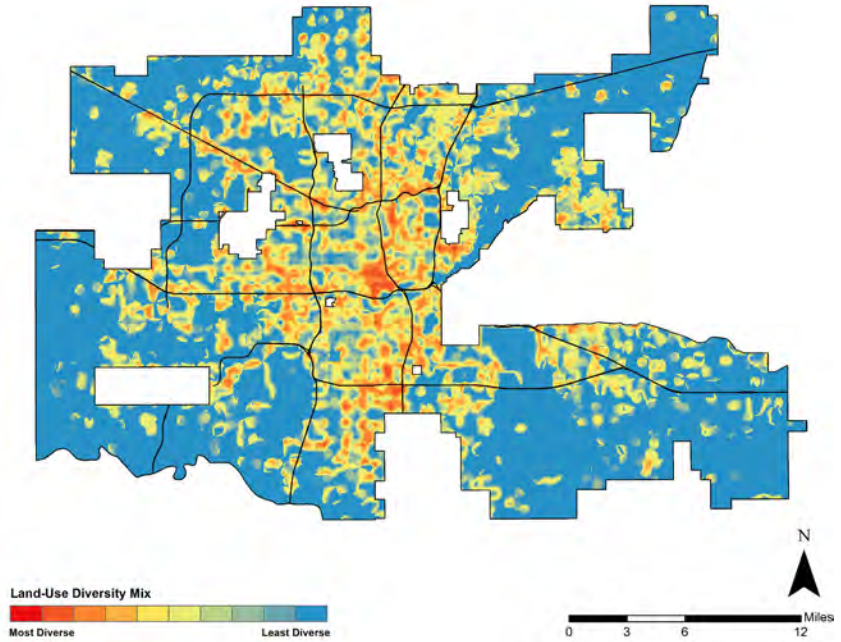


FIGURE 1: This Land Use Diversity Index (LUDI) heat map illustrates the level of land-use diversity across the city at a bikeable distance, with a radial comparison of 1/4-mile.

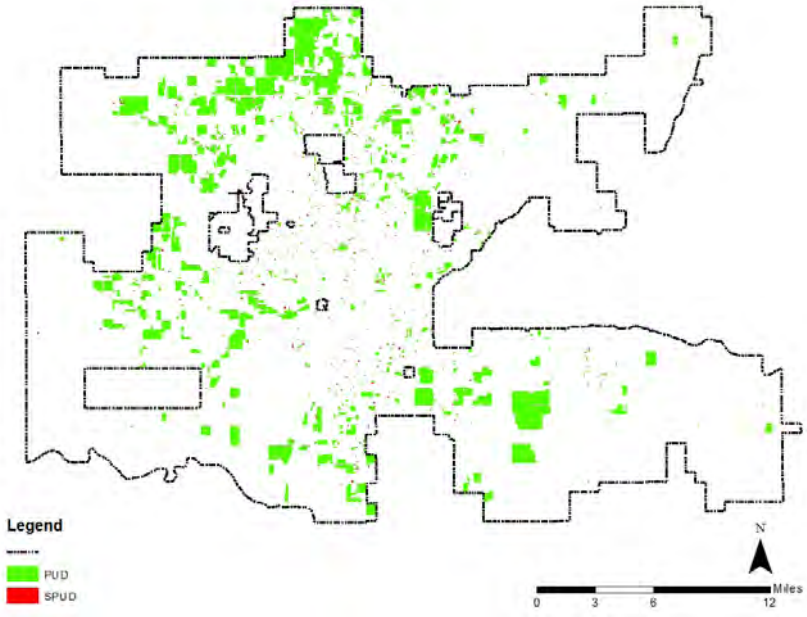


FIGURE 2: This map shows the distribution of PUD and SPUD development around the city. The majority of these parcels are outside of the primary urban area.

The Effect of Regulation on Walkability

Presently, there are several ways that walkability can be degraded by the City's subdivision regulations. Additionally, the zoning classifications PUD and SPUD have the potential to circumvent sidewalk requirements. In 2013 the Board of Adjustment did not deny any sidewalk variance requests despite City staff's opposing recommendations.

SUMMARY OF FINDINGS

In order to improve health conditions related to land use, efforts to improve sidewalks and bike infrastructure should be focused on areas that have a good land-use diversity score at the walkable and bikeable scales. Development should be focused on the currently urbanized area such that a robust active transportation network can effectively serve this area. **Scenario C is the best option to ensure that these opportunities are attained at the lowest cost. The pattern of development in Scenario C lends itself to a greater mix of land-use types, and completing the sidewalk network will be easier as much of the new development will occur where partial sidewalk networks already exist.**

COMPARISON OF SCENARIOS

The analysis of the three scenarios provided the following conclusions:

Scenario A

Health would decline in Scenario A due to negative changes in the following:

- Land-use diversity scores poorly at a walkable and bikeable distance when compared to Scenarios B and C. This would lead to continued dependency on motor vehicles, which could lead to an increase in obesity, chronic disease, respiratory disease from air pollution, and negative impacts on mental health as people will have to spend more time commuting in single-occupancy vehicles.
- With the majority of new development occurring in regions of the city with high instances of sidewalk variations, Scenario A would see a higher percentage of the population living in areas without active transportation options.

Scenario B

Health would improve in Scenario B due to positive changes in the following:

- Land-use diversity scores higher at a walkable and bikeable distance. This would likely result in a population that relies less on motor vehicles for trips to take care of daily needs, leading to greater active transportation.

Health would stay the same in Scenario B due to no change in the following:

- There would likely be a negligible change in the number of households living in areas with active transportation options as development will be split between urban and rural areas. PUDs and the BOA would permit development without sidewalks at the same rate as today.

Scenario C

Health would improve in Scenario C due to positive changes in the following:

- Land-use diversity scores the best of the three scenarios at a walkable and bikeable distance. The more compact development pattern naturally places different uses in proximity to one another. Filling in gaps in the existing urban area with new development achieves this end.
- With the majority of development occurring within the urbanized area, it is likely that Scenario C would have the highest percentage increase of the population living in areas with access to active transportation. This would likely result in reduced rates of sedentary living, obesity, and improvements in air quality and water quality.

HEALTH-PROMOTING RECOMMENDATIONS

Develop policies to protect rural character:

- Regulate fringe area development to restrict haphazard growth.
- Ensure that uses in agriculture areas are compatible with farming practice.

Develop polices to increase connectivity:

- Enforce connectivity requirements for sub-division development such that access to surrounding land uses is available. i.e. Discourage dead-end roads and cul-de-sacs in the urbanized areas of the city.
- Focus efforts to improve sidewalks and walkability on key locations and connections between places where people live, work, learn and play.
- Require multi-modal access to all land uses.
- Promote the importance and benefits of connectivity for streets, sidewalks, and bicycle routes.
- Mandate sidewalks for all development in urban areas regardless of land-use type to ensure that future development have access to a completely connected sidewalk network.

Invest in neighborhood revitalization and mixed use:

- Encourage mixed-use developments.
    - Merge concepts from Euclidean zoning, performance zoning, conditional zoning and design-based zoning to allow for a customizable land use mix.
- Incentivize redevelopment of abandoned properties.
- Facilitate community improvements (gardens, parks, physical activity uses, etc.) particularly near schools and higher-density residential areas. Springboard neighborhood revitalization from these strategic projects.
- Work with neighborhoods and districts to organize and advocate for their areas.
- Promote the integration of healthy uses into the land use mix at the neighborhood scale.
- Improve the ability to start neighborhood-scale small businesses.

Rethink existing regulation to ensure walkability and connectivity:

- Ensure that PUDs only enhance walkability. i.e. PUDs should never allow for a sidewalk to not be built in return for adding some other feature to the site.
- A sidewalk variance should be defined as an ineligible request of the Board of Adjustment.

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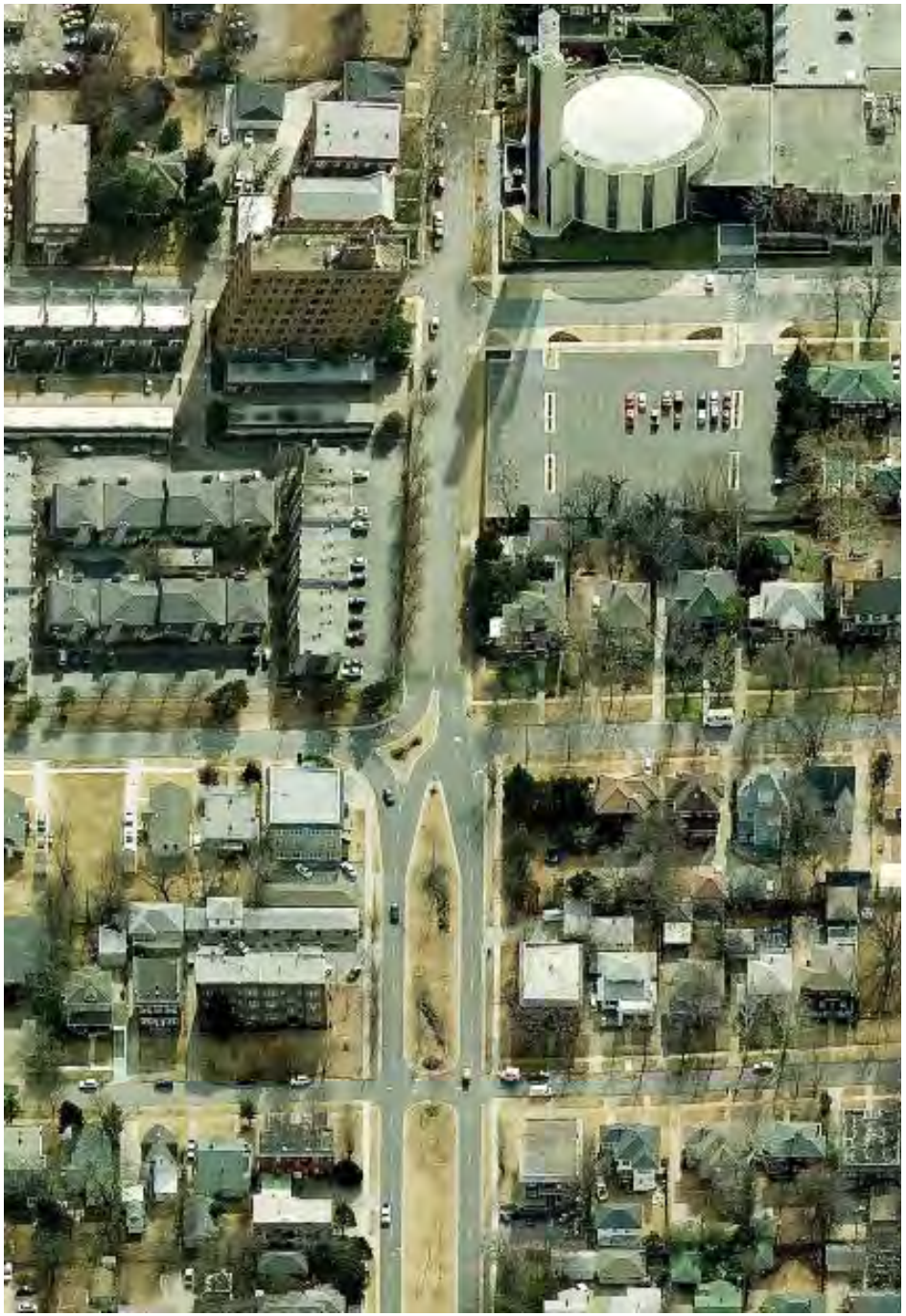
DOWNTOWN | Good LUDI Score/Good Pedestrian Infrastructure and Connectivity



PUD SUBDIVISION | Poor LUDI Score/Poor Pedestrian Infrastructure and Lack of Connectivity

connectokc

transportation

OVERVIEW

The purpose of this section of the HIA is to analyze existing transportation networks in the city, as well as what the benefits of active transportation (any human-powered transportation - walking, cycling, using a wheelchair, skating, skateboarding, etc.) would mean for Oklahoma City. This element focuses on the implications of vehicle- miles traveled (VMT), commute time, modal share, collisions, and transportation expenditures, and what the impacts of the three development scenarios will have on these indicators.

HEALTH INDICATORS

Oklahoma City is well-known to be a "car city". Decades of development that stretches great distances from the core urban areas of the city have been enabled by a virtually endless street grid that primarily serves motor vehicles. Sidewalks were largely deemed unnecessary, resulting in a perforated network of pedestrian infrastructure; this has discouraged walking implicitly as roads without sidewalk are more dangerous and much less accessible to anyone who is not driving. Because of this great reliance on motor vehicles, Oklahoma City suffers from air quality issues. Additionally, obesity rates in the city may be influenced by the low numbers of people who take advantage of or have access to active transportation. The following indicators were analyzed in order to determine how different land use patterns would affect the transportation choices people have, and what the benefits or drawbacks of these conditions might be.

C.1 Average Vehicle-Miles Traveled (VMT)

C.2 Average Commute by ZIP Code

C.3 Commute Mode Share (Transit, Cycling, Walking)

C.4 Ratio of Street Miles and Access to Public Transit, Bicycle and Pedestrian Facilities

C.5 Number and Rate of Bicycle and Pedestrian Injury Collisions

C.6 Proportion of Income Spent on Transportation

HEALTH IMPLICATIONS

- VMT is directly correlated to the proliferation of air pollutants such as ozone and particulate matter. This leads to increased rates of respiratory and cardiovascular diseases[vi].
- VMT is directly correlated to greenhouse gas emissions that contribute to global warming, leading to extreme weather events, an increase in heat-related death, and increases in vector, rodent, and airborne disease[viii].
- High rates of VMT indicate more people are driving and that there is a greater risk for debilitating or fatal vehicle collisions[ix].
- Higher rates of VMT correlate with lower amounts of physical activity, which increases the risk of obesity and diabetes[x].
- The more reliant people are on motor vehicles, the greater the percentage of household income used for transportation costs, making healthy choices and healthcare less affordable[xi].
- Long commutes can have negative impacts on social interaction and mental well-being, increasing risk for high blood pressure, cardiovascular risk factors and premature death[xii].
- A large percentage of drivers consider rush hour the most stressful part of their day, leading to irritability, back or neck pain, and depression[xiii].
- Using public transit increases individuals' physical activity levels, reducing the risks for obesity, cardiovascular disease, diabetes, degraded bone health, cancer, and depression[xiv].
- Motor vehicles cause noise pollution that degrades the quality of sleep people get at night, and increase levels of mental stress during the day[xv].
- A more balanced ratio of transportation modes provides a safer environment for pedestrians and bicyclists, who are especially susceptible to life-altering injury in the event of a collision[xvi].

EXISTING CONDITIONS

Average Vehicle Miles Traveled

The daily VMT in the Oklahoma City Area Regional Transportation Study Area (OCARTS) is rough 36.8 million miles. The per capita VMT per year is 11,019 miles per year per person.

Average Commute by ZIP Code

The average commute time in Oklahoma City is 22.6 minutes. This includes ZIP codes in surrounding cities (Moore, Norman, Yukon, El Reno, etc.).

Commute Mode Share (Transit, Bicycling, Walking)

Regarding modal share, 96.63% of trips are made by motor vehicle, while 2.13% are by walking, 0.45% are by bicycle, and 0.78% are by transit.

Ratio of Street Miles to Public Transit, Cycle and Pedestrian Facilities

There are 4,811.63 miles of road (14,000 lane miles) in Oklahoma City. There are 1,368 miles of sidewalk; a 1/3.52 ratio. There are 324.5 miles of transit routes; a 1/14.83 ratio. There are 95 miles of on-street bicycle facilities; a 1/50.65 ratio.

Number and Rate of Bicycle and Pedestrian Injury Collisions

There were 1,401 pedestrian collisions between 2003 and 2013, 100 of which ended in a pedestrian fatality. 94% of these fatalities occurred on roads with speed limits above 30 miles per hour. Pedestrians are twice as likely to be fatally injured on streets without sidewalks. There were 607 cyclist collisions between 2003 and 2013, 7 of which resulted in a fatality. Nearly two-thirds of the collisions occurred on streets with speed limits above 30 miles per hour.

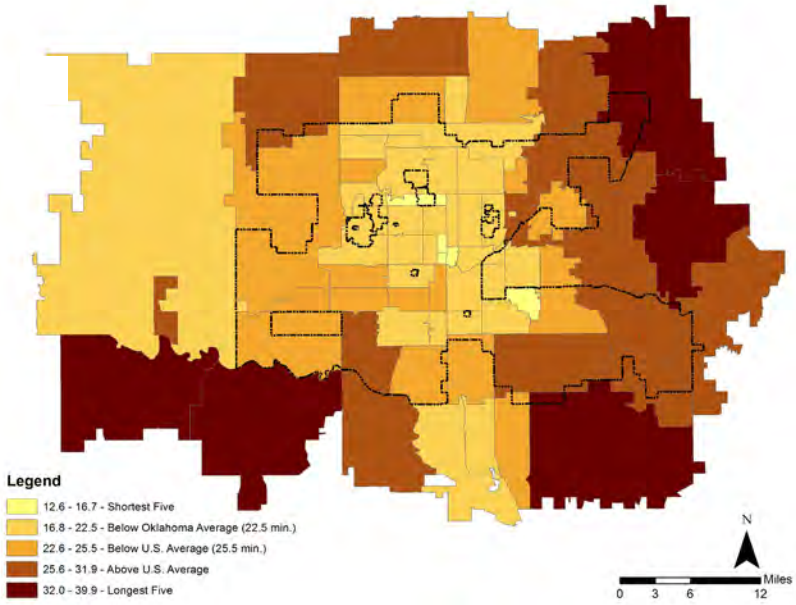


FIGURE 3: This map shows the average commute time by ZIP code relative to State and National levels

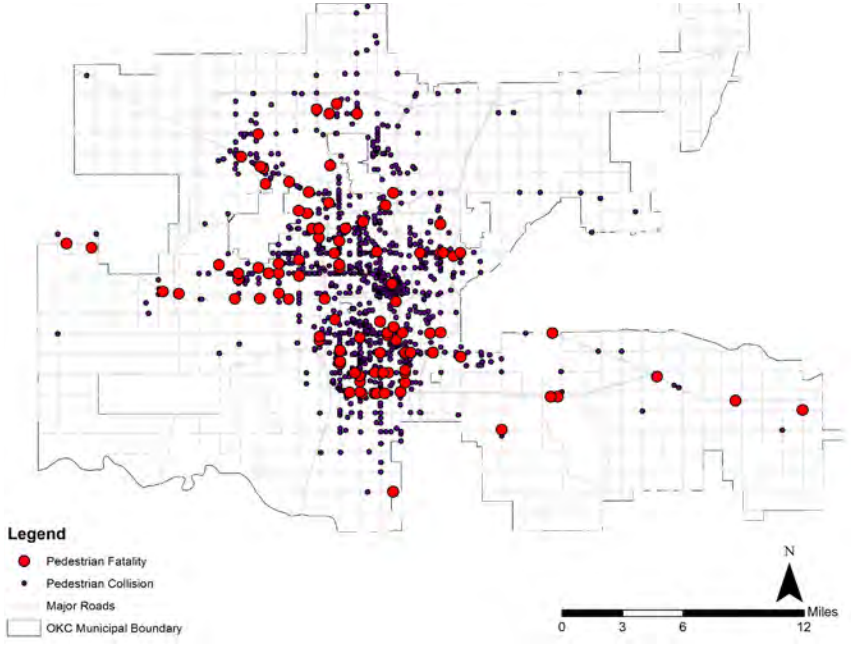


FIGURE 4: This map shows vehicle/pedestrian collisions and fatalities (2003 to 2013)

Proportion of Average Income Spent on Transportation

The average household in Oklahoma City spends 29.41% of its income on transportation. For every dollar spent on housing, this household would spend $1.30 on transportation costs.

SUMMARY OF FINDINGS

In order to improve health conditions related to transportation, steps need to be taken to allow people to be less dependent upon motor vehicles. Strategically investing in pedestrian and bicycle infrastructure, as well as public transit, coupled with regulations related to parking, pedestrian behavior, and mixed use, can help to increase levels of active transportation in Oklahoma City. The more compact the development pattern is, the more reasonable it is to depend upon active transportation; therefore, **Scenario C is the best option to reduce VMT, commute time, and the overall dependence upon motor vehicles in Oklahoma City.**

COMPARISON OF SCENARIOS

The analysis of the three scenarios provided the following conclusions:

Scenario A

Health would improve in Scenario A due to positive changes in the following:

- Total vehicular fatal collisions per capita would decrease.

Health would stay the same in Scenario A due to no change in the following:

- Average commute time would stay the same as in existing conditions.

Health would decline in Scenario A due to negative changes in the following:

- Total and per-capita VMT would increase, 56.7% and 1.9% respectively.
- The percentage of trips made by walking, cycling, and transit would all decrease, while motor vehicle trips increases. Less active transportation suggests that physical activity levels would decrease.
- The average length of a vehicle trip increases 0.4 miles. This multiplied by all the drivers in the city would add a great deal of air pollution as well as wear-and-tear to the streets.
- 12.9% less of the population would live within ½-mile of a transit route.
- 10.8% less of the population would live on streets with sidewalks.
- 2% less of the population would live on streets with bike infrastructure.
- Total vehicle collisions per capita would increase.
    - Total injury collisions would increase.
    - Pedestrian and cyclist collisions would likely be more severe due to higher vehicular speeds and longer distances traveled.
- There would be a 3.7% increase in the average amount of money spent on transportation, which would bring the average percentage of total income spent on transportation up to 30.5%.

Scenario B:

Health would improve in Scenario B due to positive changes in the following:

- Average commute time would decrease by 2.3%.
- VMT per capita would decrease by 5%.
- The percentage of trips made by walking, cycling, and transit would all increase, while the share of motor vehicle trips decreases.
- The average length of a vehicle trip decreases by 5.3%.
- Total vehicular fatal collisions per capita would decrease.
- There would be a 1.9% decrease in the average amount of money spent on transportation, which would bring the average percentage of total income spent on transportation down to 28.9%.

Health would stay the same in Scenario B due to no change in the following:

- Injury vehicle collisions per capita would stay the same.
- Pedestrian and bicycle collisions may occur more frequently, but at the same severity of existing conditions.

Health would decline in Scenario B due to negative changes in the following:

- Total VMT would increase by 46%.
- 9% less of the population would be within ½-mile of a transit route.
- 8.2% less of the population would live on streets with existing sidewalks.
- Total vehicle collisions per capita would increase.
- 0.9% less of the population would live on streets with bike infrastructure.

Scenario C

Health would improve in Scenario C due to positive changes in the following:

- VMT per capita would decrease by 12.8%
- Average Commute time would decrease by 3.71%.
- The percentage of trips made by walking, cycling, and transit would all increase, while the share of motor vehicle trips decreases.
- The average length of a vehicle trip decreases by 14%.
- Pedestrian and cyclist collisions would occur most frequently due to higher modal share; however, these crashes would likely be the least severe of the three scenarios, and an improvement upon existing conditions.
- There would be a 7.3% decrease in the average amount of money spent on transportation, which would bring the average percentage of total income spent on transportation down to 27.2%.

Health would stay the same in Scenario C due to no change in the following:

- There would be no change in the percentage of the population living on streets with existing bicycle infrastructure.

Health would decline in Scenario C due to negative changes in the following:

- Total VMT would increase by 33.8%.
- 3% less of the population would be within ½-mile of a transit route.
- 4.1% less of the population would live on streets with existing sidewalks.

HEALTH-PROMOTING RECOMMENDATIONS

Bolster public transportation services to reduce personal vehicle usage:

- Conduct studies and marketing to bolster the reputation and overall perception of public transit to overcome misconceptions of danger and unreliable service.
- Increase funding for public transit.
    - Implement Sunday service.
    - Extend hours later into the evening.
- Increase paratransit services into non-urban areas to extend further than the present ¾-mile buffer from a fixed transit route.
- Support the development of a regional transit authority (RTA).
- Consider a variety of vehicle sizes to be as efficient as possible.
- Develop standards for transit shelter amenities (seating, schedules, etc.) tailored to local conditions/resources.
- Support a tax-funding source for public transit.
- Partner with ACOG and nearby municipalities to increase transit service to all surrounding areas.

Improve pedestrian and bicycle infrastructure and connectivity:

- Improve connectivity throughout the city for all modes of transportation, particularly amongst neighborhoods and subdivisions, as well as between residential and other (retail, commercial, etc.) uses.
- Increase the rate of sidewalk and bike lane improvements.
- Incorporate concepts from Complete Streets into standard road construction practice.
    - Resurfacing projects should include restriping to include bike lanes.
- Utilize traffic-calming measures along urban streets that are the most useful for pedestrian and cyclist traffic.
    - Prioritize roads and corridors that provide the greatest access via sidewalks and bike routes to the greatest amount of uses.
    - Offset high-traffic motor vehicle routes from major pedestrian and cyclist routes.
- Reduce speed limits and design street speed capacity to a maximum of 25 miles per hour along all street types that are deemed a priority for pedestrian and bicyclist routes.
- Improve signage of pedestrian and bike facilities to bring awareness to drivers, riders, and walkers.
- Update the ordinances related to pedestrian crossings to increase the amount of time given to cross intersections before full liability is leveraged upon the pedestrian. (Ord. § 32-66)
    - Give pedestrians a head start when the lights change.
- Develop streetscape standards that emphasize pedestrian and bike safety (lighting, trees, and traffic calming measures).
- Develop building design standards and revise zoning codes to emphasize pedestrian/bike safety, especially on key pedestrian, bike and transit corridors.

Facilitate transit-oriented design districts, and efficient growth:

- Create zoning regulations such that transit-oriented design (TOD) districts are more easily established and incentivized.
- Explore creating TOD nodes of development with incentives for businesses to locate there, including connectivity for all modes of transportation.
- Develop transit-oriented streetscape and building design standards for key transit nodes and corridors.

- Encourage development to occur within existing developed areas to ensure commute times are not substantially increased.
- Evaluate parking requirements for new developments to find ways to lower the required amounts.
- Unbundle cost of parking from housing units, freeing up parking to become profitable for the owner.
- Control urban sprawl to lessen the percentage of the population that lives at a distance from land uses they utilize.
    - Incentivize inclusionary zoning to ensure an equitable housing mix.

Encourage employer-sponsored programs that reduce motor vehicle usage:

- Incentivize Transportation Demand Management programs among large private sector and public sector employers.
- Improve amount and awareness of employer-based incentives for taking transit, including programs to purchase transit from before-tax income and employer-subsidized public transportation.
- Incentivize private and public-sector employers to allow some employees to work remotely.
- Incentivize and increase carpooling. For example, building upon ACOG's Central OK GO program.
- Re-evaluate regulation on businesses being run from a residence allowing more people to work from home.

Create education campaigns to explain benefits of active transportation:

- Promote alternative transportation options with an acknowledgement of the cost savings afforded to those who drive less or choose to go car-less.
- Improve the perception of safety for transit, cycling, and pedestrian transportation.
- Implement educational programming for residents regarding walking/ safe routes to work and schools.

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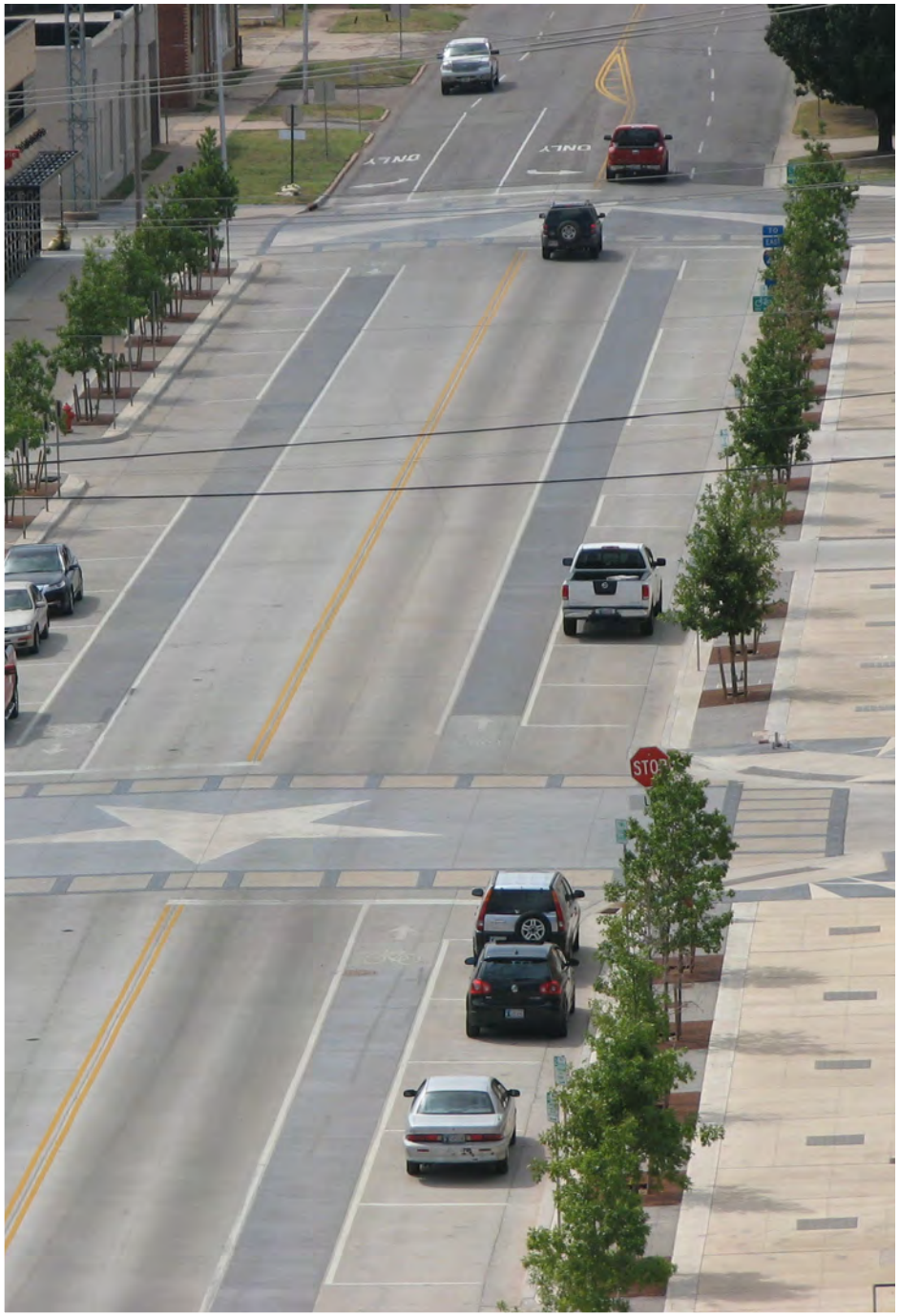
FILM ROW | Sidewalks, Bike Lanes, Parking, Street Trees



NW EXPRESSWAY | ~~Sidewalks, Bike Lanes, Parking, Street Trees~~

greenokc
environmental & natural resources

OVERVIEW

greenokc is the environmental and natural resources element of planokc. The purpose of this section of the HIA is to assess the impacts of development on farmland, air and water quality, energy use, biological systems, as well as individual and public health. Focusing on prioritizing valuable natural resources and green infrastructure will result in a healthy environment that is consolidated, not fragmented, and self-sustaining. Likewise, prioritizing air quality, water quality, and energy efficiency will result in a healthier population.

HEALTH INDICATORS

For quite some time there have been legitimate concerns regarding water and air quality in Oklahoma City. Continued suburban development into rural areas has degraded potential farmland and brought about a great deal of impervious surface and vehicular traffic. Additionally, the proliferation of intensive land uses, such as oil and gas wells, puts natural features, natural resources, and other environmental conditions at risk, as well as personal health. The following indicators were analyzed to determine what different development patterns would mean for environmental and personal health:

G.1 Proportion of Land with Potential for Farming Uses

G.2 Total Impervious Areas

G.3 Air Quality Conditions

G.4 Urban Heat Island Effect

G.5 Water Quality (Groundwater and Water Bodies)

G.6 Average Residential Energy Usage

G.7 Light and Noise Pollution

G.8 Residential Proximity to Oil/Gas Wells and Industrial Sites

HEALTH IMPLICATIONS

- Fresh local foods provide higher nutrient value; increased availability of locally grown, fresh produce may encourage healthier choices than if the local option was not offered[xvi].
- Environmental noise pollution can lead to hearing impairments[xvii].
- Lakes, rivers, and wetlands can be adversely affected by air pollution, specifically nitrogen oxide produced during acid rain[xviii].
- Smog, which contains nitrogen oxide and carbon monoxide, can lead to impaired lung function, particularly amongst children and those with respiratory problems[xix].
- Urban heat-island effect can increase the risk of heat-related death[xx].
- A significant percentage of CO2 emissions are a result of residential energy usage[xxi].
- Oilfield operations can lead to air-borne and water-borne disease, noise pollution, and loss of green space for recreational physical activity[xxii].
- Air-borne dust and particles from oil and gas well sites and industrial land uses can cause or exacerbate asthma and reactive airway syndrome of downwind residents. This may include hydrogen sulfide, which also has the potential to cause neurological damage at concentrationas as low as 1 part per million[xxiii].
- Contaminated run-off from oil and gas wells, industrial sites, and transportation can degrade the quality of surface and sub-surfaces waters, which can spread to other waterways[xxiv].

EXISTING CONDITIONS

Proportion of Land with Potential for Farming Uses

There is 152,546 acres of potentially farmable land in the city. 51,505 acres are usable prime farmland, while 46,733 acres are usable non-prime farmland. The remaining 54,308 acres are within the flood plain, forested, or impervious.

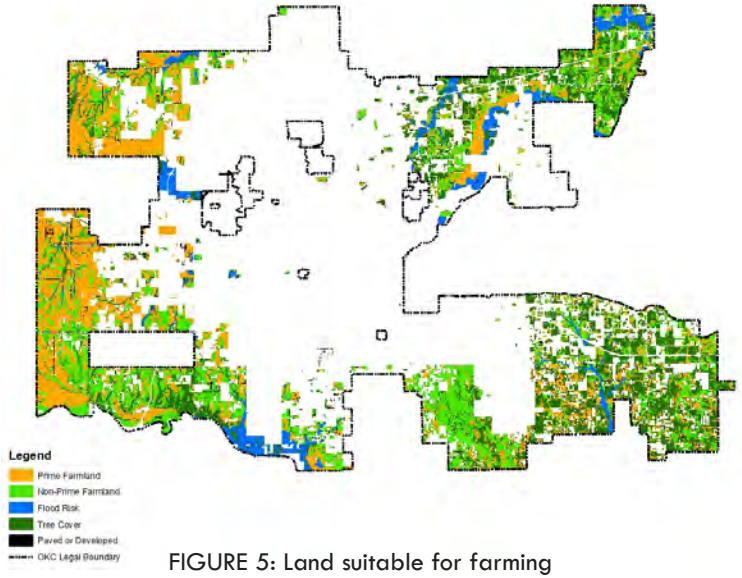


FIGURE 5: Land suitable for farming

Total Impervious Area

15.6% of the total area of the city is impervious. In the urbanized area the TIA is 35.6%, and in the rural areas the TIA is 4.6%. Buildings account for 33.1% of TIA in the urbanized area; parking lots account for 30.7%. Roads account for 22.7%; the rest is made up of sidewalks, driveways, and other miscellaneous slabs.

Air Quality Conditions

An average of 4.24 metric tons of vehicular emissions (VOCs, CO, CO2, NOx, PM10, PM2.5, and SOx) is released each day in Oklahoma City. More than 125,000 people live within a potentially dangerous distance (1,500') of a major highway, as well as 28 schools (19 elementary, 14 middle, and 11 high schools). More than 50,000 people live within a verifiably dangerous distance (500') of a major highway, as well as 8 schools (7 elementary, 2 middle, and 1 high school).

Urban Heat Island Effect

With more impervious surfaces in the urbanized area of the city and greater amounts of suburban development into formerly rural areas, there is a 3.6°F higher temperature overnight in the urban area, and a 2.7°F higher temperature overnight in suburban areas when compared to surrounding rural areas.

Water Quality (Groundwater and Water Bodies)

Roughly 70% of major water bodies in Oklahoma City are impaired due to high levels of phosphorus and nitrogen. There are potentially between 2,000 and 8,000 failed septic systems in Oklahoma City based upon a DEQ study*. 16 of the 40 sub-watersheds in Oklahoma City are above 10% impervious surface, which indicates likely ecological damage.

Average Residential Energy Usage

The average Oklahoma household uses 210 million BTUs of energy per year on residential uses, and 168 million in transportation uses.

Light and Noise Pollution

The City's light pollution scores between a Class 4.5 and Class 8 on the Bortle Dark-Sky Scale; south of I-44 and north of I-240 between Lake Overholser and Midwest City has the worst light pollution, scoring a Class 8. | There is no data for noise pollution in Oklahoma City, but due to the high reliance upon motor vehicles, and the fact that motor vehicles account for the majority of noise pollution, it's fair to assume a high potential for noise pollution presently.

Oil/Gas Wells and Industrial Sites in Proximity to Residential Property

Of the 1,403 oil and gas wells in the city, 970 are within ¼-mile of a residential parcel, affecting more than 126,000 individuals, or 20% of the total population. Roughly half of the total population lives within ½-mile of an oil or gas well, and 80% live within 1 mile. Adding industrial sites increases the percentage of people within ¼-mile of these sites to nearly 25%, within ½-mile to more than 55%, and within 1 mile to almost 90% of the total population.

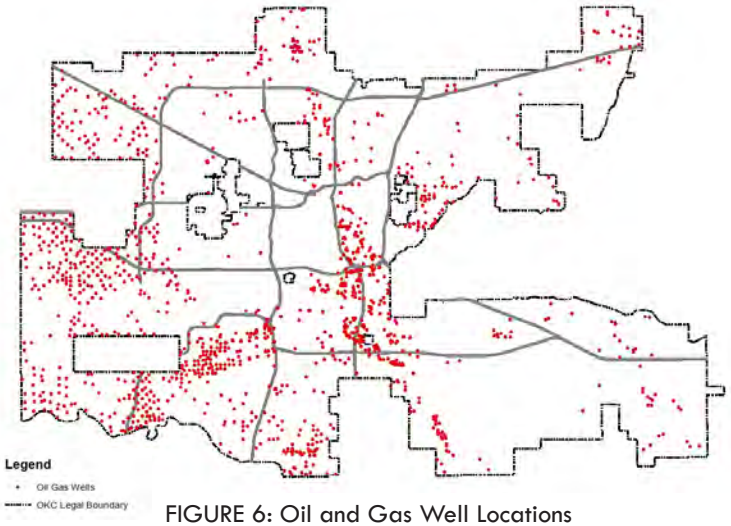


FIGURE 6: Oil and Gas Well Locations

SUMMARY OF FINDINGS

With an anticipated increase in population of nearly 50% it is all but a guarantee that negative impacts upon the natural environment will increase. Greenfield development, increased numbers of vehicles, and new impervious surfaces will have a negative impact on air quality, water quality, soil quality, noise and light pollution levels, as well as natural habitats and landscapes. One role of the comprehensive plan should be to mitigate or offset these impacts **Thusly, Scenario C is the best option to ensure the greatest level of consideration is given to mitigate the environmental risks associated with development.**

COMPARISON OF SCENARIOS

The analysis of the three scenarios provided the following conclusions:

Scenario A

Health would improve in Scenario A due to positive changes in the following:

- There would be a 2.9% decrease in the total population living within 500' of a major highway, and a 4.4% decrease in the total population living within 1,500' of a major highway.

Health would decline in Scenario A due to negative changes in the following:

- 69% of potential farmland would be lost to development.
- Impervious area would grow by 38.9% to cover 21.7% of the total city.
- Total vehicle emissions would increase by 56.7% to 6.64 daily metric tons.
- Rates of deforestation would likely increase.
- There would be a 135.6% increase in the number of septic systems in the city, increasing water quality risks associated with septic failures.
- Four new sub-watersheds would be above 10% total impervious area.
- Noise pollution levels would increase due to increased reliance upon motor vehicles, which make up the majority of noise pollution culprits.
- A greater number of households will live in proximity to oil and gas wells and industrial sites.

Scenario B

Health would improve in Scenario B due to positive changes in the following:

- There would be a 2.5% decrease in the total population living within 500' of a major highway, and a 2.9% decrease in the total population living within 1,500' of a major highway.
- Noise pollution levels would likely decrease due to a modal share that favors motor vehicles less.

Health would stay the same in Scenario B due to no change in the following:

- Rates of deforestation would likely stay the same.

Health would decline in Scenario B due to negative changes in the following:

- 48% of potential farmland would be lost to development.
- Impervious area would grow by 29.2% to cover 20.2% of the total city.
- Total vehicle emissions would increase by 46% to 6.19 daily metric tons.
- There would be a 62.6% increase in the number of septic systems in the city, increasing water quality risks associated with septic failures.
- One new sub-watershed is at risk of entering into a hazardous level of total impervious area.
- A greater number of households will live in proximity to oil and gas wells and industrial sites.

Scenario C

Health would improve in Scenario C due to positive changes in the following:

- There would be a 2.8% decrease in the total population living within 500' of a major highway, and a 3.6% decrease in the total population living within 1,500' of a major highway.
- Deforestation would likely occur at a lower rate than current conditions.
- Noise pollution levels would likely decrease due to a modal share that favors motor vehicles less.

Health would decline in Scenario C due to negative changes in the following:

- 18.9% of potential farmland would be lost to development.
- Impervious area would grow by 22.5% to cover 19.1% of the total city.
- Total vehicle emissions would increase by 33.8% to 5.67 daily metric tons.
- There would be a 24.2% increase in the number of septic systems in the city, increasing water quality risks associated with septic failures.
- One new sub-watershed is at risk of entering into a hazardous level of total impervious area.
- A greater number of households will live in proximity to oil and gas wells and industrial sites.

HEALTH-PROMOTING RECOMMENDATIONS

Preserve and promote preservation of land suitable for farming uses:

- Incentivize the food production cycle for local producers, distributors and consumers.
    - Provide tax rebates for producers that sell a specified proportion of their yields in local markets.
- Utilize zoning and land use designations to protect farm land from development.
    - Restrict the allowed development uses such that they correspond with agricultural uses. Such uses should be limited in size and clustered to minimize disturbance to agricultural production.
    - Place a high priority on land that is usable and considered prime farmland and a protective constraint against land that is forested or in the flood plain.
- Provide education to the public regarding the benefits of local farming.
- Consider a structure that allows landowners to sell development easements in order to maintain rural character, while allowing denser development in the urban area (Transfer of Development Rights).
- Consider a "Clean and Green Act" like Pennsylvania to tax farmland by its production potential rather than its market rate land value.
- Improve access to healthy local foods by improving community gardens and incentivizing grocery stores and convenience stores to sell fresh local produce.

Mitigate the effect of and limit the amount of total impervious area (TIA):

- Create incentives that transition to regulation for the control of run-off requiring pervious pavers and unpaved areas in development standards.
- Build more densely in order to require fewer new roads and parking lots, which typically increase rates of TIA.
- Limit TIA in each sub-watershed. Protect non-impaired sub-watersheds.
- Incentivize green roofs and rainwater collection processes to mitigate the threats of excessive run-off.
- Implement policies that decrease or remove parking requirements in non-urban areas.
- Encourage the construction of parking garages to limit the amount of ground surface used for parking.
- Enhance the tree canopy and other vegetation over impervious surfaces to help reduce run-off.

Support energy efficiency and alternative energy:

- Engage the Corporation Commission to ensure that additional fees and costs for residential renewable energy operations are warranted. Make sure customers are paid retail rates of net metering on site.
- Encourage attached single-family and multi-family residential developments.
- Mandate the disclosure of energy use/cost accounting to maintain an active energy management plan.
- Promote energy efficiency in single-family residential properties through education programming, funded by a revolving loan to ensure long-term guidance and support.
- Encourage development that abides by standards such as Energy Star, including active monitoring.
    - Implement and enforce IECC2009 for all new development.
- Explore technologies of, and incentivize the use of wind, photovoltaics, and other renewable energies for residential and commercial uses.
- Lead by example; establish benchmarks and set goals to decrease the City's energy usage each year.
- Use education programs to solidify the connection between water consumption and energy usage by incentivizing efficient water features.
    - Encourage the use of efficient fixtures indoor and outdoor.

Improve air quality:

Vehicles and Industry

- Implement policies such as Complete Streets that enable people to use all modes of transportation.
- Continue the transition of City fleets to alternative fuels. Set benchmarks and goals for the reduction of dependency on diesel and unleaded gasoline reported in Leading for Results (LFR).
- Encourage industrial technologies that emit lower levels of harmful chemicals into the air.
- Establish special development and building standards for development built within a dangerous distance of major highways.
    - Conduct studies to establish buffer distances.
    - Include more rigorous safety and filtration standards for HVAC systems for homes, commercial, retail, etc. within these areas.
    - Disallow the construction of any schools, parks, places for outdoor activities, or places targeted toward children within a dangerous buffer of major highways.
    - Require the monitoring of indoor air quality conditions.
- Incentivize fuel-efficient vehicles and lower-emitting alternative fuels.
- Create a street-tree planting program focusing on creating barriers between areas of industry and high-use transportation corridors from residential and related uses.
- Utilize EECBG standards; institute a recurring review
    - Quantify greenhouse gas and other emissions, both existing and projected over a specified time period, resulting from activities within a defined geographic area.
    - Identify and analyze the emissions resulting from specific actions or categories of actions anticipated within the geographic area.
- Create standards for generator emissions and incentivize cleaner models
- Synchronize traffic signals to improve traffic flow and minimize traffic congestion. Expand Intelligent Traffic Systems (ITS).
- Improve public transit service to reduce vehicle traffic and increase public transit mode share during peak traffic congestion periods.
- Improve bicycle and pedestrian infrastructure to reduce vehicle traffic and increase bicycle and pedestrian mode share during peak traffic congestion periods.
- Adjust pedestrian crosswalk signal timing to minimize waiting time for vehicles turning right or otherwise sharing green light time with pedestrians. Give pedestrians a head start before traffic signal turns green.
- Limit heavy-duty truck traffic during peak hours. Designate truck routes that divert truck traffic away from congested intersections.
- Limit vehicle maneuvers that add to congestion during peak hours.

Construction

- Monitor and enforce compliance with best practices in construction to reduce the amount of residual dust and other air contaminants.
    - Ensure and enforce that all haul trucks transporting soil, sand, or other loose material off-site are covered.
    - Limit all vehicle speeds on unpaved roads to 15 mph.
    - Ensure that clear signage is provided for construction workers at all access points.
    - Ensure that all construction equipment is maintained and properly tuned, and checked by a certified mechanic prior to operation.

Reduce urban heat-island effect (UHIE):

- Increase efforts to plant street trees and other vegetative elements in and around areas with high rates of impervious surfaces (shade trees, green walls, etc.).

- Incentivize the use of green roofs and cool roofs in all areas and land uses within Oklahoma City.
- Promote the use of reflective and permeable pavement materials.
    - Host workshops to explain installation, benefits, etc.
- Reduce vehicle emissions by investing in alternative transportation.
- Encourage community involvement in volunteer efforts, including demonstration projects, urban forestry programs, outreach and education programs, and awards.

Improve and protect water quality:

- Control nonpoint source (NPS) pollution:
    - Continue to promote responsible fertilizer use.
    - Encourage the use of dedicated car-wash facilities and educate why vehicles should be washed on pervious surfaces, and the use of environmentally-friendly cleaning supplies.
    - Continue to promote the usage of rain barrels.
    - Promote the usage of native plant species in landscaping as they have adapted to use reasonable amounts of water.
    - Enforce farming and construction run-off regulation.
    - Incentivize low-impact design features in development, such as pervious pavement, rain gardens, etc.
    - Coordinate with local agencies to educate community members on recreational water quality through;
        - Media campaigns (expand reach of current campaigns).
        - Timely web updates on water conditions, preferably all recreational facilities reporting on one domain.
        - Public service announcements and television
        - commercials encouraging the use of lakes, rivers, and ponds for recreational uses.
- Establish a funding source for remediation and prevention of water body impairments.
- Conduct research at wastewater treatment plants to determine any needs to increase treatment requirements for substances not currently tested (excess nutrients, pharmaceuticals, etc.)
- Research the feasibility of a stormwater disposal rate on sewer bills. The fee could fund education, monitoring, and restoration efforts.
- Create a permitting program to keep track of septic properties; include a mechanism for enforcement. Test periodically.
- Create policies that mitigate the impacts of development on existing natural resources, such as wooded areas, habitat areas, and floodplains, riparian areas, and water quality.
    - Work with partners, such as the Environmental Protection Agency, Oklahoma Biological Survey, Oklahoma Department of Wildlife and Conservation, and Oklahoma Department of Environmental Quality to develop strategies and programs that protect and preserve environmentally sensitive areas, such as native prairie, cross timbers, wetlands, and riparian areas.
    - Require new development to maintain or decrease the site's predevelopment run-off rate.
    - Incentivize green infrastructure in new development in an effort to reduce flows into treatment systems.

Reduce light pollution:

- Replace light fixtures throughout the city with shielded directional fixtures like those implemented through Project 180.
    - Create a policy to require street and public space light design standards that mitigate the negative impacts of light pollution.
    - Update street lighting policy, and work with electricity providers to use more efficient fixtures.
- Increase education for residents to use efficient lighting and indoor motion sensors.
    - Potentially use this methodology for public parks and schools.
- Consider and research the positive and negative effects of the color temperature of light fixtures. Utilize the hue that has the least negative health consequences. (warm vs. cool)
- Set more stringent regulation on the size of illuminated signage and the times at which they may be illuminated.

Reduce noise pollution:

- Plant trees and other vegetative elements or other barriers around noisy transportation corridors.
- Limit large truck routes to avoid primarily residential areas.
- Enact legislation to limit the noise levels of motorcycles based upon speed limits or a fixed noise level; many states set the limit at 82 decibels This could include noise-limiting mufflers.
- Create a "Quiet Zone" along the active railroad tracks through the city.

- Require increased levels noise-mitigating strategies for land uses that produce a high level of noise, such as heavy industrial and oil/gas extraction sites.
- Require limitations on the auditory volume of generators.
- Educate the public regarding what is included in the nuisance code to better address noise, smell, vibration, property maintenance, panhandling, animal control, delivery hours limits, and other possible negative effects.

Regulate residential proximity of oil and gas wells and industrial sites:

- Sufficient barriers to noise and light pollution should be required at every active oil or gas wells, or industrial site to protect residential areas and natural habitats. Explore the use of temporary sound walls.
- Soil testing should happen frequently and be conducted by a government-approved third party to ensure that contamination is detected in a timely manner.
- Groundwater quality testing should be conducted within a buffer distance to be set by the Oklahoma Conservation Commission and Water Resources Board.
- Oil and gas well locations should not be built within a 300' linear buffer of residential uses, schools, or other locations of "public concourse", and should not be located within residential neighborhoods.
- Ensure new residential land developments will be appropriately located away from existing or proposed oil drilling locations.
- Air quality tests should be conducted frequently to ensure that pollution from oil and gas wells or industrial sites are within a standard to be set by ODEQ.
- Create impact fees for roads and potential environmental impacts for oil, gas, and industrial uses.
- Require a closed-loop system of material usage, whereby contaminated materials are not left on site or underground.
- Require the disclosure of injection contaminants, including proprietary and trade secret ingredients, to allow environmental review and impact assessment.

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REMINGTON PARK| Vast impervious parking lots

FEDERAL BUILDING | Pervious concrete, green space

liveokc communities

OVERVIEW

The purpose of this section of the HIA is to address public health and individual health as it is affected by the strengths and weaknesses of a community. Social, economic and infrastructure conditions can impact an individual's ability to access necessities like groceries, healthcare facilities or schools in their daily lives. Searching for solutions to issues of social and ethnic isolation, the negative effects of poverty, and inequitable access to goods and services has the potential to lead to strong, healthy, livable communities.

HEALTH INDICATORS

Strong communities are those that are not plagued by crime, have well-kept walkable neighborhoods, and have a diverse population with strong connectivity and access to the contextual surroundings of their neighborhood. When individuals are afraid to walk from their home to any other land use, a negative feedback loop of distrust and disengagement can cause a community to be weakened. The following indicators were assessed in order to explore the current conditions and what public health implications exist in terms of communities:

L.1 Proportion of Population with Access to Schools

L.2 Residential Density

L.3 Proportion of Population with Access to Healthy Groceries

L.4 Rate and Concentration of Gang Activity

L.5 Isolation Index of Vulnerable Populations

L.6 Proportion of Population with Access to a Healthcare Facilities

HEALTH IMPLICATIONS

- Overweight and obesity during childhood increase risks for adverse health conditions including type 2 diabetes, high cholesterol levels, cardiovascular issues, cancer, and musculoskeletal conditions[xxv xxvi].
- Walkability studies for elementary school children have found that walking to school is negatively affected by distance and positively affected by population density[xxvii xxviii].
    - Children who walk to school are more physically active than children who are driven[xxix].
- Active transportation to school incorporates physical activity into daily routines, reduces risk of childhood obesity, and alleviates automobile congestion and air and noise pollution from traffic[xxx xxxi].
- People in low-income neighborhoods have been found to have low access to fresh produce and often to rely on convenience stores for food[xxxii xxxiii].
- The diversity and proximity of retail food outlets influence health-relevant food shopping behaviors and dietary patterns[xxxiv].
- Food deserts have emerged as a critical public health issue, as a healthy diet is linked to reduced risk of heart disease, stroke, hypertension, type 2 diabetes, and certain cancers[xxxv].
- Urban sprawl has been implicated in the prevalence of high blood pressure, diabetes, and obesity[xxxvi].
- Negative social interactions between deprived and affluent groups have been shown to increase instances of discrimination and racism, which lead to increased stress. This stress influences suicide, depression, dementia, cognitive decline over the age of 65, and chronic disease[xxxvii].
- There are strong associations between gang activity and negative health and behavioral outcomes such as delinquency, criminal offending, gun use, substance abuse, domestic violence, and teen pregnancy[xxxviii].
- Increased distance and decreased access between residences and healthcare providers is correlated with lower healthcare utilization[xxxix].

EXISTING CONDITIONS

Proportion of Population within a 10-Minute Walk of Public Schools

In the urban area 50,636 households (22% of the total population) have access to 130 schools, while 550 households (2.9% of the total population) in rural areas have access to 12 schools; this gives a total of 20.5% of the total population with a 10-minute walk to a public school. This figure rises to 24.7% when public, private and charter schools are included.

Residential Density

Residential density for the entire city land area is 0.66 units per acre. For residential land only, the density is 3.31 units per acre. Residential areas make up 20% of the total land area of the city. ZIP code 73102 has the highest average density at 60.2 units per acre, while 74851 has the lowest with 0.26 units per acre.

Proportion of Population with Access to Healthy Groceries

38% of the total population lives within 1 mile of a grocery store. Only 8.1% live within a mile of two grocery stores or more. The average NEMS-S (Nutritional Environment Measures Survey – Supermarkets*) score for the city is 33.4. 16.8% of the population have access to a supermarket with a below-average score, 21.1% have access to one with an above-average score. 62.1% of the population does not live within 1 mile of a grocery store.

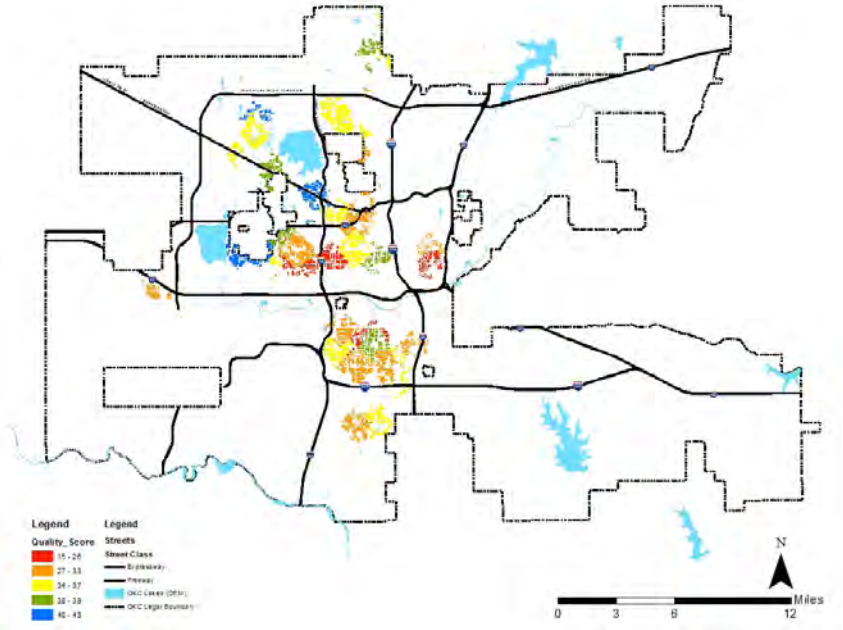

FIGURE 6: This map shows residential parcels within 1 mile of a grocery store and the NEMS-S score of each respective grocery store.

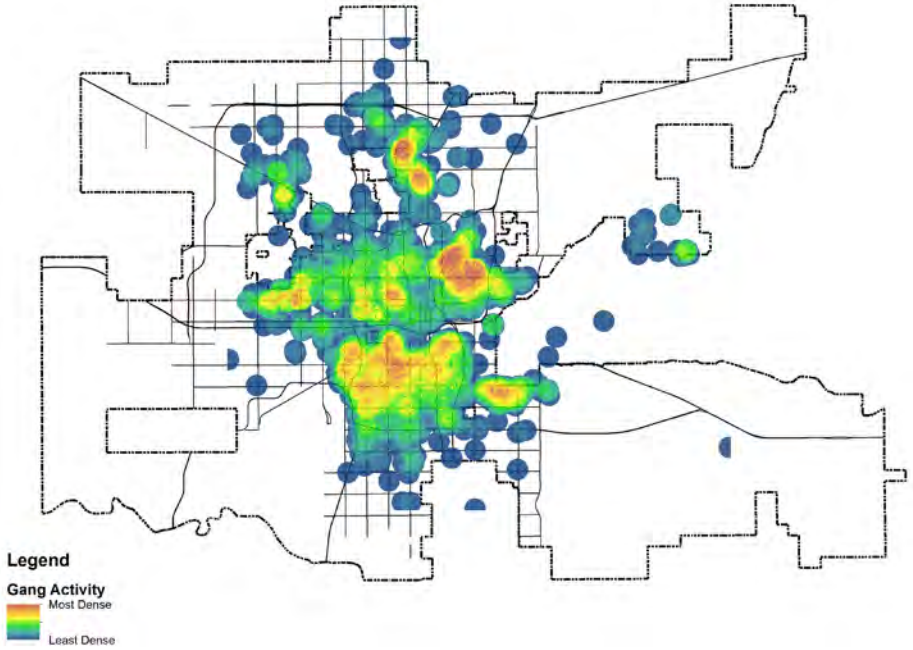

FIGURE 7: This heat map shows the frequency of the occurence of gang activity across the city.

Rate and Concentration of Gang Activity

In the last 6 years there has been an average of nearly 350 gang-related incidents records each year. Drive-by shootings are the most common offence. ZIP code 73111 has the highest total number of incidences (308) and the highest per-capita incidences (26.14).

Isolation Index of Vulnerable Populations

Asians and American Indians have the greatest isolation in the population. Blacks and Hispanics have isolation index scores that indicate clustering. Whites, being the racial majority, have the lowest isolation index score. ZIP code 73111 has high isolation indices for the elderly, the disabled and low-income households.

Proportion of the Population with Access to a Healthcare Facility

Roughly two thirds of the total population lives within 1 mile of a healthcare facility. ZIP code 73117 has the highest rate of healthcare facilities per 1,000 residents due to the OU Health Sciences Center complex. ZIP code 73134, the Quail Springs area, has the second highest rate of healthcare facilities per capita.

SUMMARY OF FINDINGS

Access to daily needs, public safety, and community cohesiveness all play a role in ensuring the public health of communities and individuals. **Scenario C improves access to daily uses from residential areas and decreases social isolation, making it the best scenario in regard to community health.**

COMPARISON OF SCENARIOS

The analysis of the three scenarios provided the following conclusions:

Scenario A

Health would decline in Scenario A due to negative changes in the following:

- There would be a decrease in the number of households and percentage of total households that live within a 10-minute walk of a school.
- A lower percentage of the population would live in close proximity to a grocery store, and a lower percentage would live in proximity to a grocery store with an above-average NEMS-S score.
- Residential density would decrease by 34.4%.
- Isolation based upon income levels would likely increase due to a homogenous trend toward large-lot single-family homes in the fringes of the city.
- There would be a 10% decrease of the population within 1 mile of a healthcare facility.

Scenario B

Health would stay the same in Scenario B due to no change in the following:

- The percentage of the population living in proximity to a grocery store would stay the same.

Health would decline in Scenario B due to negative changes in the following:

- There would be a decrease in the number of households and percentage of total households that live within a 10-minute walk of a school.
- The percentage of the population living in close proximity to a grocery store with an above-average NEMS-S score would decrease.
- Residential density would decrease by 20%.
- Isolation for vulnerable populations would likely increase (but not as much as in Scenario A).
- There would be a 6% decrease of the population within 1 mile of a healthcare facility.

Scenario C

Health would improve in Scenario C due to positive changes in the following:

- The total population within a 10-minute walk of a school would increase.
- The percentage of the population living in close proximity to a grocery store would increase. There would be a higher percentage of the population living in close proximity to an above-average NEMS-S scoring grocery store.
- Residential density would increase by 13.3%.
- Isolation based upon income levels would likely decrease because of a healthier mix of housing types and transportation options.
- There would be a 3.8% increase of the population within 1 mile of a healthcare facility.

Health would decline in Scenario C due to negative changes in the following:

- There would be a decrease in the percentage of total households that live within a 10-minute walk of a school.

HEALTH-PROMOTING RECOMMENDATIONS

Increase the number of people with walkable access to schools:

- Ensure all new large communities that are developed have a public elementary school by having developers pay a fee for the construction of a local school.
- Improve quality of Oklahoma City's urban school districts to encourage families to live nearer to city center rather than moving to the edge of the city or surrounding municipalities.
- Increase focus on improving sidewalk and bicycle infrastructure to and from schools.
- Establish a working relationship with all schools with recreation facilities to improve the use of joint-use agreements, which allow community members access to those facilities.
- Disallow the building of any new schools within a hazardous distance (to be determined through investigative studies) of a high-traffic road to mitigate the risks of childhood asthma as a result of high concentrations of airborne particulate matter.
- Retrofit schools within a hazardous distance of a high-traffic road with robust HVAC systems that will sufficiently filter incoming air.
- Make use of vegetation around outdoor recreation facilities to mitigate risks of airborne particulate matter.

Ensure appropriate residential density along the urban to rural scale:

- Create a development terminology "cheat sheet" from the glossary of the comprehensive plan for use at Commission and Council meetings.
- Encourage density levels based upon land-use typology designations in the comprehensive plan such that neighborhoods closer to the city center have higher density levels and rural residential densities are the lowest, ensuring that intensity and compatibility are well organized.
- Evaluate the cost and benefit of a Transfer of Development Rights (TDR) system, particularly as it affects undeveloped areas.
- Infill vacant lots to increase the efficiency of City services, access to transportation, schools, businesses, etc.

Increase the number of people with easy access to healthy foods:

- Provide incentives for grocery stores to sell affordable, quality produce. Prioritize areas that have low access, regardless of resident income levels.
- Compile results from all food access studies to use in a healthy food financing program.
- Support existing Healthy Food Awareness campaign that includes:
    - Strategies for selection and preparation of healthy food that is cost- and time-competitive with manufactured food.
    - A uniform curriculum associated with selecting and preparing nutritious food for use in schools, recreation centers, senior centers, technical/trade schools, farmers markets, etc.
    - Strategies to link training for unemployed people and welfare-to-work work programs with opportunities for living wage jobs in urban food-related businesses.
    - "Edible Schoolyards", a school-based program which integrates nutrition and gardening to raise awareness about the connection between healthy food choices and locally grown fresh produce.
    - Expansion of farm-to-school programs.
    - Farm-to-institution programs that offer healthy food choices to hospitals, universities, prisons, and businesses.
- Raise the level of public awareness and understanding of agriculture's ecological, economic, and cultural value, and its importance to local food security by the following actions:
    - Help raise awareness of start-up capital, credit, crop insurance, horticultural and financial advice, soil testing, markets, subsidies, tools, and inputs such as seeds and soil alterations.
    - Promote farms and gardens as a destination stop for tourists and visitors (farm tours, community garden crawl, etc.).
- Create a community garden program utilizing public property that can be contracted to local organizations.
- Provide support for the OCCHD mobile market.

Reduce gang violence:

- Explore police operations such as establishing a Crime-Free Multi-family Housing Program.
- Address neighborhood appearance standards by intensifying code enforcement in areas with chronic violations:
    - Implement stricter enforcement of property maintenance regulations and consider more significant penalties for violations.
    - Increase emphasis on the enforcement of littering laws. Impose fines against littering in a uniform and consistent manner to reinforce public perception that littering carries a definite risk.
    - Focus on environmental concerns such increasing emphasis on the enforcement of littering laws and removal of graffiti.
    - Immediately report and ensure expedient removal of graffiti visible from interstate highways and other important corridors.

- Build partnerships with organizations that programmatically intervene with at-risk youths to prevent gang association.
- Target clean-up and beautification projects in public parks, include litter and graffiti removal, improved signage and lighting.
- Standardize data recording terminology for gang-related crimes so that trends can be accurately measured and monitored.
- Find methods to cut down on recidivism, as well as to discourage gang activity within prisons. Employ positive reinforcement that does not put individuals at risk of violence from the larger gang community.

Decrease social isolation amongst vulnerable groups:

- Incentivize employers to encourage volunteering and voting.
- Increase the number of community centers (such as recreation centers, cultural centers, etc.), particularly in areas that are presently underserved.
    - Consider an impact fee or some similar funding mechanism.
- When certain types of new development (new schools, subdivisions, moderate to large businesses, etc.) locate into existing urban areas require a "community benefits package" to be realized in the form of events (festivals, block parties, concerts, etc.).
- Support programming for mentoring programs with a focus on reaching out to a diverse areas of the city.
- Support the organization of public events in all urban areas of the city.
- Create specialized districts for large cultural or ethnic groups to enhance the diversity and perceptions of the city.
- Study the supply of housing for special needs groups, such as the elderly and persons with disabilities, in locations convenient to transit, community facilities, daily needs, and appropriate support services.

Increase the number of people with easy access to a healthcare facility:

- Increase access to medical facilities by:
    - Increase transportation options to and from medical facilities.
    - Increase awareness of existing transportation options.
- Increase access to senior centers by:
    - Increasing awareness about existing senior centers.
    - Building more senior centers.
    - Increasing funding for senior centers.
    - Increasing transportation services for seniors.
- Include proximity to medical facilities as a criterion in evaluating residential projects and residential density.

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ZIP CODE 73102 | Residential Density: 60+ units per acre

ZIP CODE 73141 | Residential Density: 0.5 units per acre

enrichokc
preservation | appearance | culture

OVERVIEW

This section of the HIA focuses on Oklahoma City's identity through its built environment and cultural opportunities. The condition of neighborhoods related to the negative effects of vacant and abandoned properties, as well as Oklahoma City's cultural assets in the form of public art, sculpture and architecture, are addressed herein as they are strong indicators of community, social, and cultural health.

HEALTH INDICATORS

The appearance of the city is more than a superficial concept of what makes an area "pretty". The difference in a neighborhood plagued by vacant and abandoned buildings and one that is not impacts economics, social cohesion, safety, and aesthetics. Public art, cultural artifacts, landmarks, unique architecture, and the like all add character to an area contributing to a "sense of place" that induces economic and moral support from the surrounding community.

E.1 Number and Location of Vacant and Abandoned Buildings

E.2 Residential Proximity to Landmarks, Cultural Elements and Public Art

HEALTH IMPLICATIONS

- Vacant and abandoned buildings have a higher chance of catching fire, burning out of control, causing property damage and endangering lives[xl].
    - Fire and police response time is hindered due to the lack of an on-site responsible party[xli].
        - Fire, police, and animal services are disproportionately needed to address on-site issues at vacant and abandoned properties[xlii].
- Buildings left untouched for decades often have lead-based paints and other biological and chemical contaminants, which can lead to asthma and lead poisoning, particularly in children that live in neighborhoods with high concentrations of vacant and abandoned properties[xliii xliv].
- Vacant and abandoned buildings typically depress values of nearby properties[xlv].
- The arts is a significant economic generator for cities, bringing business to local transportation systems, eateries, museums, retail, and more[xlvi].
- Arts and culture programs provide jobs[xlvii].
- "Cultural tourism" is Oklahoma's third largest industry, bringing in more than $6 billion to the state[xlviii xlix].
- Art programs and activities help to decrease depression, anxiety, and post-traumatic stress disorder when used as a rehabilitative exercise[l li].

EXISTING CONDITIONS

Number and Location of Vacant and Abandoned Buildings

Results from the 2013 GSBS Richman Consulting study, Addressing Vacant and Abandoned Buildings in Oklahoma City, show that Ward 6 and Ward 7 have a higher than 9% long-term vacancy or abandonment rate, while Ward 2 and Ward 4 are around 5%. Ward 1, Ward 3, and Ward 8 are all below 3%. Census data shows that ZIP codes 73104, 73145, 73111, 73127, and 73134 have the highest *percentage* of any length of vacancy or abandonment in the city. 73127, 73072, 73112, 73071, and 73120 have the highest *total number* of vacant properties.

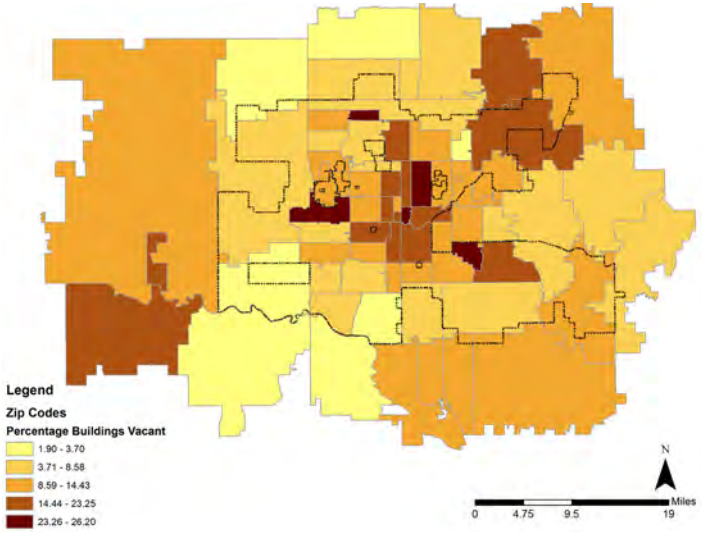

FIGURE 8: Percentage of buildings that are vacant or abandoned by ZIP code

Residential Proximity to Landmarks, Cultural Elements and Public Art

Only 7,300 households, or 3% of the population, live within a ¼-mile of a landmark, cultural element, or piece of public art. At a ½-mile distance this number increases to 27,412 households, or 11% of the total population. The majority of these households are located north of the river, primarily in the downtown area.

SUMMARY OF FINDINGS

Community appearance impacts individuals, businesses, neighborhoods, and the city as a whole. There are implications for economic strength, civic pride, community cohesion, as well as public health. **Scenario C does the best job of mitigating the negative impacts of vacant and abandoned buildings and integrates cultural elements, public art, and landmarks into the community.**

COMPARISON OF SCENARIOES

The analysis of the three scenarios provided the following conclusions:

Scenario A

Health would decline in Scenario A due to negative changes in the following:

- There would be an additional 9,209 vacant and abandoned properties covering 35 of the 63 ZIP codes in the city. ZIP codes 73127 and 73111, which currently suffer the ill effects of numerous vacant and abandoned properties, rank first and third respectively in the number of new vacant and abandoned homes. Conditions in these areas would further deteriorate.
- Because of the predominance of development in the suburban and exurban regions of the city, there is a decrease in the number and percentage of the population within ¼-mile and ½-mile of cultural elements, public art, or landmarks.

Scenario B

Health would stay the same in Scenario B due to no change in the following:

- Roughly the same percentage of the population would live within ¼-mile of a cultural element, public art, or landmark.

Health would decline in Scenario B due to negative changes in the following:

- There would be an additional 4,079 vacant and abandoned properties covering 26 of the 63 ZIP codes in the city. ZIP code 73127, which presently suffers from numerous vacant and abandoned properties, is in the top five for new VAB properties.
- A smaller percentage of the population would live within ½-mile of a cultural element, public art, or landmark.

Scenario C

Health would improve in Scenario C due to positive changes in the following:

- Rates of vacant and abandoned properties would drop in most areas of the city as redevelopment and revitalization are prevalent in Scenario C.
- A greater percentage of the population would live within ¼-mile of a cultural element, public art, or landmark.

Health would decline in Scenario C due to negative changes in the following:

- A smaller percentage of the population would live within ½-mile of a cultural element, public art, or landmark.

HEALTH-PROMOTING RECOMMENDATIONS

Mitigate the negative effects of existing vacant and abandoned properties:

- Increase educational outreach about how to report code violations.
- Create an educational program to illustrate the benefits related to rehabilitation and revitalization.
- Programmatically increase efforts to utilize vacant lots for community betterment efforts such as gardens and park space.
- Programmatically encourage neighborhood clean-up events.

Implement strategies to remediate the current vacant and abandoned property situation:

- Create incentives to encourage development of abandoned properties.
- Focus efforts in areas where the rates of VAB are the highest.
- Increase funding for rehabilitation, façade improvements, landscaping, and streetscaping.
    - Focus on lots that could be particularly productive.
    - Amenitize blighted neighborhoods.
- Develop and implement a self-sustaining program to address abandoned properties.
    - Enact penalties on VAB properties that are tax delinquent or have active, unresolved code enforcement cases.
- Work with financial institutions to develop positive financial incentives for productive re-use of vacant or abandoned properties.

Increase efforts to integrate cultural elements, public art, and landmarks into the urban context:

- Consider locations for donated public art in public spaces that are not in the downtown area.
- Continue efforts to create an "art walk" for residents and tourists. Expand program as needed into the future.
    - Consider the inclusion of audio tours and other creative experiential tours.

- Create and disseminate materials regarding public art at events and through social media.
- Explore opportunities and create a plan to encourage and commission neighborhood art projects.
- Locate public art in parks and along trails to encourage usage and physical activity.
- Encourage community art programs as ways to help build community among all different groups: schools, neighborhoods, veterans, City employees, businesses, convicts, the homeless, etc.
- Reclassify murals to be excluded from the sign code.
- Identify further funding sources for community arts programs.

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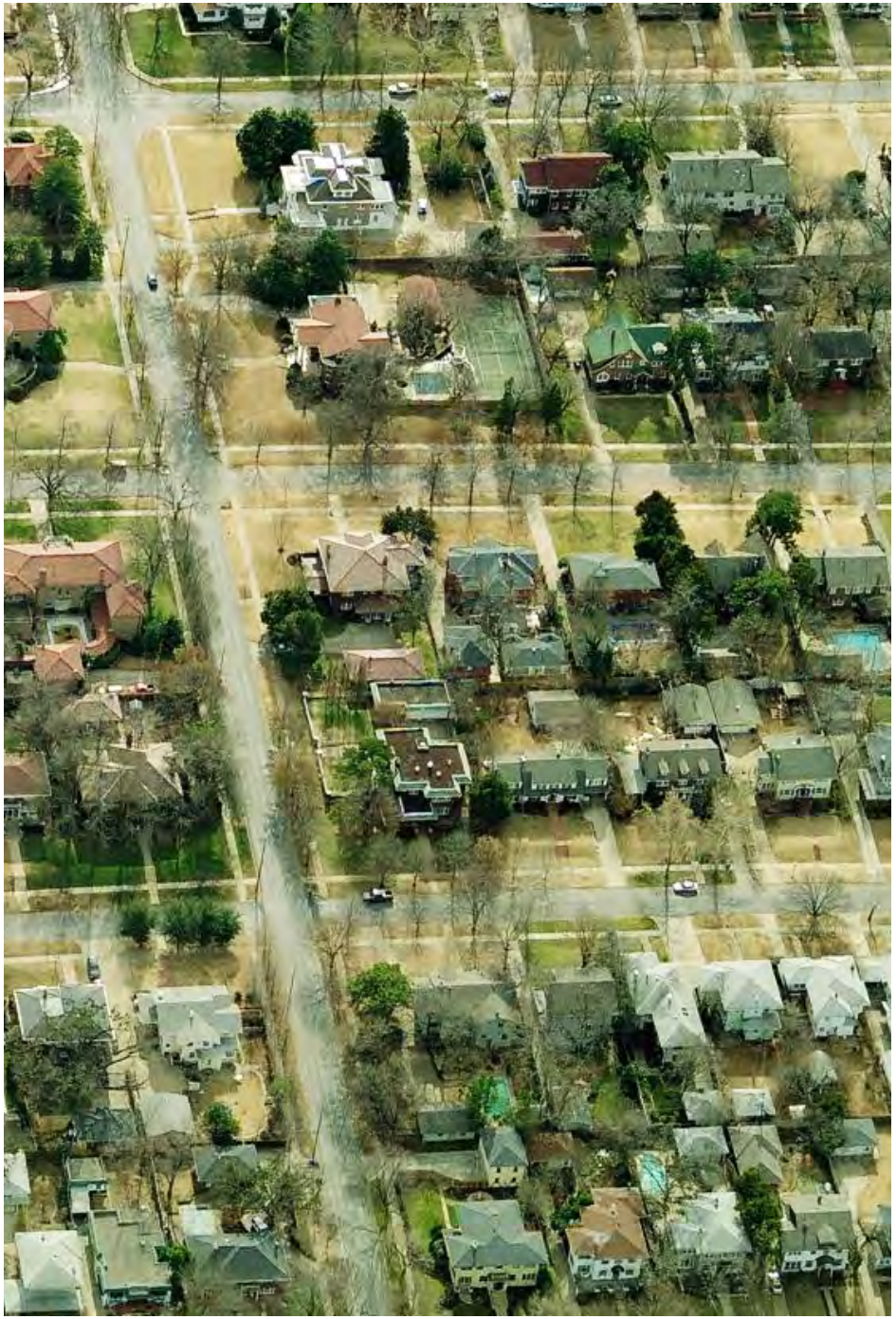
JFK NEIGHBORHOOD| 73104 - Highest VAB rate in the city (26.1%)



HERITAGE HILLS | 73103 - Low VAB neighborhood/average ZIP (13.6%)

playokc
parks & recreation

OVERVIEW

This section of the HIA encompasses public and private parks as well as the trails system throughout the city. The purpose of this section of the HIA is to identify the impacts of increasing parks and recreation needs of the community as the city grows. Adequate accessibility is essential to increasing the number of households that have actual access to these types of physical activity opportunities, in addition to well-maintained facilities.

HEALTH INDICATORS

Oklahoma City has benefited in recent years from campaigns designed to promote physical activity, nutrition, and other healthy behaviors in order to mitigate negative health risks that have become of serious concern. Obesity, heart disease, diabetes, and more are at very high levels relative to other large cities. Having access to physical activity opportunities gives residents greater opportunity to reap the health benefits associated with exercise, as well as the benefits associated with interactions with nature and the community. The following indicators were analyzed as a part of the HIA in order to determine how different land-use patterns would affect the proportion of the population with proximal access to outdoor physical activity opportunities:

P.1 Access to Public Parks

P.2 Access to Private Parks

P.3 Access to Trails Network

HEALTH IMPLICATIONS

- With an increase in access and outreach, physical activity rates increase by a median percentage of 48.4%[lii].
- Two and a half hours of moderate-to-vigorous physical activity each week decreases the risk for premature death, coronary heart disease, stroke, hypertension, type-2 diabetes, and depression[liii].
- Participating in an activity outdoors as opposed to a synthetic environment often leads to people self-reporting a more positive emotional experience[liv].
- Exposure to greenspace can produce improvements in children with behavioral conditions like Attention Deficit Hyperactivity Disorder[lv].
- Communities with greater opportunities for social interaction are more likely to have stronger bonds between neighbors[lvi].
- Greenspace has a positive impact upon environmental health, including air quality and stormwater management, leading to a lower risk of disease in humans, animals and vegetation[lvii].

EXISTING CONDITIONS

Access to Public Parks

Presently, there are 162 public parks on 4,465 acres of land. 10.9% of the population lives within a 5-minute walk of a public park. 25.1% live within a 10-minute walk of a park, and 64.2% lives within 1 mile of a public park. If the 52 schools in the city that allow residents to use their recreation facilities are included, these percentages increase by an average of 18%.

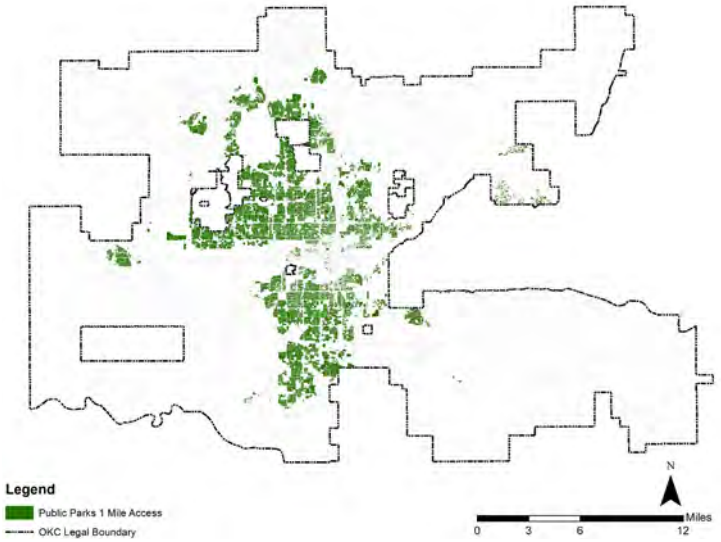


FIGURE 9: This map shows residential parcels within 1 mile of a public park

Access to Private Parks

There are 99 private parks in Oklahoma City at the time of this study, for a total of 266.5 acres. 3.7% of the population lives within a 5-minute walk of a private park, while 8.1% lives within a 10-minute walk. 22.5% of the population lives within 1 mile of a private park.

Access to Trails Network

There are 80.48 miles of existing trails in Oklahoma City. 3.2% of the population lives within a 5-minute walk of a trail, while 7.2% live within a 10-minute walk. 28.7% of the population lives within a 5-minute bike ride of a trail, and 63.2% live within 2.5 miles (a roughly 10 to 15-minute bike ride).

SUMMARY OF FINDINGS

In order to improve health conditions related to park and trail access, efforts should be focused on increased connectivity as well as pedestrian and bicycle infrastructure. New residential development should be located in areas with good access to existing parks and trails. Based upon these ideas, **Scenario C is the best option of the three scenarios; however, even Scenario C does not have a dramatic increase on the percentage of population in proximity to a park or trail. Specific consideration of parks should be incorporated into the final land use plan.**

COMPARISON OF SCENARIOS

The analysis of the three scenarios provided the following conclusions:

Scenario A

Health would decline in Scenario A due to negative changes in the following:

- The lowest percentage of the future population would live within a walkable or bikeable distance of a public park, private park or access point to the trail network. This scenario would likely result in fewer people utilizing public spaces for recreational purposes.

Scenario B

Health would stay the same in Scenario B due to no change in the following:

- Roughly the same percentage of the population would have access to the trails network and private parks as the existing population.

Health would decline in Scenario B due to negative changes in the following:

- A smaller percentage of the population would have proximal access to public parks than in existing conditions. This could lead to greater rates of obesity and degraded mental health.

Scenario C

Health would improve in Scenario C due to positive changes in the following:

- A smaller percentage of the population would rely on private parks for their outdoor recreational needs. Private parks may not be accessible to everyone who falls within a 10-minute walk due to gated communities, lack of pedestrian infrastructure or other reasons; having more people live in proximity to public parks alleviates this risk.
- A greater percentage of the population would live within a walkable or bikeable distance of the trails network. This would give more people a better opportunity to exercise and enjoy natural features of the city.

Health would stay the same in Scenario C due to no change in the following:

- Roughly the same percentage of the population would have access to public parks as the existing population.

HEALTH-PROMOTING RECOMMENDATIONS

Improve access and connectivity to parks and trails:

Public Parks

- Coordinate with schools to encourage access to recreation facilities for community use.
- Continue to expand the park & trail networks consistent with the Oklahoma City Parks Master Plan.
- Increase connectivity by improving sidewalks, trails, and bike paths.
- Require adjacent housing to face parks.

Private Parks

- Establish a new set of regulations to be included in the Subdivisions Regulations that creates an equitably accessible and sufficiently sized private park space for any new development.
    - Increase the percentage of park space required of private developers to meet a level of service comparable to public parks.
    - Create a scale by which recreational uses are selected based upon the number of residential units in a subdivision development.
    - Put more emphasis on a private park being a contiguous space that provides the greatest level of access in a development, rather than upon the space being “centrally located”.
- Ensure safe walking and biking routes to private parks.
    - Improve connectivity between neighborhoods.

Trails

- Prioritize building quality trail connections from the current trail system to existing neighborhoods with low health indicator scores before expanding system into areas with better scores.
- Include trail connections in the design of new neighborhoods adjacent to existing or planned trails, preferably that extend the trail into open space of the new development.
- Create trail connections between areas with low health indicator scores and employment/retail centers enhancing the trail system’s use as a viable transportation option.
- Utilize the trail network to increase confidence in active transportation.

    - Create "Complete Streets" that connect residential areas to the trail network, as well as employment areas, districts, and more.
- Develop policies to increase access to trail networks:
    - Encourage employer incentive programs for using trail networks.
    - Increase bus and paratransit route connection to trail networks.
    - Increase inter-connectedness of the trail network.
    - Increase public education about trail networks.
    - Increase the amount of parking access to trails.

Effectively market parks and recreation facilities:

- Ensure parks are multi-use destinations by collectively deciding what will make the space a destination. Choose uses based upon a cross-section of potential users (i.e. neighborhood associations, schools, businesses, etc.
- Encourage and/or organize "park mobs" and other impromptu or regular events in the park to increase usership.
- Place public art along the trails network to encourage greater usage, as well as encouraging local artists to engage municipal art projects.
- Market the trails system as a transportation and recreation system to residents and visitors

Ensure maintenance and safety of parks and recreation facilities:

- Prioritize and increase maintenance funding for public parks.
- Collect year-over-year data to keep track of the quality of all public parks.
    - Utilize partnerships with universities, schools, neighborhoods, and other volunteer groups to conduct field work in order to keep City expenses focused on the improvement of parks.
- Adopt policies which keep public parks safe, environmentally stable, and health equitable.
- Ensure the safety of people using the trail system.

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RIVER TRAIL

MYRIAD GARDENS

strengthenokc

economic development

OVERVIEW

This section of the HIA broadens the scope of the comprehensive plan element from economic development to all indicators specifically related to economic health. Whereas economic development has broad implications for the economic health of the city, the impact upon personal health from the perspective of affordable housing and homelessness allows for a more individualized understanding of economic health within the greater context of the city.

HEALTH INDICATORS

Ensuring affordable housing options for all of the citizens of Oklahoma City would perhaps spur the greatest overall improvement in public health. Attracting as many employers as possible, fostering local business culture, and encouraging the development of a mixed variety of housing at all prices will provide citizens the opportunity to become more productive. Presently, there is a proclivity toward detached single-family housing that is not necessarily affordable to many residents, particularly when transportation costs are included. Developments that are accessible by sidewalks, bicycle infrastructure, and public transit should include a range of housing types (multi-family, duplex, small lot single-family, etc.) to ensure that all residents have the opportunity to have an affordable home.

St.1 Proportion of Jobs Paying a Livable Wage

St.2 Affordable Housing by Income Bracket

St.3 Homelessness

HEALTH IMPLICATIONS

- Socioeconomic status is a strong predictor of school achievement, college graduation and child outcomes in general; better developmental and health outcomes are strongly associated with family wealth[lviii].
- Low-income earners are three times more likely to succumb to a premature death than individuals who earn high incomes[lix].
- Mental health impacts such as depression are often related to financial insecurity; a 1% increase in unemployment rates in the U.S. can result in 6,000 deaths, many of which come from suicide[lx].
- Households that spend more than 30% of their income on housing costs are less able to afford healthy foods and healthcare costs.
- Homeowners are less likely to suffer mental health problems[lxi].
- Homelessness may result from an adverse childhood, low educational attainment, mental illness, poverty, racism, and labor market conditions[lxii].
- Life expectancy for the average homeless male is 39 years of age[lxiii].
- Increased health concerns for the homeless include: arthritis and other musculoskeletal disorders, hypertension, respiratory tract infections, skin and foot problems, scabies and body lice. There is also increased risk of contracting tuberculosis, HIV, and other sexually-transmitted diseases[lxiv lxv].
- Unintentional injuries and deaths due to substance abuse, mental illness, and other psychosocial concerns are commonplace occurrences within the homeless population[lxvi].
- Homeless veterans who suffer from post-traumatic stress disorder are more likely to have alcohol and drug-use disorders[lxvii].

EXISTING CONDITIONS

Proportion of Jobs Paying a Livable Wage

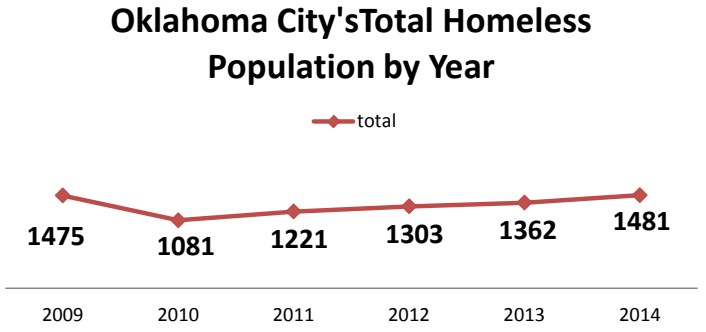
The definition of a living wage varies based upon the size of a family and the number of family members earning an income. Oklahoma City has a minimum wage of $7.25 per hour. The living wage to support a family with two adults and two children is $17.52 per hour, which is more than what two adults making minimum wage earn. 38.5% of Oklahoma City households earn less than this living wage.

Affordable Housing by Income Bracket

Roughly one third of the Oklahoma City population pays greater than 30% of their household income for housing costs, though the average household pays 22.56% of their household income.

Homelessness

As of the 2014 Point in Time study, there were 1,481 homeless individuals in Oklahoma City.



SUMMARY OF FINDINGS

The amount of money people make in their jobs is directly related to their ability to afford housing as well as their likelihood to have money available for healthy lifestyle choices. The amount of money that households have left over often impacts local business strength and higher levels of sales tax revenue. **Scenario C provides the best opportunity for individuals to have make a living wage, afford housing, and to have discretionary money left over with which to stimulate the local economy.**

COMPARISON OF SCENARIOS

The analysis of the three scenarios provided the following conclusions:

Scenario A

Health would decline in Scenario A due to negative changes in the following:

- Due to increased costs for housing, transportation, and energy, the average household in Oklahoma City would require a higher wage to qualify as a "living wage". Therefore, fewer families would be capable of earning a living wage.
- The housing mix across the city would trend toward more expensive large-lot single-family homes, as well as the majority of development would occur outside of the existing urban area, potentially leading to a depressed housing market in the urban area, and all the issues that accompany blighted areas. Fewer people will be able to afford housing in new developments.
- Higher costs of housing and transportation, less accessibility to jobs, housing, and homeless services, and less available public funds would all contribute to a larger homeless population.

Scenario B

Health would stay the same in Scenario B due to no change in the following:

- As the majority of new development will be located around the border of the existing urban area, where transportation services reach today, it is likely that the homeless will have the same access to services (perhaps better access for those who live outside of the inner city) to jobs, housing, and homeless services.

Health would decline in Scenario B due to negative changes in the following:

- Due to increased costs for housing the average household in Oklahoma City would require a higher wage to qualify as a "living wage".Therefore, fewer families would be capable of earning a living wage.
- The cost for housing in new development is significantly more expensive than the average in existing conditions, as the majority of the housing mix trends toward single-family homes.

Scenario C

Health would improve in Scenario C due to positive changes in the following:

- Due to decreased costs for transportation and energy usage, the average household in Oklahoma City will have more discretionary spending available. Lowering the wage that qualifies as a "living wage" effectively raises the percentage of the population who make a living wage.
- With the majority of development occurring within the urbanized area it is likely that there would be less homelessness as it would be easier for the homeless to transition out of their current condition. This is due to more efficient transportation, housing and services access, as well as more public funding available to pay for services to help the homeless.

Health would decline in Scenario C due to negative changes in the following:

- The cost for housing in new development is significantly more expensive than the average in existing conditions, as the majority of the housing mix trends toward single-family homes.

HEALTH-PROMOTING RECOMMENDATIONS

Coordinate efforts to ensure that the necessities of life are affordable:

- Promote strategies to control costs that can undermine a "living wage".
    - Provide education on the availability of affordable housing, affordable transportation options, and affordable energy options for all residents.
    - Promote affordable grocery options.

- Develop workforce housing with transportation access to potential jobs.
- Focus revitalization efforts to areas with low economic opportunity and poor health outcomes.
- Provide incentives for compact, accessible and visitable* multi-family development at sufficient densities.
- Require development to include a mix of housing types.
- Encourage rental unit development for a variety of income levels.
- Encourage unbundling of parking requirements from housing in the urban area.
- Provide Single-Residency Occupancy Structures by incentivizing the construction and repurposing of buildings such as hotels.
- Encourage the development of affordable senior housing.
- Ensure that housing in proximity to schools is affordable to many different income groups.

Promote and create programs to assist the financially unstable:

- Create job-training programs to have a workforce that is skilled/prepared for jobs that pay livable wages
- Provide education opportunities for home-owners to avoid foreclosure.
- Effectively market and fund existing programs that assist the homeless, those in transition, and those on public assistance to find secure housing.
- Market existing programs that connect the homeless population to education, healthy foods, rehabilitation, and physical activity.
- Increase access to employment training and placement resources.

Increase the level of service available for the homeless:

- Ensure that alternative transportation options are accessible from homeless resource centers (shelters, food banks, etc.).
- Increase access to healthcare opportunities, with an emphasis on access to mental health resources.
- Strengthen relationships with faith-based, private, public and other community organizations to provide services for the homeless.
- In addition to shelters & transitional, increase permanent supportive housing and case management resources for the chronically homeless.
- Improve discharge planning for homeless leaving medical facilities and foster care.
- Increase access to resources for homeless youth.

Promote and incentivize community and economic development efforts:

- Support the development and implementation of a Housing Trust Fund or similar community development programs.
- Increase the number of incentives for first-time homebuyers available through municipal sources.
- Explore opportunities to incentivize retrofitting abandoned properties, such as temporary tax discounts or tax rebates.
- Continue to attract employers that pay their employee's a livable wage and provide affordable health insurance, and employer's that support community development.
- Encourage coordination between educational institutions and employers.
- Increase economic diversity by supporting development of industry clusters such as aerospace, aviation, defense, bioscience (and other high-technology industries), renewable energy, new-to-market company headquarters, and advanced manufacturing.

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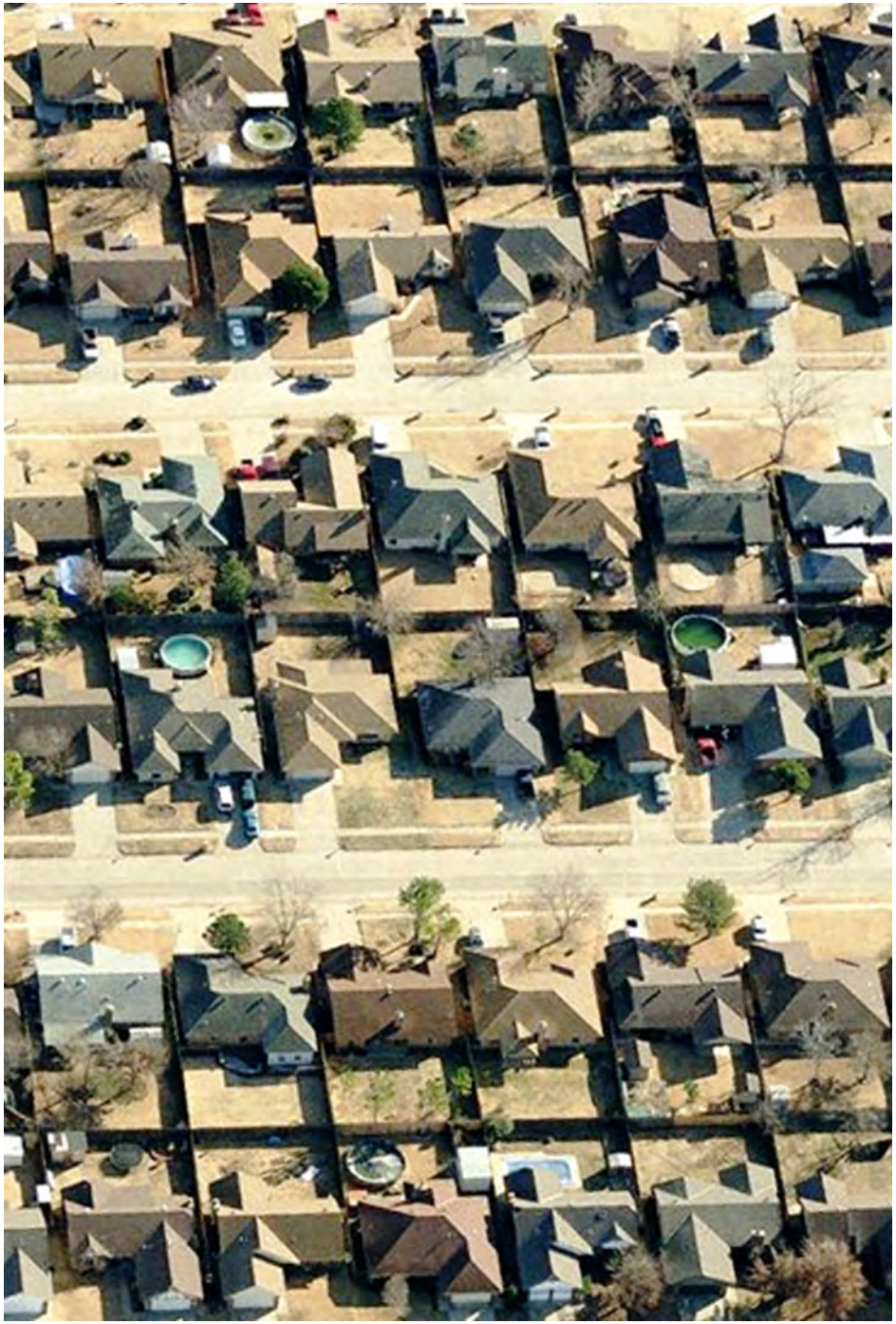
UPTOWN | Mix of housing types and affordability levels



SOUTHWEST | Homogenous housing mix and affordability level

serve okc
public services

OVERVIEW

This section of the HIA focuses on a variety of public service issues that have implications for public health. Consequences of insufficient utilities, police, fire, solid waste or disaster preparedness could negatively impact large sections of the city population. Different development patterns put contrasting levels of stress on public services, increasing or decreasing the risks associated with potential negative health impacts.

HEALTH INDICATORS

Higher population densities allow public services to function more efficiently as less distance must be covered to serve the same amount of people. A greater consolidation of resources can be achieved with an efficient public service system, whereby greater amounts of funding are available for alternative purposes. Otherwise, taxes must increase to meet demands, or service levels must be reduced to account for the greater spreading of resources.

Se.1 First Responder Time by ZIP Code: Fire and Police

Se.2 Percentage of Residences with Storm Shelters

Se.3 Rate of DUI

Se.4 Public Utility Service Area

Se.5 Recycling Rate and Residential Proximity to Recycling Locations

HEALTH IMPLICATIONS

- Adolescents from lower social classes may experience depressive symptomology from a simultaneous experience of heightened surveillance and a lack of protection from police in their communities[lxix].
- Minimizing delays in EMS response time is crucial to maximizing patient outcomes[lxx].
- Individuals with disabilities, minorities, and those with low income and low educational status are at a higher risk and further compromised by lack of emergency preparedness[lxxi].
- Immigrant communities are at greater risk during natural disasters when English is the only language that meteorologists speak. This is especially crucial for tornadoes where there is little time to react[lxxii].
- Each year, nearly 11,000 motor vehicle deaths are attributed to alcohol[lxxiii].
    - DUI collisions occur more frequently with high unemployment rates, potentially due to depression[lxxiv].
    - Rural drivers are at a greater risk of death in a DUI collision due to delayed time of medical response, higher speed limits, less use of seatbelts, more substantial vehicles, and and a general trend to consume greater quantities of alcohol[lxxv].
- The quality of water (both potable and surface) intimately interacts with the population, potentially exposing residents to biological, chemical, pharmaceutical, and even radiological pollution[lxxvi].
- Though recycling cuts down on waste, recycling facilities can create light, noise, air and water pollution that can be passed to neighboring residences via wind, rain, water supplies and other natural elements[lxxvii].

EXISTING CONDITIONS

First Responder Time by ZIP Code: Fire and Police

Only 3.04% of fire responses are for fire-related incidences, while nearly 96% are medical in nature. The average response time for the city is 4 minutes and 5 seconds. ZIP code 73102 (downtown) has the shortest average response time of 2 minutes and 51 seconds, while ZIP code 73054 (rural northeast) has the longest average response time of 10 minutes and 27 seconds. ZIP code 73127 has the highest number of fire-related incidents.

The average Oklahoma City Police Department response time for the city is 5 minutes and 37 seconds. ZIP codes 73106 and 73105 (inner-city) have the shortest average response time of 3 minutes and 22 seconds, while ZIP code 73054 (rural northeast) has the longest average response time of 21 minutes and 3 seconds.

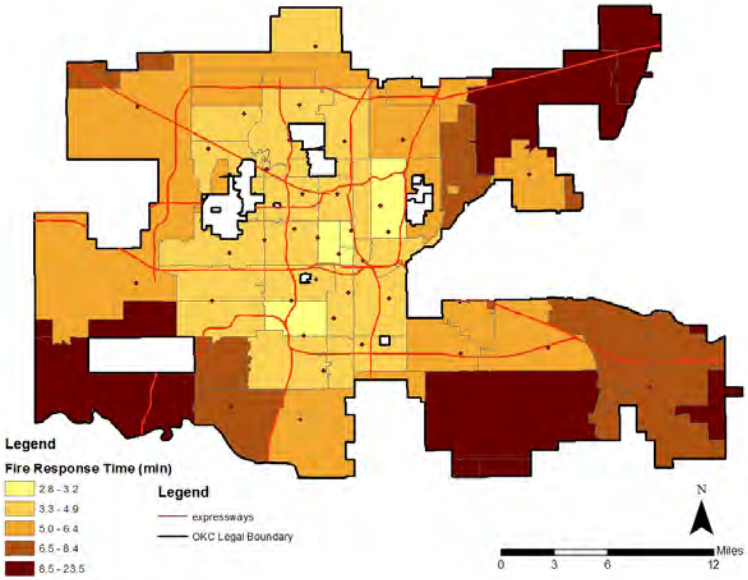


FIGURE 10: This map shows the average Fire Department response time by ZIP Code

Percentage of Residences with Storm Shelters

Only 15% of schools in Oklahoma City have shelters built to withstand an EF5 tornado. 7.7% of households within the city limits have storm shelters on their property.

Rate of DUI

In Oklahoma County in 2012 there were 6,340 alcohol-related arrests. Out of 7,274 motor-vehicle collisions, 73 were fatal. 48% of these fatal crashes involved a driver under the influence of alcohol.

Public Utility Service Area

There are more than 3,450 miles of water mains and service lines in the city, serving roughly 94% of the city population. There are just over 3,230 miles of sewer lines in the city, serving roughly 92% of the population.

Rate of Recycling and Proximity of Recycling Locations to Residential

In FY 2013 8,762 tons of recycling was collected, equating to a 3.1% diversion rate (waste diverted from landfills). The public recycling service area reaches 29.1% of households in the city, though only ¼ of those in the service area take advantage of the service, or 7.3% of all households in Oklahoma City. If the service area included multi-family, 41% of the total population would be reached by existing routes.

SUMMARY OF FINDINGS

Public services are most efficient when they serve the largest population with the smallest possible investment. Therefore, a densely populated region can be served more efficiently than an area with low population density. Police and fire response time will be quicker, the amount of new water and sewer lines will be lower, and waste management will be more easily handled in a development pattern that focuses on density. **Thusly, Scenario C, with a development pattern that densifies the population within existing urban areas, is the best option to gain the health benefits associated with efficient public services.**

COMPARISON OF SCENARIOS

The analysis of the three scenarios provided the following conclusions:

Scenario A

Health would stay the same in Scenario A due to no change in the following:

- Average fire response time would remain the same. Though this would require 21 new fire stations.
- Average police response time would stay the same. This scenario costs 8% more than Scenario C.

Health would decline in Scenario A due to negative changes in the following:

- Fatal DUI accident rates would likely increase due to higher VMT and the reliance upon streets with speed limits higher than 30 mph that are common in non-urban areas. 75.9% of the new population will be located in areas that are currently non-urbanized.
- Significant investment would be necessary to increase the water utility network by 40%.
- A large contingency of the population would not rely on sewer, adding many septic systems that could fail and impact water quality.
- A 4.1% smaller percentage of the population would be along existing recycle pick-up routes.

Scenario B

Health would improve in Scenario B due to positive changes in the following:

- Average fire response time would improve by 1%. This would require 15 new fire stations.
- Average police response time would improve by 0.6%. This scenario costs 4% more than Scenario C.
- The water utility network would grow by 35%, while the population would grow more than 40%; a more efficient pattern than current trends.

Health would stay the same in Scenario B due to no change in the following:

- The same percentage of the population would live along existing recycle pick-up routes.

Health would decline in Scenario B due to negative changes in the following:

- Fatal DUI accident rates would likely increase due to higher VMT and the reliance upon streets with speed limits higher than 30mph that are common in non-urban areas. 66.8% of the new population will be located in areas that are currently non-urbanized.

Scenario C

Health would improve in Scenario C due to positive changes in the following:

- Average fire response time would improve by 2.7%. This would require 8 new fire stations.
- Average police response time would improve by 1.1%. This would also be the most affordable scenario.
- The growth of the water utility network would be 23%, roughly half the rate of growth of the population; this is by far the most efficient growth strategy for utilities.
- There would be a 5.6% increase in the percentage of the total population residing along existing recycle pick-up routes.

Health would stay the same in Scenario C due to no change in the following:

- Though total VMT would increase, with the decrease in per capita VMT, shorter average drive distances, and a tendency toward streets with lower speed limits, it's likely that DUI fatality rates would stay roughly the same.

HEALTH-PROMOTING RECOMMENDATIONS

Improve fire and police first response time:

- Create new forms of first response for the fire department such that ladder trucks are not required for the 97% of calls that are not fire related. This could be some sort of car, motorcycle, or SUV.
- Create an alternative location for police officers to book those whom have been arrested other than the downtown location, to shorten travel distances and times in order to ensure that patrol is constant.
- Encourage dense development in order to avoid stretching resources further and requiring greater funding to build new stations, greater amounts of patrol mileage, and wear and tear on vehicles.
- Support clustered development in regions where water supply is adequate for fighting fires.
- Improve connectivity for ease of access for first responders in new and existing subdivisions.
- Maximize fire safety through actions such as:
    - Require subdivisions to have more than one point of access.
    - Minimize the threat of fire risk at the interface of the urban and rural areas.
    - Requiring exceptional, effective, and easy access to sites augmented by a thorough system of connections within and between developments.

Increase the population's emergency readiness:

- Work with area school districts to create a retrofit program for installation of storm shelters.
- Require all new schools to be fitted with sufficient storm sheltering.
- Incentivize the installation of storm shelters in homes.
- Encourage currently trained EMTs to gain paramedic training.
- Increase emergency preparedness, particularly in the reaction planning process.
    - Ensure the organization of volunteers by identifying volunteer collection sites.
- Expand funding for training and publicity about emergency preparedness.
- Set benchmarks on how many citizens are trained to respond to emergencies in each area. Designate a public agency responsible.
- Support the Oklahoma City Red Cross, and other outreach programs, in outreach efforts to bring people into their CERT training (Community Emergency Response Team).

- Adopt design standards to enable emergency management resources to be highly effective, such as resilient buildings and interconnected transportation networks.
- Require storm shelters as a part of new single-family residential construction.
- Require multi-lingual reporting of emergencies concurrently with English-speaking reporting.

Decrease DUI rates:

- Implement evidence-based interventions and policies against impaired driving:
    - Implement 0.08% blood alcohol concentration (BAC) laws.
    - Increase the use of sobriety checkpoints.
- Support education efforts:
    - Fund mass media campaigns to educate the population about the dangers of drunk driving.
    - Increase school-based education programs to educate students about the dangers of drunk driving or riding with a drunk driver.
    - Promote safe driving habits and encourage community education programs to reduce the number of DUI related incidences.
- Increase patrolling police presence in areas that have high rates of DUI based upon results from sobriety checkpoints.
- Create harsher punishments for DUI incidents where the driver was traveling above 30mph, or a speed that would likely prove fatal if a pedestrian or cyclist were hit.

Efficiently manage the growth of the public utility service area:

- Coordinate with DEQ to find failures of compliance and to enforce strict regulation of septic tanks.
- Locate any new utility pipes under the street or sidewalk to ensure that street trees and other vegetative elements can be planted in the right-of-way.
- Require all new utility lines to be buried and bury existing utility lines when possible (e.g., when roads are widened).

Increase the rate of recycling in the city:

- Increase recycling service to include multi-family housing within serviced areas.
- Increase recycling service to include businesses within serviced areas.
- Expand the service area in the city to include areas not currently served.
- Actively participate in, and support recommendations that are consistent with the comprehensive plan for the long-range solid waste flow and disposal plan. Ensure robust vetting with other departments and citizen oversight.
- Promote recycling habits and encourage community education programs to increase the usage of recycling programs within the city.
    - Merge public outreach efforts of all relevant City departments (Office of Sustainability, Solid Waste, etc.)
- Design performance-based incentives tailored to specific land uses for the regulation of waste and waste products.

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CLASSEN TEN PENN | Short fire/police response time

73054 | Long fire/police response time

OVERALL COMPARISON OF SCENARIOS

In the table below, a '+' represents an improvement in overall health outcomes for a given scenario, while an '=' represents no significant change, and a '-' represents a negative impact on health.

Indicator	Description		Scenario A Impact	Scenario B Impact	Scenario C Impact
	sustainOKC – Land Use				
Su.1	Land-Use Integration (Mixed Use)		-	+	+
Su.2	The Effect of Regulation on Walkability		-	=	+
	connectOKC – Transportation				
C.1	Average Vehicle-Miles Traveled (VMT)	Total	-	-	-
		per-Capita	-	+	+
C.2	Average Commute by ZIP Code		=	+	+
C.3	Proportion of Commute Trips by Public Transit, Cycling and Walking		-	+	+
C.4	Ratio of Street Miles and Access to Public Transit, Bicycle and Pedestrian Facilities		=	+	+
C.5	Number and Rate of Bicycle and Pedestrian Injury Collisions		-	=	+
C.6	Proportion of Income Spent on Transportation		-	+	+
	greenOKC – Environmental and Natural Resources				
G.1	Proportion of Land with Potential for Farming Uses		-	-	-
G.2	Total Impervious Areas		-	-	-
G.3	Air Quality Conditions		-	-	-
G.4	Urban Heat Island Effect		TBD	TBD	TBD
G.5	Water Quality (Groundwater and Water Bodies)		-	-	=
G.6	Average Residential Energy Usage		-	=	+
G.7	Light and Noise Pollution		-/-	-/=	-/+
G.8	Residential Proximity to Oil/Gas Wells and Industrial Sites		-	-	-
	liveOKC – Communities				
L.1	Proportion of Population with Access to Schools		-	-	-
L.2	Residential Density		-	-	+
L.3	Proportion of Population with Access to Healthy Groceries		-	=	+
L.4	Rate and Concentration of Gang Activity		TBD	TBD	TBD
L.5	Isolation Index of Vulnerable Populations		-	-	+
L.6	Proportion of Population with Access to Healthcare Facilities		-	-	+
	enrichOKC – Preservation, Appearance & Culture				
E.1	Number and Location of Vacant and Abandoned Buildings		-	-	+
E.2	Residential Proximity to Landmarks, Cultural Elements and Public Art		-	-	=
	playOKC – Parks and Recreation				
P.1	Residential Access to Public Parks		-	-	=
P.2	Residential Access to Private Parks		-	=	+
P.3	Residential Access to Trails Network		-	=	+
	strengthenOKC – Economic Development				
St.1	Proportion of Jobs Paying a Livable Wage		-	-	+
St.2	Affordable Housing by Income Bracket		-	-	-
St.3	Homelessness		-	=	+
	serveOKC – Public Services				
Se.1	First Responder Time by ZIP Code: Fire and Police		=	+	+
Se.2	Percentage of Residences with Storm Shelters		TBD	TBD	TBD
Se.3	Rate of DUI		-	-	+
Se.4	Public Utility Service Area		-	+	+
Se.5	Recycling Rate and Residential Proximity to Recycling Locations		-	=	+
			-31	**-9**	**+15**

CONCLUSIONS

The results of the three scenario comparisons illustrate the fact that Oklahoma City is at a crossroads when it comes to deciding what issues to prioritize. The city can either:

1) Continue to develop farther from the city center, remain dependent on single-occupancy motor vehicles, and increase the health risks associated with the 35 indicators in this health impact assessment...

OR

2) Development can stop pushing out from the urban area, redevelop urban properties, invest in active transportation and public transit, and improve health in most of the health indicators in this health impact assessment.

The conclusion of this health impact assessment is that Scenario C is without question the best option to move forward with in the comprehensive plan when health is the main concern. In fact, a scenario that focuses more on densification would be even better for overall public health. An increase in the amount of multi-family housing, for example, would be an improvement upon Scenario C. Also, development specifically oriented in proximity to parks and schools would encourage more active transportation.

Owning a large lot single-family home may be the traditional American dream, but the ill effects of haphazard sprawl should be a warning that this way of life is outmoded and contributing to the decline in health in our country, state and city. The recommendations generated for each of the 35 indicators in this HIA should inform policy to resist the status quo development pattern, and strive for a walkable, accessible, and connected city with clean air and water, healthier citizens and habitats -- a better place to live.

planokc Comprehensive Plan

Health Impact Assessment

DETAILED INDICATORS

TABLE OF CONTENTS

planokc Health Impact Assessment: Health Overview

What is Health?

Every individual around the world views health differently, depending on an array of personal, cultural, and moral values that make each human unique. The topic of health often sparks debate amongst every social class, demographic, political realm, educational institution, and even in each home across America, and is more than just a population or individual free of disease. While health can be perceived differently by each individual, the World Health Organization defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity[1]." As even this definition brings on controversy surrounding "complete" state of health, the United States has taken this concept seriously and strives to improve the Nation's health.

The Health of a Nation

The Healthy People 2020 initiative provides science-based, 10-year national objectives for improving the health of all Americans. For 3 decades, Healthy People has established benchmarks and monitored progress over time in order to: encourage collaborations across communities and sectors, empower individuals toward making informed health decisions, and measure the impact of prevention activities. The mission of Healthy People 2020 strives to "identify nationwide health improvement priorities, increase public awareness and understanding of the determinants of health, disease, disability, and the opportunities for progress." It also "attempts to provide measurable objectives and goals that are applicable at the national, State, and local levels, engage multiple sectors to take actions to strengthen policies and improve practices that are driven by the best available evidence and knowledge, and identify critical research, evaluation, and data collection needs[2]."

The four main goals of Healthy People 2020 focus on measures of general health, health-related quality of life and well-being, determinants of health, and health disparities[3]. Examples of assessments which monitor general health status include life expectancy, physical and mental unhealthy days, chronic disease prevalence, and years of potential life lost. All of these help to provide information on the population as a whole.

Health-related quality of life (HRQoL) is a multi-dimensional concept that includes domains related to physical, mental, emotional and social functioning. It goes beyond direct measures of population health, life expectancy and causes of death, and focuses on the impact health status has on quality of life. Positive evaluations of a person's life can include the presence of positive emotions in daily activities, participation in society, satisfying relationships, and overall life satisfaction. These attributes are commonly referred to as well-being and are associated with numerous benefits related to health, work, family, and economics[4] [5]. For example, positive emotions and evaluations of life are associated with decreased risk of disease, illness, and

[1] Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948.
[2] U.S. Department of Human Services (2013). *Healthy People 2020*. Retrieved from http://www.healthypeople.gov/2020/default.aspx
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injury, as well as better immune functioning, speedier recovery, and increased longevity[6] [7] [8] [9] [10] [11]. People with high levels of well-being are more productive at work and are more likely to contribute to their communities[12]. This could stand to reason that people with lower levels of well-being are less productive, miss more days of work, and contribute less to their communities. These emotional barriers can also be considered for communities with high unemployment rates and lower poverty levels. In addition, more research is supporting the view that positive emotions – which are central components of well-being – are not merely the opposite of negative emotions but rather may be independent dimensions of mental health[13].

Determinants of health are the factors that influence health such as the personal, economic, and environmental factors. Generally, determinants of health fall under factors such as policymaking, social factors, health services, individual behaviors, and biology or genetics. Determinants of health reach beyond the boundaries of traditional health care and public health sectors; sectors such as education, housing, transportation, agriculture, and environment can be important allies in improving population health[14]. Some policies affect entire populations over extended periods of time while simultaneously helping to change individual behavior. Social determinants of health reflect social factors and the physical conditions in the environment in which people are born, live, learn, play, work and age. Examples of social determinants include; availability of resources to meet daily needs, such as educational and job opportunities, living wages, or healthful foods. Additional examples include social norms and attitudes, such as discrimination, exposure to crime, quality schools, transportation options, public safety, and residential segregation[15]. It has been discovered that poor health outcomes are often made worse by the interaction between individuals and their social and physical environment. For example, millions of people in the United States live in places that have unhealthy levels of ozone or other air pollutants. In counties where ozone pollution is high, there is often a higher prevalence of asthma in both adults and children compared with State and national averages. Poor air quality can worsen asthma symptoms, especially in children[16]. Healthy People 2020 directly addresses access to health services as a topic area and incorporates quality of health services throughout a number of topic areas, including access to care and health care interventions. Lack of access, or limited access, to health services greatly impacts an individual's health status. For example, when individuals do not have health

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insurance, they are less likely to participate in preventive care and are more likely to delay medical treatment[17]. Many public health and health care interventions focus on changing individual behaviors such as substance abuse, diet, and physical activity. Positive changes in individual behavior can reduce the rates of chronic disease in this country. Examples of individual behavior determinants of health include; diet, physical activity, alcohol, cigarette, and other drug use and hand washing[18].

Healthy People 2020 defines a *health disparity* as "a particular type of health difference that is closely linked with social, economic, and/or environmental disadvantage." Health disparities adversely affect groups of people who have systematically experienced greater obstacles to health based on their racial or ethnic group; religion; socioeconomic status; gender; age; mental health; cognitive, sensory, or physical disability; sexual orientation or gender identity; geographic location; or other characteristics historically linked to discrimination or exclusion."[19]

While a national health campaign is imperative to addressing the needs of the population, implementation and enforcement cannot be accomplished without a state and local backbone. The Healthy People State and Territorial Coordinators make Healthy People happen every single day across the United States. Each State and Territory has a Healthy People Coordinator who serves as a liaison with the Office of Disease Prevention and Health Promotion (ODPHP). The Coordinator ensures that the development of a State or Territorial plan is in line with Healthy People goals and objectives. Currently for the State of Oklahoma, the Director of Health Promotion Community Development Service housed at the Oklahoma State Department of Health (OSDH) is tasked with the Coordinator role. The vision of the Oklahoma State Department of Health is "Creating a State of Health" and the mission is "to protect and promote health, to prevent disease and injury, and to cultivate conditions by which Oklahomans can be healthy."[20]

The Health of a State

Overview:

In an effort to inform the public OSDH has published the 2011 STATE OF THE STATE'S HEALTH REPORT which provides data regarding Oklahoma's health ranking and a call to action. Even though Oklahoma's health ranking has improved from 49th to 46th in the nation, Oklahoma's health status indicators are among the worst in the United States. Regions, communities, and individual homes are all affected and contribute to these rankings. Oklahoma has a high prevalence of smoking and obesity, limited

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state report card

Indicator	U.S.	OK	Grade
Mortality			
Infant Mortality (per 1,000)	6.8	8.6	D
Total Mortality (per 100,000)	760.2	933.0	F
Leading Causes of Death (per 100,000)			
Heart Disease Deaths	190.9	242.1	F
Malignant Neoplasm (Cancer) Deaths	178.4	198.3	D
Cerebrovascular Disease (Stroke) Deaths	42.2	53.8	F
Chronic Lower Respiratory Disease Deaths	43.3	61.3	F
Unintentional Injury Deaths	40.0	58.5	F
Diabetes Deaths	22.5	29.4	F
Influenza/Pneumonia Deaths	16.2	20.1	D
Alzheimer's Disease Deaths	22.7	23.1	C
Nephritis (Kidney Disease) Deaths	14.5	15.7	C
Suicides	11.3	14.7	D
Disease Rates			
Diabetes Prevalence	8.3%	11.0%	F
Current Asthma Prevalence	8.8%	10.0%	D
Cancer Incidence (per 100,000)	481.7	498.9	C
Risk Factors			
Fruit & Vegetable Consumption	23.4%	14.6%	F
No Physical Activity	23.8%	31.4%	F
Current Smoking Prevalence	17.9%	25.5%	F
Obesity	26.9%	32.0%	D
Immunizations < 3	69.9%	70.2%	C
Seniors Influenza Vaccination	70.1%	72.3%	B
Seniors Pneumonia Vaccination	68.5%	72.1%	B
Limited Activity Days (average)	4.3	5.2	D
Poor Mental Health Days (average)	3.5	4.2	D
Poor Physical Health Days (average)	3.6	4.3	D
Good or Better Health Rating (average)	85.5	80.4	D
Teen Fertility (per 1,000)	22.1	30.4	D
First Trimester Prenatal Care	83.2%	76.3%	
Low Birth Weight	8.2%	8.2%	C
Dental Visits - Adults	71.3%	57.9%	F
Usual Source of Care	81.0%	77.6%	C
Socioeconomic Factors			
No Insurance Coverage	14.3%	19.8%	D
Poverty	13.2%	15.7%	D
New Indicators (per 100,000)			
Occupational Fatalities	2.1	3.6	D
Preventable Hospitalizations	1762.6	2120.9	D

2011 STATE OF THE STATE'S HEALTH REPORT | 7

access to prenatal care and availability of primary care physicians, and high rates of preventable hospitalizations and cardiovascular disease. As a state, Oklahoma has fewer babies that survive their first birthday and a life expectancy for our residents that is shorter than almost every other state in the country[21].

Causes of Death:

Oklahoma leads the nation in mortality rates, grounded from the sum of these conditions. Oklahoma still leads much of the nation with deaths due to heart disease, cerebrovascular disease, and respiratory disease. Likewise, Oklahoma's cerebrovascular disease deaths (strokes) are much higher than much of the nation. Of particular concern is the disproportionate burden of heart disease and cerebrovascular disease deaths among African Americans, with higher rates than any other ethnic group in Oklahoma. Chronic lower respiratory disease continues to plague Oklahoma at higher than national rates, primarily because of Oklahoman' continued dependency of tobacco and tobacco products. Another chronic condition where Oklahoma ranks among the 10 worst states is diabetes, with significant disparities seen among Native Americans and African Americans[22].

Oklahoma's death rate is one of the highest in the United States. Although research shows that unhealthy lifestyles and behaviors contribute to most of today's leading causes of death[23], preventative actions, initiatives, programs, and state policies can help to influence those personal choices. Heart disease is the leading cause of death in the United States. Oklahoma claims the same title with more than 9,000 deaths in 2007 alone from heart disease[24]. High blood pressure, high cholesterol, smoking, physical inactivity, obesity, poor diet, and diabetes are the leading causes of cardiovascular disease[25]. Chronic lower respiratory diseases, e.g., COPD, emphysema, chronic bronchitis, and asthma, are the third leading cause of death in Oklahoma[26]. Some of the programs the state can implement to encourage better heart health include smoke-free environments, better food choices, improved labeling, and decreased salt content of foods[27]. Oklahoma is actively implementing programs such as Breath Easy, which requires smoke-free environments, and the Oklahoma State Stroke System Advisory Committee (OSSSAC), which focuses on heart disease and stroke prevention. Oklahoma has one of the five highest rates of death due to cerebrovascular disease (stroke) in the U.S., totaling 2100 deaths in 2007[28]. When considering that stroke is a leading cause of long-term disability in the United States[29], it is very important to connect the relationships to aging population and both current and trending workforce. Tying in unemployment rates and poverty levels of communities with a large aging population, may also have a greater impact on heart health. High blood pressure, smoking, diabetes, high cholesterol, obesity, and physical inactivity are risk factors for stroke that can be changed[30]. These

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factors, if monitored, treated effectively, and are discovered early through prevention methods can positively affect an individual's overall health. Cardiovascular disease is the major complication and the leading cause of premature death among people with diabetes.

Diabetes also is a large contributor to Oklahoman's death toll, and diabetes-related health expenditures were estimated at $3.28 billion in Oklahoma in 2007[31]. Kidney diseases (nephritis, nephrotic syndrome and nephrosis) were the ninth leading cause of death in Oklahoma. Chronic renal failure and end-stage kidney disease accounted for 82.1 percent of deaths from renal failure in Oklahoma. Diabetes is the leading cause of renal failure, and responsible for 44 percent of new cases in Oklahoma[32]. These expenditures are partly paid for by medical insurance companies, individual out-of-pocket deductibles and copays, and hospital write-offs. But, when considering the large percentage of the Oklahoma population who do not have health insurance benefits, or enough assets to pay medical bills, these costs end up being a burden on the healthcare industry, hospitals, and eventually the taxpayers. These costs are only a portion of what future costs will become.

While there are many risky behaviors and factors that affect both heart disease and stroke, obesity is a leading cause. Excess weight increases the risk of developing chronic disease, such as heart disease, stroke, diabetes, and some cancers. Obesity is also associated with increased mortality[33]. Oklahoma ranked 47th in the nation for obesity (or fifth most obese) and two-thirds of Oklahoma adults had a Body Mass Index (BMI) of 25+ (overweight and obese)[34]. Fourteen percent of Oklahoma youth were obese and 16 percent were overweight[35]. As an individual's BMI increases, so do the number of sick days, medical claims, and health care costs[36]. Obesity increases a child's risk for a range of health problems and negatively impacts mental health and school performance[37] [38]. Oklahoma schools, nursing homes, camps, and assisted living centers have put greater emphasis on healthy meals and physical activity programs that are designed to positively affect the weight of the state. While deaths from health related causes is a major concern of many organizational and community groups, mortality from unintentional deaths also tops the charts in Oklahoma.

While death from health-related causes is a major concern of many organizations and community groups, mortality from unintentional deaths also tops the charts in Oklahoma. In Oklahoma unintentional injuries accounted for 1 of every 17 deaths. Oklahoma's death rates due to motor vehicle crashes, drowning, and fire/burns were higher than the national average and the leading cause of unintentional injury death in Oklahoma was traffic crashes, followed by poisonings and falls in 2007[39]. The State Department of Health has a vested interest in reducing unintentional deaths as the average medical cost for a non-fatal injury

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hospitalization was $22,000[40]. Not included in unintentional deaths are suicides. In additional to previously mentioned figures, the suicide rate in Oklahoma was 30 percent higher than the U.S. rate[41]. Issues that are most likely to increase a person's risk for suicide are mental illness, intimate partner problems, and physical health problems[42]. It is important to understand how these type of concerns can trickle down to the community level and impact the daily lives and routines of community living. This is an alarming figure for public health professionals as for every suicide death, there were approximately 4.5 people hospitalized for a suicide attempt or non-fatal, self-inflicted injury[43].

Disease and Health-Limiting Factors:

Prevalence of diseases is a prime factor in the health of a community, geographic region or population. Diabetes, asthma, and risky behaviors also play an unintentional role in how a community interacts. Community organizations, government, and civil groups can directly impact the prevalence of these kinds of diseases by supporting laws, regulations, and ordinances intended to keep the public and communities safe. Diabetes prevalence continues to be a growing concern for the health community including state department and public officials, hospitals, nursing homes, and private physicians. Many groups are stepping up to inform their communities on the risk factors associated with diabetes and ways to reduce risk. Cardiovascular disease has also been linked to diabetes. Risk factors of diabetes include, but are not limited to obesity, overweight conditions, and lack of physical activity. Oklahoma adults who participated in leisure-time physical activity reported significantly lower prevalence of diabetes, despite the fact that approximately 304,500 Oklahomans age 18+ have been diagnosed with diabetes, which translates to 1 in 5 hospital admissions in Oklahoma include a diagnosis of diabetes[44]. One way to control diabetic symptoms is healthy eating. Eating more fruits and vegetables can lower the risk of chronic disease, including some cancers, diabetes, heart disease, and obesity[45]. Oklahoma ranks 49th in the nation for lack of physical activity[46]. Physical activity has a role in reversing or preventing health problems[47] and reduces the risk of premature death[48]. The World Health Organization estimates that 1.9 million deaths worldwide are attributable to physical inactivity[49].

Asthma prevalence in a state or county can come from a host of environmental factors, such as automobile emissions, natural vegetation or landscape, and industry pollution. Other factors that contribute to asthma include genetics and the cleanliness of air inside the home, schools and public places. In 2008, there were 4,367 hospital admissions with asthma as the principal diagnosis, and 66.3 percent of them were

[40] Oklahoma State Department of Health, Injury Prevention Service. *Injuries in Oklahoma, 2004-2008*. Retrieved from <http://www.ok.gov/health/documents/Injuries_in_OK_2004-2008.pdf>.
[41] Oklahoma State Department of Health. (2011*). 2011 State of the State's Health Report*. Oklahoma City
[42] Oklahoma State Department of Health, Injury Prevention Service. (2010*). Summary of Violent Deaths in Oklahoma, Oklahoma Violent Death Reporting System, 2004-2007*. Available at <http://www.ok.gov/ health/documents/Violent percent20Deaths percent202004-2007.pdf>.
[43] Oklahoma State Department of Health, Injury Prevention Service. (2006). *Fatal and Nonfatal Self-Inflicted Injuries in Oklahoma, 2002-2004*. Available at <http://www.ok.gov/health/documents/Suicide_2002-2004.pdf>
[44] Oklahoma State Department of Health, Chronic Disease Service. *Diabetes Surveillance Report, Oklahoma 2008.*
[45] Malas, N., Tharp, K.M., and Foerster, S.B. (2010). Diet and Nutrition. In Remington, P., Brownson, R., and Wegner, M. *Chronic Disease Epidemiology and Control* (pp.159-197). Washington, DC: American Public Health Association.
[46] Oklahoma State Department of Health. (2011). *2011 State of the State's Health Report*. Oklahoma City
[47] U.S. Department of Health and Human Services, *2008 Physical Activity Guidelines for Americans*. Available at <http://www.health.gov/paguidelines/guidelines/chapter2.aspx>.
[48] Ainsworth, B.E. and Macera, C.A. (2010). Physical Activity. In Remington, P., Brownson, R., and Wegner, M.*Chronic Disease Epidemiology and Control* (pp.199-227). Washington, DC: American Public Health Association.
[49] World Health Organization. *Risk Factor: Physical Inactivity*. Available at <http://www.who.int/ cardiovascular_diseases/en/cvd_atlas_08_physical_inactivity.pdf>.

admitted from the emergency room. Most asthma hospital admissions came from Oklahoma City and Tulsa; however, some counties in western Oklahoma had higher rates of hospitalization[50].

Risky behaviors for poor health include, but are not limited to, poor nutritional intake, lack of exercise, and less than favorable activities such as smoking. Not only do these risky behaviors exclude individuals from achieving a positive health status, they also end up becoming costly. Eating more fruits and vegetables can lower the risk of chronic disease, including some cancers, diabetes, heart disease, and obesity[51]. Only 1 in 7 (14.6 percent) Oklahoma adults reported eating fruits and vegetables five times or more per day, ranking Oklahoma 51st in the nation[52]. Only 15 percent of Oklahoma youth ate fruits and vegetables five times or more per day[53]. Food industry marketing, many fast food restaurants, and few grocery stores are community factors that influence unhealthy food choices. Only 57.4 percent of Oklahoma census tracts had healthy food retailers in or within half of a mile of tract boundaries. Only 0.3 percent of cropland acreage was harvested for fruits and vegetables[54]. Physical activity has a role in reversing or preventing health problems[55] and reduces the risk of premature death[56]. 30 percent of Oklahoma adults report not being physically active. Oklahomans with less income were less physically active[57]. Smoking kills more Oklahomans than alcohol, auto accidents, AIDS, suicides, murders and illegal drugs combined[58]. Smoking costs Oklahomans an estimated $2.7 billion in medical expenses and lost productivity each year[59]. Smokers miss an average of 50 percent more work days than nonsmokers[60]. Twenty-six percent of Oklahoma adults smoke, compared to about 18 percent nationally[61]. Each year, about 5,400 Oklahoma children become new daily smokers[62].

Additional detriments of health include poverty and access to health services. The percentage of Oklahomans living in poverty was 19 percent worse than the U.S. rate[63]. The U.S. Census Bureau establishes poverty thresholds which reflect the point under which people lack the basic resources necessary to have a

[50] Oklahoma State Department of Health, Chronic Disease Service. *Asthma Surveillance Report, Oklahoma 2008*
[51] Malas, N., Tharp, K.M., and Foerster, S.B. (2010). Diet and Nutrition. In Remington, P., Brownson, R., and Wegner, M. Chronic *Disease Epidemiology and Control* (pp.159-197). Washington, DC: American Public Health Association.
[52] Centers for Disease Control and Prevention. (2009). *Behavioral Risk Factor Surveillance System Survey Data*. Atlanta, Georgia: U.S. Department of Health and Human Services, CDC.
[53] Centers for Disease Control and Prevention. (2010). *Youth Risk Behavior Surveillance – United States 2009*. MMWR Surveillance Summaries 59, no. SS05. Available at <http://www.cdc.gov/mmwr/pdf/ss/ss5905.pdf>.
[54] Centers for Disease Control and Prevention. (2009). *State indicator report on fruits and vegetables, 2009*. US Department of Health and Human Services, CDC. Available at <http:www.fruitsandveggiesmatter. gov/indicatorreport>.
[55] U.S. Department of Health and Human Services. (2008). *Physical Activity Guidelines for Americans*. Available at <http://www.health.gov/paguidelines/guidelines/chapter2.aspx>.
[56] Ainsworth, B.E. and Macera, C.A. (2010). Physical Activity. In Remington, P., Brownson, R., and Wegner, M. *Chronic Disease Epidemiology and Control* (pp.199-227). Washington, DC: American Public Health Association.
[57] Centers for Disease Control and Prevention. (2009). *Behavioral Risk Factor Surveillance System Survey Data*. Atlanta, Georgia: U. S. Department of Health and Human Services, Centers for Disease Control and Prevention.
[58] Centers for Disease Control and Prevention. (2009). *State-Specific Smoking-Attributable Mortality and Years of Potential Life Lost – United States, 2000-2004*.
[59] Centers for Disease Control and Prevention. *Data Highlights 2006 [and underlying CDC data/estimates; CDC's State System average annual smoking attributable productivity losses from 1997-2001 (1999 estimates updated to 2004 dollars)*.
[60] Halpern, M.T., et al. (2001). Impact of smoking status on workplace absenteeism and productivity. Tobacco Control 10(3): 233-238.
[61] Behavioral Risk Factor Surveillance System. (2009).
[62] U.S. Department of Health and Human Services (HHS). *Results from the 2009 National Survey on Drug Use and Health*.
[63] U.S. Census Bureau. *2008 American Community Survey*. Available at <http://factfinder.census.gov/home/saff/main.html?_lang=en>.

healthy standard of living[64]. Those living in poverty are more likely to engage in unhealthy behaviors, be exposed to environmental hazards, and have limited access to health care services[65]. While opportunities exist around the city for poverty-stricken individuals to seek care, other barriers arise such as language, cultural, transportation, mental and physical obstacles.

The State of Oklahoma has observed the need for a healthier state and is actively reaching out to the population to provide programs, educational opportunities, low cost activities, and additional support for needs at the state level. Immunization outreach, improving behaviors that contribute to high mortality rates, and prevention programs are all state initiatives to improve health. Immunization outreach is working to vaccinate 90 percent of Oklahoma seniors (65+) against influenza and pneumonia[66], which will help to lower the state's mortality rate from these diseases. By addressing these needs proactively, cost savings are predicted, as well as an increase in quality of life.

State Health Programming:

There are several programs throughout the state focusing on improving behaviors that contribute to high mortality rates, such as the Shape Your Future initiative, the Oklahoma Heart Disease and Stroke Prevention Program, which focuses on policy, environmental factors, and systems changes to promote heart health and moderate unhealthy behaviors, as well as the Oklahoma State Stroke System Advisory Committee (OSSSAC) that provides stroke education and advocate for policy change.

Current prevention efforts include child safety seat programs, smoke alarm installations, poisoning education, and Tai Chi classes to prevent falls among older adults. The Partnership for a Strong and Healthy Oklahoma is supporting programs that adopt the physical activity state plan. The Oklahoma Action for Healthy Kids state team has embraced "screen time reduction" as their focus area. The Oklahoma Safe Routes to School program provides schools with opportunities to encourage walking and bicycling to school. The Oklahoma State Department of Health has begun a four-year pilot utilizing an evidence-based physical activity and nutrition curricula in multiple school districts. Implementation of the state plan to reduce obesity, Get Fit, Eat Smart, is a priority of the Oklahoma Health Improvement Plan (OHIP). Worksites, schools, and faith-based organizations can help increase fruit and vegetable consumption through education, availability, and social support[67].

In the 2011 State of State's Health Report call to action The Oklahoma Board of Health and the State Department of Health encourages faith partners, businesses, individuals, schools, local turning point partnerships, city councils, families and state policymakers to unite together to make a positive difference in Oklahoma's state of health. The State Board of Health and the Oklahoma State Department of Health realize the challenges facing funding, locating external resources, sustaining the health workforce and ultimately obtaining the vision of the organization; creating a state of health. They also examine the idea that this task cannot be accomplished without the residents and communities involvement. The (SOSH) also fore

[64] U.S. Census Bureau. *How the Census Bureau Measures Poverty*. Available at <http://www.census.gov/hhes/www/poverty/methods/definitions.html>.
[65] National Center for Health Statistics. (2010). *Health, United States, 2009: With Special Feature on Medical Technology*. Hyattsville, MD. 2010.
[66] U.S. Department of Health and Human Services. *Healthy People 2010*. 2nd ed. *With Understanding and Improving Health and Objectives for Improving Health*. 2 vols. Washington, D.C.: U.S. Government Printing Office, November 2000.
[67] Malas, N., Tharp, K.M., and Foerster, S.B. (2010). Diet and Nutrition. In Remington, P., Brownson, R., and Wegner, M. Chronic *Disease Epidemiology and Control* (pp.159-197). Washington, DC: American Public Health Association.

mentions that data collected for this informational document has inconsistent data ranges. Not all data represents the exact same time frame; therefore, an aggregated total or comparison is extremely difficult. This is where the county health departments become a crucial partner in data collection, statistics, and knowledge of their communities.

The Health of Oklahoma County

Through the 2011 STATE OF THE STATE'S HEALTH REPORT the following data represents Oklahoma County.

Oklahoma County

Mortality and Leading Causes of Death

- Oklahoma County ranked 21st in the state for age-adjusted total mortality.
- Oklahoma County's leading causes of death were heart disease, cancer, and chronic lower respiratory disease.
- Oklahoma County had the sixth lowest rate of deaths due to unintentional injury in the state.

Disease Rates

- Oklahoma County's disease rates for diabetes and asthma were lower than the overall state rates.

Risk Factors, Behaviors and Socioeconomic Factors

- Oklahoma County ranked in the middle of the other counties for most indicators.
- Adults in Oklahoma County experienced fewer limited activity days than adults in most other counties.
- Oklahoma County had one of the higher rates of recent dental visits among adults (rank: 12th).

Changes from Previous Report

- Most of the indicator rates remained consistent with the previous time period.
- The prevalence of diabetes among adults increased 25 percent.
- The prevalence of asthma among adults increased 14 percent.
- There were 13 percent more obese adults.
- Fifteen percent fewer children had completed the primary immunization series.

	PREVIOUS	CURRENT	GRADE
MORTALITY			
INFANT (RATE PER 1,000)	8.9	9.0	D
TOTAL (RATE PER 100,000)	904.9	892.3	F
LEADING CAUSES OF DEATH			
(RATE PER 100,000)			
HEART DISEASE	247.5	231.0	D
CANCER	191.5	185.9	C
STROKE	56.8	52.5	F
CHRONIC LOWER RESPIRATORY DISEASE	55.3	57.1	F
UNINTENTIONAL INJURY	43.8	45.9	D
DIABETES	26.4	26.6	D
INFLUENZA/PNEUMONIA	20.3	20.0	D
ALZHEIMER'S DISEASE	19.4	20.9	C
NEPHRITIS (KIDNEY DISEASE)	14.3	13.2	C
SUICIDE	14.4	14.3	D
DISEASE RATES			
DIABETES PREVALENCE	7.9%	9.9%	D
ASTHMA PREVALENCE	8.6%	9.8%	D
CANCER INCIDENCE (RATE PER 100,000)	542.2	544.2	F
RISK FACTORS & BEHAVIORS			
FRUIT/VEGETABLE CONSUMPTION	16.4%	16.7%	F
NO PHYSICAL ACTIVITY	29.5%	29.7%	D
SMOKING	25.1%	23.9%	F
OBESITY	25.4%	28.7%	C
IMMUNIZATIONS < 3 YEARS	81.3%	68.7%	C
SENIORS FLU VACCINATION	73.5%	73.4%	B
SENIORS PNEUMONIA VACCINATION	68.9%	73.4%	A
LIMITED ACTIVITY DAYS (AVG)	4.4	4.5	C
POOR MENTAL HEALTH DAYS (AVG)	3.9	4.1	D
POOR PHYSICAL HEALTH DAYS (AVG)	3.8	3.9	C
GOOD OR BETTER HEALTH RATING	81.2%	82.2%	D
TEEN FERTILITY (RATE PER 1,000)	37.2	38.0	F
FIRST TRIMESTER PRENATAL CARE	78.1%	78.5%	
LOW BIRTHWEIGHT	8.9%	8.8%	C
ADULT DENTAL VISITS	63.2%	61.8%	F
USUAL SOURCE OF CARE	75.1%	74.2%	D
SOCIOECONOMIC FACTORS			
NO INSURANCE	22.5%	23.8%	F
POVERTY	17.6%	16.1%	F

Note: A "-" is used to denote <5 events in mortality fields and <5 observations or <50 in the sample population for BRFSS data, which result in unstable rates.

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Structure of Organization:

The Oklahoma State Department of Health, through its system of local health services delivery, is ultimately responsible for protecting and improving the public's health status through strategies that focus on preventing disease. Three major service branches, Community & Family Health Services, Prevention & Preparedness Services and Protective Health Services, provide technical support and guidance to 68 county health departments as well as guidance and consultation to the two independent city-county health departments in Oklahoma City and Tulsa. Oklahoma City County Health Department (OCCHD) operates with a mission of "working to protect health, promote wellness, and prevent disease" and a vision of "working with the community for a healthy future". OCCHD has established a Wellness Now initiative, started in April of 2010. This initiative is community-led, comprised of individuals and organizations who share a vision to improve the health and wellness of Oklahoma City and County. The initiative has developed into a Coalition of partners committed to making changes in order to create a healthy and well community. Through the Wellness Now initiative, a Wellness Score is determined. The Wellness Score helps OCCHD and our community partners determine what areas of Oklahoma County have the greatest need and what will have the greatest impact[68].

Community partnerships make the Wellness Score possible and The Oklahoma City-County Health Department (OCCHD) utilizes the Mobilizing for Action through Planning and Partnership (MAPP) tool to conduct community-wide health needs assessments. The MAPP process engages a broad, and diverse coalition of stakeholders to collect qualitative and quantitative data across four distinct assessments that include the: Wellness Score (Community Health Profile), Forces of Change, Strengths & Themes, and the Local Public Health System Assessment. Each assessment utilizes a distinct methodology, representing a robust cross-section of quantitative and qualitative data[69]. The resultant data completes the findings the Wellness Score.

Many organizations, businesses, communities and political officials depend on population change to base their needs. By determining if the population base is growing, decreasing, or just shifting can help government, business owners, and families make better business decisions, which can increase economic stability. Oklahoma County saw an increase in the overall population by 8.8% between 2000 and 2010, with an estimated population of 718,633 individuals in 2010[70]. Oklahoma City and County had an estimated combined population total of 1,014,827 individuals in 2011. The Oklahoma City County Health department covers approximately 27% of the entire state's population. The range of ages and concentrations of certain age groups can play a significant role in community health outcomes and priorities for improvement. Oklahoma County's median age (34.3 years) is nearly two years younger than the state median (36.2 years), and nearly three years younger than the national median (37.2 years). Gender differences may also play a role in health needs and priorities. In Oklahoma County, males and females make up approximately the same percent of the overall population. What it means for providers is they can use age and gender to target more specific policy and program development strategies. Understanding the population makeup by age and gender will aid in the development of resources needed to address the mission of county agencies[71].

[68] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.
[69] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.
[70] U.S. Census Bureau 2010 or 2011 population estimates
[71] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.

Economic:

Social and public health services in low-income communities are often determined by the socio-economic level data obtained by the agencies, such as income, education levels, state benefits, and Social Security income. These disparities can be addressed by focusing on programs that consider job-training, education, and affordable housing. In order to utilize programs to create the greatest health impact, Oklahoma City and County will need to encourage partnerships between new and existing programs, and the integration for a common goal. First, identify social barriers. Lower-income households are often found to have higher risk for poor health outcomes regardless of age, increased dependence on community-based health services, and lower levels of education attainment. The estimated median household income in Oklahoma County is $44,287. Poverty is one of the most important signs of community health and wellness. It can be used to predict many poor behavioral choices and negative health outcomes. In addition, poverty is associated with an increased need for public health and other social services. Poverty-stricken communities are often associated with lack of access to medical care. Providers can use this data to help direct programs, services, and policies that enable targeted outreach and service delivery to overcome this barrier. Oklahoma County has 17.3% of its population living in poverty. This is 1% higher than the Oklahoma state rate. Unemployment rates can be a sign of economic strengths or weaknesses and can indicate the overall economic stability of a community. Areas with higher levels of unemployment may have increased levels of poverty, indicating the potential need for associated social and health care access services. Unemployment rate increases often go hand in hand with increased levels of social and health services, indicating a direct link between unemployment and health outcomes. Providers can utilize this data to support programs, policies and services that drive down unemployment rates in our community. The unemployment rate in Oklahoma County was at 5% in July of 2013, which was 2.4% lower than the national unemployment rate[72].

Education:

Like social economic factors, educational attainment is one of several critical factors that influence overall health and well-being of an individual and the community as a whole. Higher levels of education are associated with delayed childbirth in females and higher-wage jobs for families in general. Education level is also associated with behavioral and lifestyle choices that can impact community health. For providers of health and social services, the average level of education in a community can be used to predict the types of education and outreach that is appropriate and relevant to individual needs. Using education levels to inform programs, policies, and services ensures messaging is relevant to the community. Community residents can use this data to advocate for policies, programs, and services that increase education and training opportunities in communities at risk for not graduating from high school or less likely to pursue additional education and training opportunities. Advocating for sound education and training centers in our community will play a significant role in improving overall health outcomes. 13.7% of Oklahoma County residents have not attained a high school diploma or equivalent[73].

Infectious Disease:

Infectious diseases can be detrimental to a community, as some can be released quickly into the community and if not treated, could lead to death. Hepatitis B, Hepatitis C, along with other infectious diseases can be of great concern to Oklahoma City residents. Other infectious disease includes all other

[72] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.

[73] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.

reports of disease within the community that can be spread from person to person. These diseases include pertussis, meningococcal invasive disease, West Nile virus, and Haemophilus Influenza. The remaining diseases investigated are primarily transmitted from person to person through direct contact with respiratory droplets (saliva or nasal mucus) or arboviral (infected insect/animal). Hepatitis B is a viral infection which can cause acute (up to 6 months) or chronic (lifetime) symptoms. This disease is spread through blood and bodily fluids (semen). Approximately 600,000 people die each year nationally from Hepatitis B, according to the CDC. There were 41 cases of acute hepatitis B and 260 cases of chronic hepatitis B identified in Oklahoma County from 2010-2012. Oklahoma County has had lower rates of acute hepatitis B (2.23 per 100,000 in 2010 and 2.37 per 100,000 in 2011) reported than the state rates (3.12 per 100,000 in 2010 and 2.67 per 100,000 in 2011) for the past several years. Hepatitis C is a viral infection which can cause acute (up to 6 months) or chronic (lifetime) symptoms. This disease is spread through blood-to-blood contact with another individual. Most people become infected from Hepatitis C by sharing needles or other equipment to inject drugs. Unlike Hepatitis A and B, there are no vaccines for Hepatitis C, and it is believed that over 3.2 million Americans have chronic Hepatitis C with a large portion unaware of their disease status. There were 20 cases of acute Hepatitis C and 803 cases of chronic Hepatitis B identified in Oklahoma County from 2010-2012. Oklahoma County has had lower rates of acute Hepatitis B (0.42 per 100,000 in 2010 and 0.83 per 100,00 in 2011) reported than the state rates (1.09 per 100,000 in 2010 and 1.39 per 100,000 in 2011) for the past several years[74].

Chronic Disease and Mortality:

According to the Wellness Score, chronic disease mortality demonstrates the burden of chronic disease within our community. Chronic mortality includes death caused from cardiovascular disease and stroke. More than 60% of all chronic disease mortality is due to lifestyle and behavior factors that could be modified to improve health and well-being. There are a number of on-going efforts in the community aimed at reducing the burden of chronic disease, but there is also a growing body of evidence to support new, innovative practices to achieve this goal. The overall mortality rate for Oklahoma County from 2010-2012 was 873.5 per 100,000 people. This is higher than the national rate or 747.0 per 100,000 and lower than the state rate of 951.7 per 100,000. Mortality rates were highest among American Indians and males.

Cardiovascular disease (CVD) is the leading cause of death nationally and in Oklahoma County. Major risk factors include smoking, physical inactivity, diabetes, high cholesterol, and hypertension – all of which can be modified. High rates may indicate areas for diet, smoking, or physical activity interventions, or areas with low access to regular medical care or healthy foods. The mortality rate for the county was 269.1 deaths per 100,000, making cardiovascular disease the leading cause of death. This was higher than the US rate of 234.2 deaths per 100,000, but lower than the state rate of 303.9. Mortality rates were highest among American Indians. Stroke is a rapid loss of brain function due to disturbances in the blood supply of the brain. Approximately 130,000 Americans die each year from strokes, and approximately 795,000 people have a stroke event. Strokes are a leading cause of serious long-term disability. The most powerful modifiable risk factor for stroke is hypertension, or high blood pressure. Smoking, high cholesterol, and obesity are also major risk factors, all of which can be modified through lifestyle changes. The mortality rate for the county for stroke was 42.0 deaths per 100,000, roughly equal to the statewide rate. This is higher than the national rate of 39.1 deaths per 100,000. American Indians had the highest mortality rate. Heart attack, combined with stroke, accounts for nearly 25% of all cardiovascular deaths in Oklahoma County. Preventing heart attack

[74] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.

occurrence depends on controlling cardiovascular disease and its underlying causes such as hypertension, obesity, and physical inactivity. Providers should work with other stakeholders in the community to align policies and practices with local health and wellness efforts focused on addressing the root cause of heart attack occurrence. Policies, programs, and services that seek to address environmental, social, and behavioral norms, combined with physical health and wellness, will have the greatest impact. The mortality rate for the county was 22.8 deaths per 100,000 people. This was lower than the national rate of 36.5 deaths per 100,000[75].

Additional mortality concerns include deaths that are often preventable, by maintaining good health habits, medication, and routine exams, such as diabetes and hypertension. Diabetes is an increasing cause of death nationally and in Oklahoma County. Risk factors for diabetes include physical inactivity and a bad quality diet. Diabetes itself is a risk factor for other diseases such as CVD. High rates of diabetes-related deaths may indicate low access to medical care, low access to healthy foods, areas or populations for whom physical activity is difficult or unsafe, or areas or populations with low access, resources or knowledge to buy or use necessary equipment. The age adjusted mortality rate for Oklahoma County was 27.7 deaths per 100,000 people. This was higher than the national rate of 20.8 deaths per 100,000 but lower than the state rate of 29.7 deaths per 100,000. Death due to hypertension includes death due to hypertensive heart disease, hypertensive heart and renal disease, or essential hypertension and hypertensive renal disease. Prevention strategies include a well-balanced diet, exercise, and lowering salt intake. It can be managed by similar means as well as by medication. Death due to hypertension may indicate lack of access to healthy foods or exercise opportunities, lack of education about personal risk, and lack of access to care. The mortality rate for the county was 27.6 deaths per 100,000 people, which was roughly equal to the state rate of 27.9 deaths per 100,000 and higher than the national rate of 18.8 deaths per 100,000. Rates were highest among American Indians[76].

While lung cancer is not specifically addressed in the national health agenda, it is still an indicator of quality of life on the individual level and is measurable indicator of air quality and the effects of tobacco. Lung cancer is the leading cause of cancer deaths in Oklahoma County. It is difficult to detect and difficult to treat effectively. Nearly all lung cancer can be attributed to smoking. Behavioral change could drastically reduce this rate. Through local public health efforts such as the Tobacco Settlement Endowment Trust and Wellness Now, providers can collaborate with other community stakeholders to work on developing policies and practices to address lung cancer within the community. Providers should work with other stakeholders in community health to align policies and practices with Wellness Now and local public health efforts. Tobacco use is the single most critical factor in determining risk for lung cancer, with those who smoke or who are exposed to secondhand smoke at highest risk. As a community, advocating for programs, policies, and services that reduce tobacco use and exposure to secondhand smoke is critical to reducing lung cancer mortality. The mortality for lung cancer in Oklahoma County was 52.2 deaths per 100,000 people. This was higher than the rate for the country of 47.6 deaths per 100,000 but lower that the state rate of 61.9 per 100,000. Lung cancer alone accounted for 28% of the cancer mortality in Oklahoma County[77].

[75] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.
[76] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.
[77] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.

Mental Health:

The World Health Organization defines mental health as a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make contribution to his or her community. Overall social health includes conditions within the population that influence individuals and group difference in health; specifically, risk factors found in one's life, such as built environment, economics, or accessibility. The social health of a community can impact perceptions of health and well-being. Mental and social health indicators are a measure of the emotional quality of life of Oklahoma City and County residents. Mental and social health is a primary indicator of physical health. This knowledge has the led the Wellness Now Coalition to prioritize mental health and substance abuse for the updated Community Health Improvement Plan. The Oklahoma City-County Health Department actively engaged in partnerships and grants to increase access to mental and social health services, as well as program activities directed at reducing youth suicide through training system providers to recognize the signs and symptoms of depression[78].

While suicide may consist of mental and physical health warnings, it is still considered a largely preventable cause of death. Recognition and treatment for those at risk is crucial for lowering the number of deaths. Similarly, public awareness and lowering of stigma for use of mental health care may improve outcomes. Widespread inclusion of mental health treatment in health plans may help increase the use of these services and decrease the number of deaths as well. Areas with high rates may indicate low access to medical or mental health care or low knowledge of resources. Trends in suicide rates are often indicative of community norms and changes in cultural and societal expectations. Residents have an opportunity to improve community awareness and system changes along with developing or advocating for programs, services, and policies that aim to reduce suicide mortality through targeted community campaigning and education. The rate of suicide was 16.6 per 100,000 in Oklahoma County. This was higher than the national rate of 12.1 deaths per 100,000 and lower than the state rate of 18.1 per 100,000. Mortality was highest in American Indians and males.

Nutrition:

Free and reduced lunch is provided to children as a nutrition supplement and is made eligible to low-income families in Oklahoma County. This is a secondary indicator of economic hardship and can be used in conjunction with socioeconomic data to identify areas within the community to target for social and health services. Total for Oklahoma City-County region that receive free and reduced lunch is 117,616 which equal 115 per 1,000 persons. For *free* lunch the rate is 105 per 1,000 persons, and *reduced* lunch is 10 per 1,000. Of those who get free or reduced 54% are Caucasian followed by 33% being African American/Black[79]. Although schools are an excellent source of accessing healthy food choices, parents and families cannot purchase all meals through the school system. They are left to make choices at home without consequence or concern as to which foods are bought and consumed. In many circumstances low-income families may have barriers that restrict the purchase of healthy foods. Access to healthy food choices are an indicator for the standard of health for the community. Eating fresh fruits and vegetables will lower the chances for chronic disease such as diabetes, stroke, hypertension, and many more. Areas that have a low number of grocery stores and high number of convenient stores and fast food restaurants are considered food deserts. Local

[78] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.
[79] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.

public health efforts such as Wellness Now and the Tobacco Settlement Endowment Trust, along with community partnerships, can assist providers in identifying resources to impact social inequalities and assure policies and programs are in place to address decreased grocery store accessibility, especially in low-income communities where public transportation is the primary form of commuting. Local public health initiatives require that action plans and strategies take into account community residents, ideas and activities. Residents have an opportunity to improve community awareness and system changes along with developing or advocating for programs, services, and policies that aim to reduce social inequality and increasing social and health services in our community geared towards access to grocery stores. According to the Wellness Score data, the Oklahoma City-County region averages 0.10 grocery stores per capita, while fast food restaurants is 0.29 per capita; there are 0.29 convenience stores per capita as well.

Violence:

When considering the direct impact of health on mortality, the indirect impact of health on mortality is often overlooked, such as physical assaults, homicides, and rapes/sexual assault. In many low-income communities, homicides account for the largest number of years of avoidable life lost. Witnessing and experiencing community violence causes longer-term behavioral and emotional problems in youths. Community violence also impacts the perceived safety of a neighborhood, inhibiting social interactions and adversely impacting social cohesion. Parental concerns about neighborhood crime strongly influence their willingness to allow their children to actively commute (e.g. walk or bike) to school, influencing children's levels of physical activity. The presence or absence of criminal activity in a given community has a critical influence upon physical activity, social and mental health, and overall well-being. Areas with higher rates of crime experience higher rates of unemployment, poorer health outcomes, and often have lower rates of educational attainment. Crime is one of a number of underlying indicators that contribute to the overall Wellness Score, and also represent and opportunity to bring new partners to the table as we develop our updated Community Health Improvement Plan[80].

Healthcare:

The Wellness Score also looked at the number of emergency room visits, preventable hospitalizations, and the delayed access to primary care networks as important factors that attribute to Oklahoma City and County health status. Lack of access to adequate and timely services can lead to increased use of the hospital ER as a source of primary care. Frequent ER use has been associated with poor health, and the uninsured and underinsured are disproportionately affected. In 2012, Oklahoma County had 552,217 emergency room visits, of which 373,292 were Oklahoma County residents, for an approximate overall rate of 519 per 1,000 population. This is most likely an overestimate for county residents because zip code was unknown for 17 percent of visits. The 2007 rates were 447 and 401 per 1,000 for Oklahoma and the US, respectively. Females (53%) accounted for more visits than males (47%). 24 percent of visits were for individuals 24-34 years of age. The largest portions of ER visits were from central Oklahoma County residents.

Preventable hospitalizations are a symptom of the quality and accessibility of primary health care services available to a community. Areas with higher density of primary care providers usually have lower rates of hospitalization for ambulatory care-sensitive conditions. If access to high-quality primary care is increased, a community may be able to reduce its preventable hospitalizations. Providers can work with local public health and hospital systems to develop policies and programs to increase access to primary care services and

[80] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.

decrease preventable hospital stays. This information is vital in understanding the burden of cost of medical services in the community and identifying individual savings that could be made by all residents seeking a medical home within Oklahoma County. In Oklahoma County, 61 out of 1,000 Medicare enrollees were discharged from the hospital for preventable hospitalizations[81].

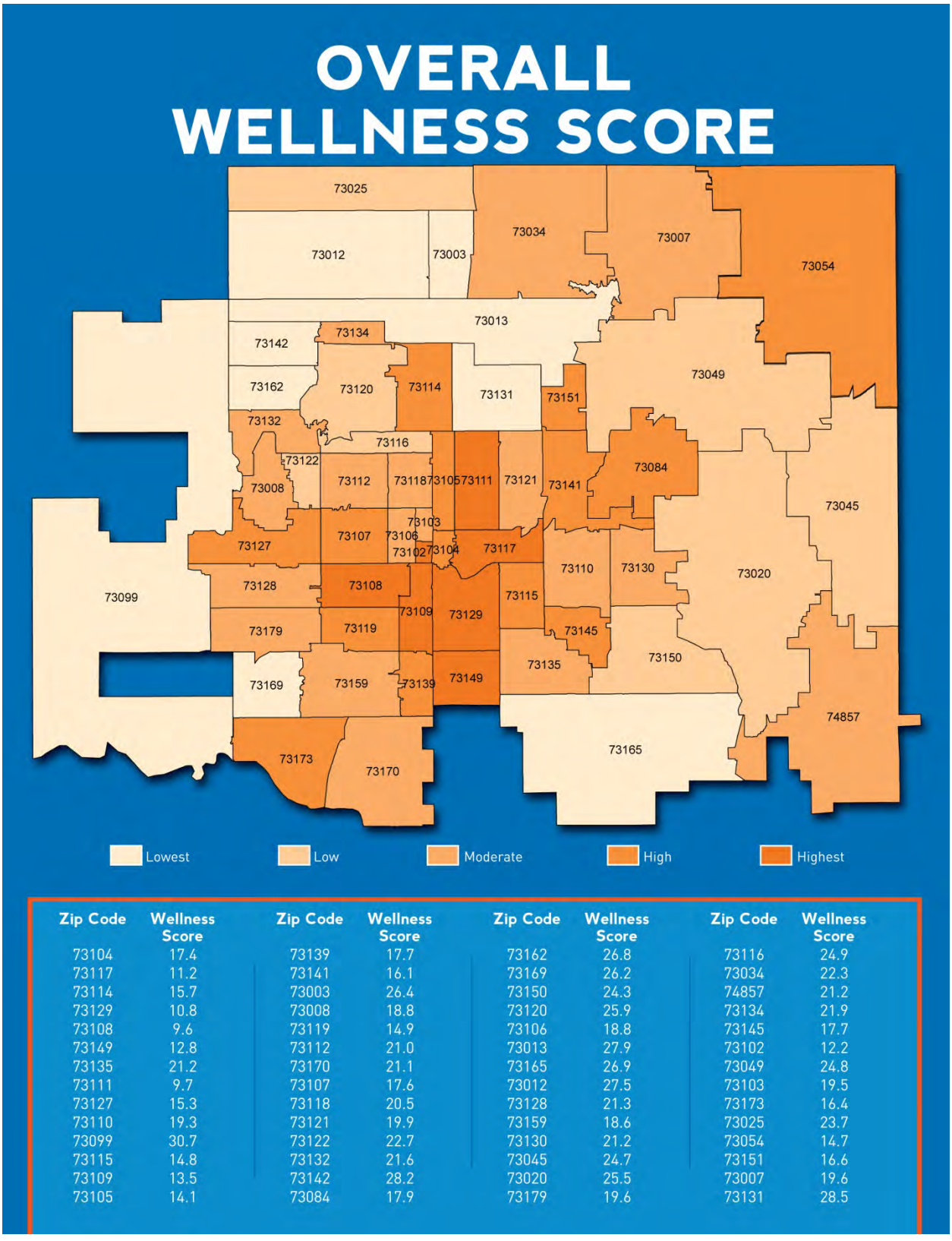
The Wellness Score data also identifies a lack of or delayed access to primary care physicians can lead to poor health outcomes because of inadequate preventative care and delayed treatment. Transportation for medical appointments is often a challenge for low-income residents, which results in increased use of hospital emergency rooms. Providers can work with local public health and hospital systems to develop policies and programs to increase access to primary care services and increase the physician-to-client ratio. Residents can utilize this information to expand community awareness around primary care access and preventable hospital stays. This information is vital in understanding the burden of cost on medical services in the community and identifying individual savings that could be made by all residents seeking a medical home within Oklahoma County. The county health ranking indicates that there are approximately 1,241 patients per primary care provider. This is better than the state ratio but worse than the national ratio.

Health Improvement:

Just as the State of Oklahoma has observed the need for a healthier state, the Oklahoma City County Health Department has also identified the need for change within communities, and is actively reaching out to the population to provide programs, educational opportunities, low cost activities, and additional support for needs at the county and community levels.

Health improvement plans, disease management, physical education in schools, and nutrition programs are all county initiatives to improve health. The Wellness Now Coalition has identified chronic disease mortality as a priority focus area for the updated Community Health Improvement Plan. The Oklahoma City-County Health Department has a number of ongoing programs intended to reduce the burden of chronic disease in our community, including: My Heart – A chronic disease management project that incorporates primary care services with public health interventions (Total Wellness) to improve health behaviors and reduce causes of cardiovascular disease mortality such as hypertension, obesity, diabetes, and diet; Community Transformation Grant activities include integration of physical activity into the classroom of local public schools; and Tobacco Settlement Endowment Trust (TSET) initiatives utilize a coalition-focused approach to engaging stakeholders in developing strategies and plans that systematically address nutrition, physical activity, and tobacco use as primary indicators of chronic disease mortality.

[81] Wellness Now. (2014). *Oklahoma County Wellness Score 2014: Community Health Status Assessment*. Oklahoma City: Oklahoma City County Health Department.



Zip Code	Wellness Score	Zip Code	Wellness Score	Zip Code	Wellness Score	Zip Code	Wellness Score
73104	17.4	73139	17.7	73162	26.8	73116	24.9
73117	11.2	73141	16.1	73169	26.2	73034	22.3
73114	15.7	73003	26.4	73150	24.3	74857	21.2
73129	10.8	73008	18.8	73120	25.9	73134	21.9
73108	9.6	73119	14.9	73106	18.8	73145	17.7
73149	12.8	73112	21.0	73013	27.9	73102	12.2
73135	21.2	73170	21.1	73165	26.9	73049	24.8
73111	9.7	73107	17.6	73012	27.5	73103	19.5
73127	15.3	73118	20.5	73128	21.3	73173	16.4
73110	19.3	73121	19.9	73159	18.6	73025	23.7
73099	30.7	73122	22.7	73130	21.2	73054	14.7
73115	14.8	73132	21.6	73045	24.7	73151	16.6
73109	13.5	73142	28.2	73020	25.5	73007	19.6
73105	14.1	73084	17.9	73179	19.6	73131	28.5

sustainokc indicators

Su.1 Land-Use Integration (Mixed-Use)

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
How integrated are the land uses within OKC?	Land use diversity index	Physical activity; access to daily needs; community cohesion; air quality	Obesity, Chronic Disease, Respiratory Disease, Mental Health

Su.2 The Effect of Regulation on Walkability

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
How do the myriad municipal regulations related to walkability, impact it?	Number of variances given to exclude sidewalks or pedestrian facilities	Physical activity; community cohesion; air quality; access to daily needs; economic strength	Obesity, Chronic, Disease, Respiratory Disease, Mental Health, Poverty

I. sustainokc Indicators

Su.1 Land-Use Integration (Mixed-Use)

Su.2 The Effect of Regulation on Walkability

Health-based Rationale

Mixed-use development has become a term that conjures images of a walkable cityscape with shops, restaurants, commercial offices, recreation and residential. While a single development may strive to achieve all of these elements, what is most important is how each development fits into its urban context. How a city's different parts fit together can be the difference between a population that is nearly completely dependent on motor-vehicles, suffers from obesity, and does not have a strong community, to one where people walk everywhere, are healthy, and have cultivated a strong identity based upon their ability to engage with a 'sense of place' within their city.

Stemming from this concept is the idea that proper land use integration will promote physical activity. Sprawling sub-urban development generally indicates a poor walking environment, and people who live in regions with this development form tend to walk less and weigh more than those who do not live in this type of environment[82]. Due to the lack of walkability of suburban sprawl, motor vehicles are the most common mode of transportation, causing greater amounts of pollutants to degrade air quality. For example, Atlanta, Georgia's car-dependent nature has led to an average of 40 'code orange' days every summer for the last 15 years, meaning that the air quality is dangerous to humans; Atlanta ranks #2 in the country for the amount of air pollution from vehicles[83]. Respiratory disease and cardiovascular disease are of a higher risk in areas with poor air quality.

Improper land use development can also have an impact upon water quality. There have been great strides taken to reduce water pollution in the U.S., but the majority of these interventions have occurred at point sources (factories, water treatment facilities, etc.) and not at non-point sources, or land that has not been developed with the impact of run-off in mind (urban streets, suburban developments, agricultural fields, etc.)[84]. Runoff from farm lands can include harmful chemical agents in the form of pesticides, which can poison water supplies.

Sprawl also reduces the amount of open land available for farming, putting pressure on food systems, and increasing the distance that food has to travel. In turn, this causes more air pollution to proliferate from the trucking industry, and the quality of the food is lesser than if it were sourced more locally[85]. This impacts individual, economic and climatic health.

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[82] Atlanta Regional Health Forum, Atlanta Regional Commission, (2006*). Land use planning for public health: The role of local boards of health in community design and development*. Retrieved from National Association of Local Boards of Health website: http://www.cdc.gov/healthyplaces/publications/landusenalboh.pdf

[83] Southern Environmental Law Center. (2005). *Facing the facts about Atlanta's air quality*. Retrieved from http://www.southernenvironment.org/cases/clean_air_in_atlanta2/facing_the_facts_about_atlantas_air_quality

[84] Cudmore, W. W. Chemeketa community College, Northwest Center for Sustainable Resources. (n.d.).*The impact of land use on water quality: A watershed evaluation from canoes*. Retrieved from website: http://learnforests.org/sites/default/files/ImpactofLandUseonWaterQuality.pdf

[85] Natural Resources Defense Council (2007*). Food miles: How har your food travels has serious consequences for your health and the climate*. Retrieved from: http://food-hub.org/files/resources/Food%20Miles.pdf

If land uses develop in such a way that uses, income groups and age groups are segregated, there is an increased likelihood that vulnerable populations will suffer from social and physical isolation. This means that those who are most susceptible to the negative impacts of land use decisions can have lesser access to healthy foods, jobs, and suffer higher rates of poverty, with all the negative individual and community health consequences that follow: violence, HIV/AIDS, weather-related deaths, and more[86].

These impacts can be avoided by proper zoning code revision, but without proper enforcement and with too lax of conditions for granting variances, the risk for poorly integrated development persists.

Existing Conditions

In order to evaluate the integration of land use at the city scale Simpson's Diversity Index[87] was used. The primary purpose of evaluating this diversity index is to get an idea of areas within Oklahoma City that could be walkable or bikeable due to there being many useful land-use types within a reasonable area.

Simpson's Diversity Index is based upon the following formula:

$$D=\sum (n / N)^2$$

Where:

n = the total area of a particular land use
N = the total area of all land uses
D = Diversity; where D is greater than or equal to 0, and less than or equal to 1.

A diversity score of 0 implies complete diversity, while a diversity score of 1 implies complete homogeneity.

In order to better understand the land use diversity of the city relative to different modes of transportation, the radius by which the diversity tool is calculated was modified to correspond to a walkable area and a bikeable area. These radial distances of 100 yards and ¼-mile respectively were selected as reasonable measures of walkability and bikeability. The rationale for these distances is that a specific district or location should not be assessed in terms of the distance from a single midpoint, but should be viewed on a continuous pathway, such as the circumference of the area, whereby the radial distances of 100 yards and ¼-mile derive a reasonable distance to walk or bike at a reasonable speed. In this case, 100 yards equates to between ¼-mile and ½-mile in distance, or a 10-minute walk; and ¼-mile equates to just over 1.5 miles, or a 10-minute bike ride.

In order to keep from skewing the diversity indexing for the entire city, areas that are undeveloped or large single-use properties (farms, airports, lakes, etc.), which score a 1 on the diversity index, were removed. For the 100-yard radius, this encompassed 544.14 square miles, or roughly 90% of the area within the city limits. The remaining 77 square miles is therefore balanced in its classification, revealing an average land-use diversity index score of 0.59. For the ¼-mile radius, this encompassed 307.48 square miles, or roughly one-

[86] Atlanta Regional Health Forum, Atlanta Regional Commission, (2006). *Land use planning for public health: The role of local boards of health in community design and development*. Retrieved from National Association of Local Boards of Health website: http://www.cdc.gov/healthyplaces/publications/landusenalboh.pdf

[87] From http://www.tiem.utk.edu/~gross/bioed/bealsmodules/simpsonDI.html: "Simpson's diversity index (D) is a simple mathematical measure that characterizes species diversity in a community."

half of the area within the city limits. The remaining 314 square miles is therefore balanced in its classification, revealing an average land-use diversity index score of 0.57. We can use these numbers as averages for the developed areas of the city.

The numbers generated from this indexing are by no means completely indicative of a walkable or bikeable environment, but they can aid in pointing out areas that could become development nodes around the city.

The maps below illustrate in a raster heat map what the land use diversity landscape for the City of Oklahoma City looks like at a walkable and bikeable distance. From this map, twelve locations were selected to get a sampling of what the diversity index is for each. Clearly visible in the heat maps is the diversity of land uses along transportation corridors and within the downtown and midtown areas. The Northwest Expressway and I-240 corridor stand out, and most of the points where major arterials intersect are hot spots.

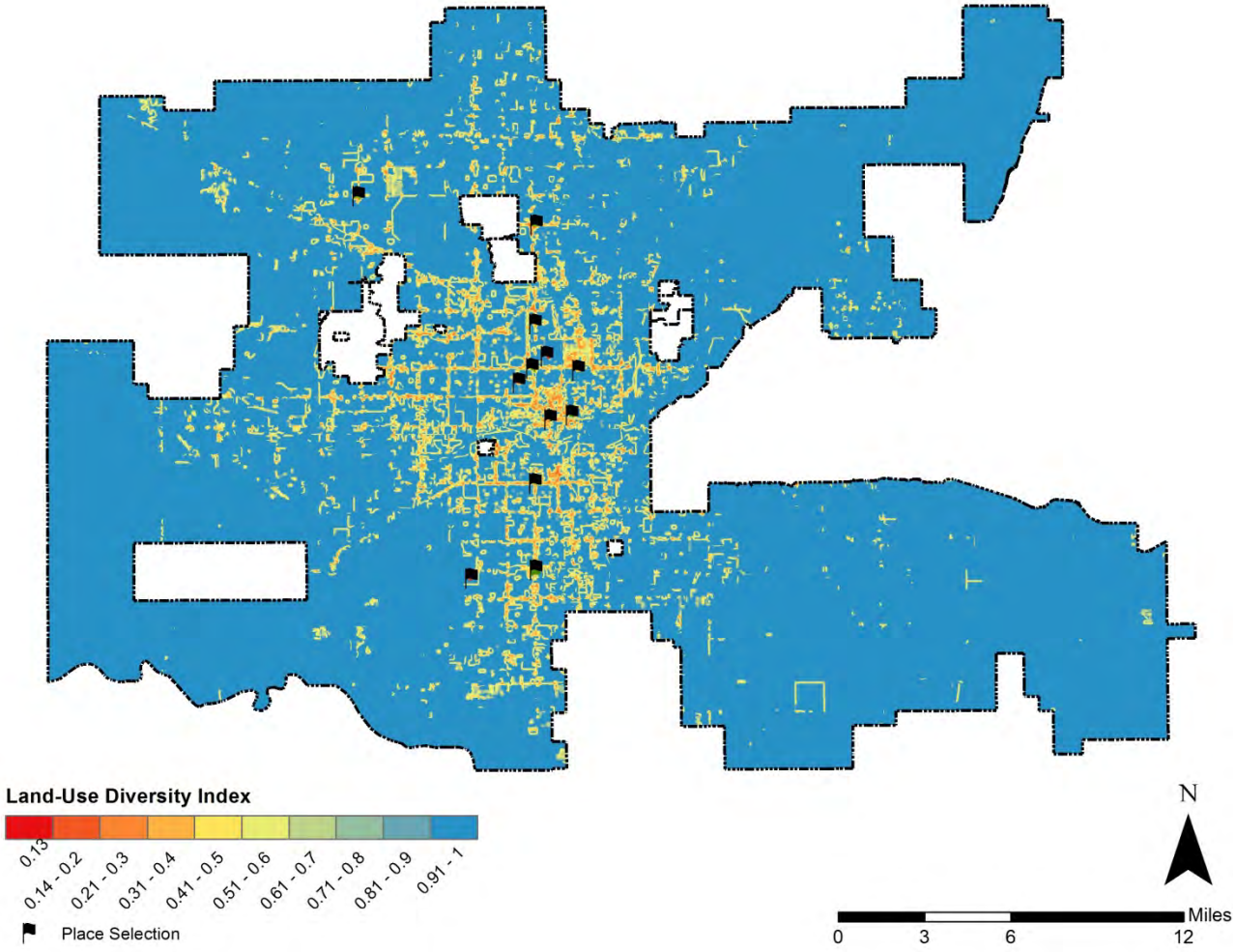

Figure 1: Land-Use Diversity at a Walkable Distance

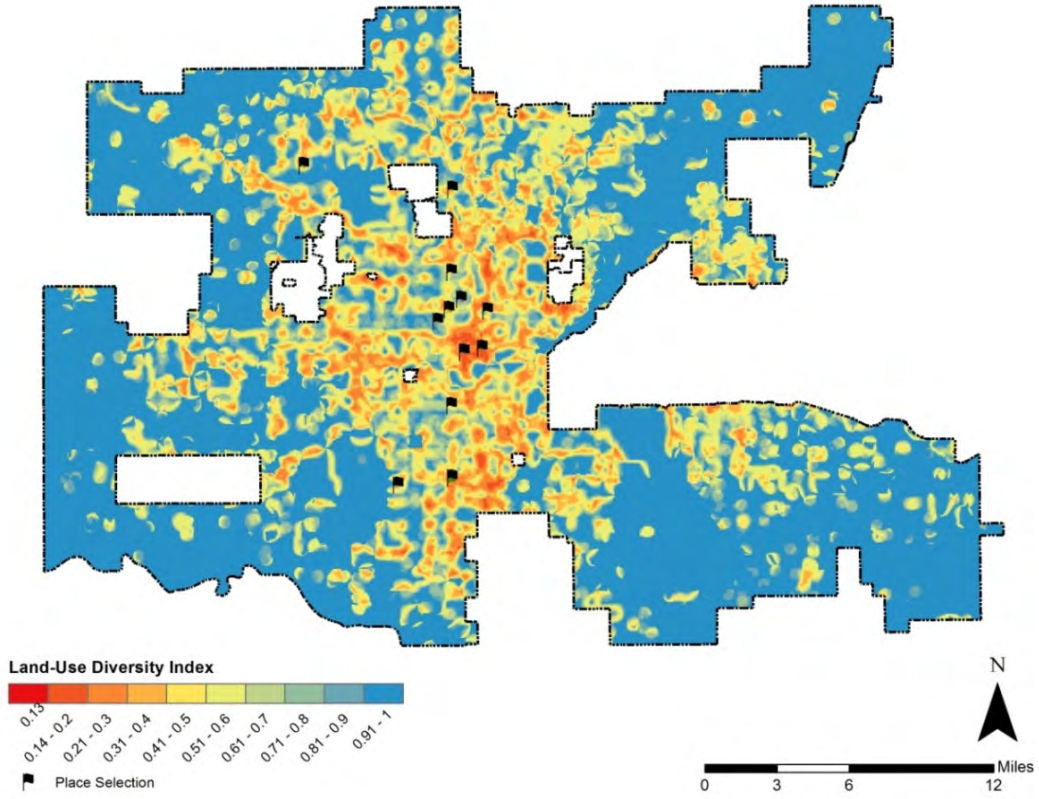

Figure 2: Land-Use Diversity at a Bikeable Distance

In the table below are the scores for 12 locations selected from around the city with their corresponding diversity index score compared to the average for the city. There are some interesting relationships between a walkable distance and a bikeable distance at some of these locations. Plaza District and the Paseo Arts District are very walkable, and score better than average at that distance, but due to their small size, they actually score worse than average for a bikeable distance. Three locations scored well for both walking and biking: 29th and Western, West Main Street (downtown), and Brittontown. This list can help prioritize modal improvements in each area.

Land Use Diversity		Walkable	Bikeable
	Location	**Score**	**Score**
1.	23rd Street and Classen Drive	0.56	0.30
2.	29th Street and Western Avenue	0.44	0.43
3.	West Main Street	0.23	0.18
4.	Deep Deuce	0.59	0.26
5.	OCCC	1.00	0.88
6.	Plaza District	0.39	0.84
7.	Hefner Road and Rockwell Avenue	0.59	0.34
8.	43rd Street and Western Avenue	0.39	0.60
9.	Capitol	0.98	0.56
10.	Paseo Arts District	0.48	0.84
11.	Brittontown	0.32	0.35
12.	I-240 and Western Avenue	0.56	0.26

Diverse
Average
Not Diverse

Scenario Analysis

The Envision Tomorrow tool has several fields dedicated to the concept of land-use diversity indexing. At distances of 1 mile, ½-mile, and ¼-mile, a value between 0 and 1, 0 representing complete homogeneity, and 1 representing complete diversity, can be generated for each of the three scenarios. In order to compare the three scenarios average values for each scenario at each distance were compared, as well as the ratio of acreage within the city limits by five standard classifications of diversity. Because the scale of diversity is linear from 0 to 1 (i.e. not logarithmic or any other scalar measure) it was reasonable to break the scale into five distinct chunks with a range of 0.2: 0 – 0.2; 0.2 – 0.4; 0.4 – 0.6; 0.6 – 0.8; 0.8 – 1.

Using this system resulted in the table below, which illustrates the land-use diversity at the city scale among the three scenarios:

Average Land-Use Diversity Index Score - City			
Radius	Scenario A	Scenario B	Scenario C
¼-Mile	0.21	0.19	0.19
½-Mile	0.30	0.27	0.27
1 Mile	0.39	0.35	0.35

Considering that Scenario C densifies development into more compact mixed-use areas, this result is initially puzzling. The reason we see this trend of Scenario A appearing to be more diverse is due to the scale at which the analysis has been conducted; Scenario A sprinkles development of all types around the greatest area of the three scenarios, while Scenarios B and C preserve the rural and agricultural character of the outskirts of the city, thereby skewing the averaging for the city. Essentially, a higher value for the land-use diversity score at the city-wide scale does not imply that a Scenario A is more walkable, bikeable or accessible; it implies that development is stretched more broadly over the entire 621 square miles of Oklahoma City.

In order to prove this concept, the analysis was then run for a smaller area that is generally considered to be a walkable area in existing conditions; Downtown. This area for analysis includes Downtown from Shartel Avenue on the west to I-235 on the east (as well as to include OUHSC), I-40 to the south, and bordering upon Midtown to the north. The table below illustrates the land-use diversity index score for each of the three scenarios relative to this downtown area:

Average Land-Use Diversity Index Score – Downtown (Including OUHSC)			
Radius	Scenario A	Scenario B	Scenario C
¼-Mile	0.64	0.72	0.75
½-Mile	0.69	0.77	0.79
1 Mile	0.75	0.79	0.80

Here we see results that would be expected; Scenario B and C score better than Scenario A in terms of land-use diversity at a scale that is easily traversable for a pedestrian or cyclist.

Conclusions

A) Under Scenario A there would be higher average land-use diversity for the entire city; however, at more manageable areas, the average land-use diversity would be less than Scenario B and C. Due to the small amount of mixed-use nodes around the city in Scenario A, it would be reasonable to expect a fairly consistent mix of uses in all of the developed areas.

B) Under Scenario B there would be lower average land-use diversity for the entire city than Scenario A, but nearly the same diversity level as Scenario C. At the smaller scale at which walking and biking are viable modes of transportation, Scenario B performs better than Scenario A, but not quite as well as Scenario C. With moderately intense mixed-use nodes spread across the developed area, the rate of diversity from one location to another could vary greatly, from homogenous agricultural and rural areas, to diverse mixed-use developments.

C) Under Scenario C there would be lower average land-use diversity for the entire city than Scenario A, but nearly the same diversity level as Scenario B. At a walkable and bikeable scale, Scenario C performs the best of the three scenarios. There would be a great degree of difference in the land-use diversity of the outskirts of the city when compared to the high-intensity mixed-use nodes spread over the developed areas in this scenario.

Policy Review

Overview:

Through residential, industrial, and commercial development, integration of land uses can be focused towards promoting a healthy mix of compatible and complementary traits, and help preserve resources, habitat, and existing communities. The integration of land uses relies on regulations to help protect sensitive lands and focus on open space, recreational, and agriculture uses in rural, open space, and environmental areas.

Relevant Policies:

Sustain.Land Use Patterns.**252**

Sustain.Land Use Patterns.**272**

Sustain.Land Use Patterns.**345**

Sustain.Land Use Patterns.**705**

Connect.Trails.**197**

Green.Agriculture and Food.**312**

Live.Neighborhood Stability.**499**

Recommendations

- Regulate development in fringe areas of the city to restrict haphazard growth.
- Ensure that uses in agricultural areas are compatible with farming practices.
- Encourage mixed-use developments.
    - Merge tenets of Euclidean zoning, performance zoning, conditional zoning and design-based zoning to allow for a customizable land use mix.
- Enforce connectivity requirements for sub-division development such that access to surrounding land uses is available. i.e. Discourage dead-end roads and cul-de-sacs in the urbanized areas of the city.
- Incentivize redevelopment of vacant and abandoned properties.
- Facilitate community improvements such as gardens, park space, physical activity uses particularly in proximity to schools, and high-density residential areas.
- Require multi-modal access to all land uses.
- Programmatically encourage neighborhoods and districts to organize and advocate for their areas.
- Enable and promote the integration of healthy uses into the land use mix at the neighborhood scale.
    - Encourage neighborhood-scale small businesses.

I. sustainokc Indicators

Su.1 Land-Use Integration (Mixed-Use)

Su.2 The Effect of Regulation Upon Walkability

Health-based Rationale

Mixed-use development has become a term that conjures images of a walkable cityscape with shops, restaurants, commercial offices, recreation and residential. While a single development may strive to achieve all of these elements, what is most important is how each development fits into its urban context. How a city's different parts fit together can be the difference between a population that is nearly completely dependent on motor-vehicles, suffers from obesity, and does not have a strong community, to one where people walk everywhere, are healthy, and have cultivated a strong identity based upon their ability to engage with a 'sense of place' within their city.

Stemming from this concept is the idea that proper land use integration will promote physical activity. Sprawling sub-urban development generally indicates a poor walking environment, and people who live in regions with this development form tend to walk less and weigh more than those who do not live in this type of environment[88]. Due to the lack of walkability of suburban sprawl, motor vehicles are the most common mode of transportation, causing greater amounts of pollutants to degrade air quality. For example, Atlanta, Georgia's car-dependent nature has led to an average of 40 'code orange' days every summer for the last 15 years, meaning that the air quality is dangerous to humans; Atlanta ranks #2 in the country for the amount of air pollution from vehicles[89]. Respiratory disease and cardiovascular disease are of a higher risk in areas with poor air quality.

Improper land use development can also have an impact upon water quality. There have been great strides taken to reduce water pollution in the U.S., but the majority of these interventions have occurred at point sources (factories, water treatment facilities, etc.) and not at non-point sources, or land that has not been developed with the impact of run-off in mind (urban streets, suburban developments, agricultural fields, etc.)[90]. Runoff from farm lands can include harmful chemical agents in the form of pesticides, which can poison water supplies.

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[89] Southern Environmental Law Center. (2005). *Facing the facts about Atlanta's air quality*. Retrieved from http://www.southernenvironment.org/cases/clean_air_in_atlanta2/facing_the_facts_about_atlantas_air_quality

[90] Cudmore, W. W. Chemeketa community College, Northwest Center for Sustainable Resources. (n.d.).*The impact of land use on water quality: A watershed evaluation from canoes*. Retrieved from website: http://learnforests.org/sites/default/files/ImpactofLandUseonWaterQuality.pdf

[91] Natural Resources Defense Council (2007). *Food miles: How har your food travels has serious consequences for your health and the climate*. Retrieved from: http://food-hub.org/files/resources/Food%20Miles.pdf

If land uses develop in such a way that uses, income groups and age groups are segregated, there is an increased likelihood that vulnerable populations will suffer from social and physical isolation. This means that those who are most susceptible to the negative impacts of land use decisions can have lesser access to healthy foods, jobs, and suffer higher rates of poverty, with all the negative individual and community health consequences that follow: violence, HIV/AIDS, weather-related deaths, and more[92].

These impacts can be avoided by proper zoning code revision, but without proper enforcement and with too lax of conditions for granting variances, the risk for poorly integrated development persists.

Existing Conditions

Zoning codes exist to provide a framework for a municipality and developers to use in order to best meet the needs of the city and citizens. Safety, health concerns, economics and logic are key tools in determining what zoning regulations become law, as well as when, where, why and how to allow variances to these regulations. When these decisions degrade walkable and inter-connected infrastructure, it becomes difficult to overcome precedents that allowed development without sidewalks or without street connections.

In Oklahoma City there are several ways that walkability can be degraded or ignored through development. Firstly, building sidewalks is not required for subdivisions with lots greater than one acre (OKC Code 59-12100G). This regulation negatively impacts walkability without a reliable standard; a sub-division filled with lots that are greater than one acre in area, but with less than 100' of linear frontage is not required to have sidewalks, despite the fact that the lots are in a walkable distance, which is what the code appears to be considering. The discrepancy of area vs. linear frontage distance causes this disconnect.

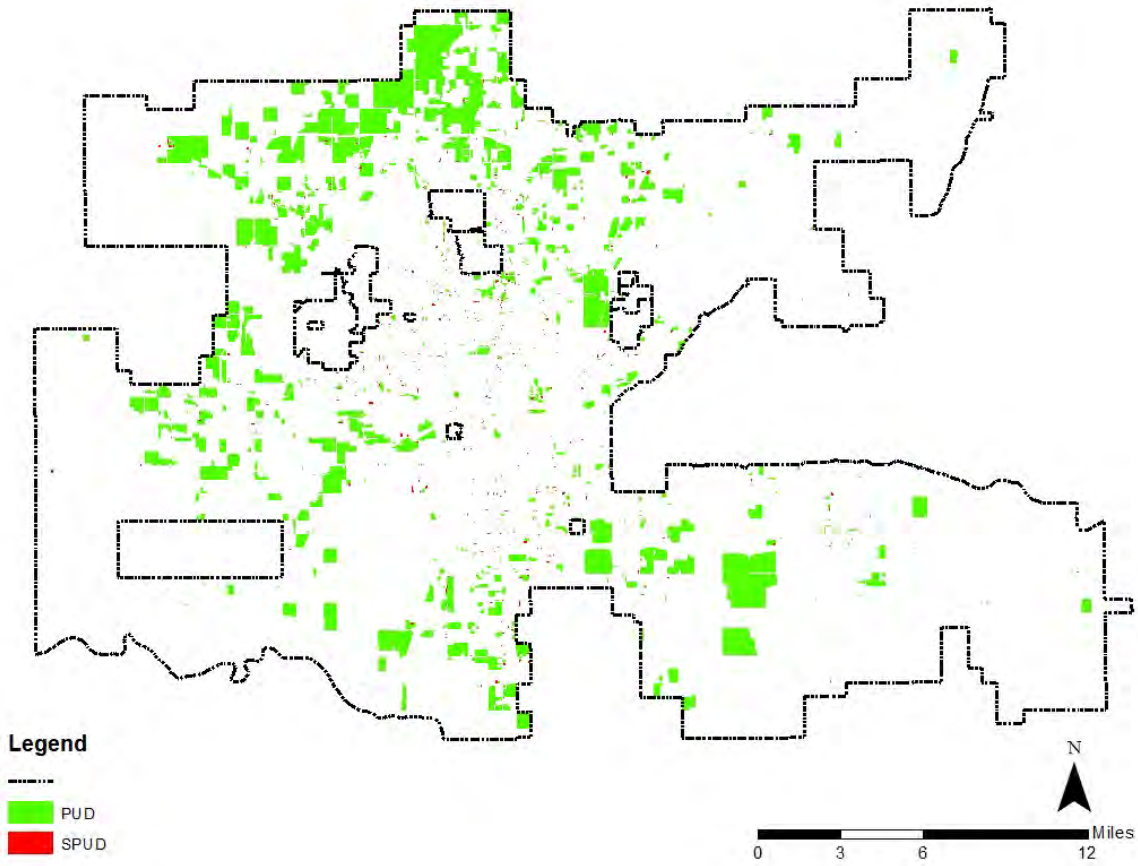
Subdivision regulations in Oklahoma City have provisions which can degrade the walkability of neighborhoods:

- Cul-de-sac streets three hundred (300) feet or less: No sidewalks shall be required. (Sec.5.8.2.B.1(a))
- Cul-de-sac streets between three hundred one and six hundred (301 – 600) feet: Sidewalks shall be required unless the cul-de-sac is designed with special design features which promote slower traffic speeds. (Sec.5.8.2.B.1(b))
- Alternative Plans for internal streets. The Planning Commission may accept an alternative plan for pedestrian traffic on all applications. The developer shall either demonstrate that sidewalks are not feasible in particular locations due to unusual and difficult terrain obstacles or the developer shall propose a plan that provides a safe and convenient pedestrian network connecting all portions of the development. The sidewalk plan shall be submitted as part of the preliminary plat application. (Sec.5.8.2.B.2)

There is an option for developers to pay a "fee in lieu of sidewalk improvements" with City Engineer approval in situations where sidewalk installations would be impractical. This fee is intended to be used for funding pedestrian infrastructure when the project becomes feasible.

[92] Atlanta Regional Health Forum, Atlanta Regional Commission, (2006*). Land use planning for public health: The role of local boards of health in community design and development*. Retrieved from National Association of Local Boards of Health website: http://www.cdc.gov/healthyplaces/publications/landusenalboh.pdf

Another way that walkability can be degraded is through a zoning category that allows subversion of the rest of the zoning code; Planned Unit Development (P.U.D.).This zoning classifications allows the Planning Commission to participate in a more holistic planning process, and the intent is to have a net positive gain above and beyond the zoning code based upon what is removed and added. However, sometimes a developer will avoid putting in sidewalks or pedestrian bridges in order to save money for other parts of the development. This creates gap in the City's sidewalk network, which then becomes the City's responsibility to correct, and with the intermittency of funding sources available for sidewalk construction, these gaps may exist for long extents of time. There are more than 2,000 instances of PUD and SPUD (similar to PUD but generally much smaller areas) development in the city, which is a risky situation that could undermine the intentions of the City's zoning code regulations.



The Board of Adjustment is in charge of granting variances, and much like the process of the PUD/SPUD with the Planning Commission, developers can argue their case against including pedestrian infrastructure. Variances are often granted in areas with industrial zoning and land use, but do occur in areas zoned residential. In the past variances were granted out-right, but in 2013 the majority of sidewalk variances were issued conditionally. These were articulated in two ways:

1. In five years the applicant has to return to determine if a sidewalk is now necessary

2. For the duration of the time that the given tract of land is being used in a specific capacity, the variance will be in force. However, if the character of the tract changes, the variance will no longer be applicable.

This is done in an effort to protect from future legal constraints in the promotion of walkability. The Board of Adjustment did not deny any sidewalk variance requests in 2013, but did express concern that granting variances unconditionally could have grave impacts in the future. In order for a developer or land-owner to be granted a variance they must meet four criteria:

1. The application of the Ordinance to the particular piece of property would create an unnecessary hardship;
2. Such conditions are peculiar to the particular piece of property involved;
3. Relief, if granted would not cause substantial detriment to the public good, or impair the purposes and intent of the Ordinance or Comprehensive Plan; and
4. The variance, if granted, would be the minimum necessary to alleviate the unnecessary hardship.

The most common claim of hardship is that there is nearly no pedestrian usage in the area, and it is peculiar to include a sidewalk because none of the adjacent properties have sidewalks. In a vacuum, this could be valid, but connectivity across the city is very important, which is why the Public Works Department and Development Services nearly always are on record saying that they recommend against granting a variance.

Scenario Analysis

Quantitative Analysis:

There is no quantitative method that can accurately make predictions regarding the regulation of sidewalk placement with differentiation among the scenarios.

Qualitative Analysis:

In discussions with current and long-range planners, patterns of walkability and connectivity based upon variances and PUDs for each of the three scenarios were defined as a ratio of developments that would utilize variances and PUDs to improve walkability and connectivity to contextual land uses, and those that would use PUDs and variances to sidestep these features.

In Scenario A, where a great deal of development will occur outside of the existing Urban Development boundary, it is likely that PUD will be utilized similar to development in this area today; whereby, walkability will be a low priority due to the poor connectivity of developments to one another. With walkability and connectivity as a goal, PUDs will likely not add value to the development or context in relation to the people who will use these developments. Additionally, growth in Scenario A will often stretch beyond existing public services. PUD development should deal with providing these public services, as well as how to be unobtrusive neighbors to the rural surroundings.

In Scenario C, PUDs will likely be utilized to incorporate mixed-use development into the more densely developed Urban Development area, adding value to the project and context by increasing the land-use diversity, and connectivity. Scenario B will likely have a mixture of the PUD conditions that Scenarios A and C could have; wherein, developments along major corridors could use the special zoning category to implement mixed-use projects, but developments in existing rural areas would use the special zoning to

reduce developer costs of implementation. Adjustments to the zoning code could bypass the uncertainty of PUD in relation to the future growth scenarios.

Conclusions

A) Under Scenario A it would be reasonable to expect that very little would change regarding the current variance capacity for undermining walkability as the greatest percentage of growth will continue to sprawl into regions of the city that have more relaxed regulation for sidewalks. Large lot residential units being exempt from sidewalk implementation may result in even less walkability, particularly as a percentage of total residential development. The Board of Adjustment process may continue to allow the lack of existing sidewalks to qualify as a hardship and peculiarity when developers request a sidewalk variance.

B) Under Scenario B with some densification of development around high-traffic corridors, it is likely that the total ratio of walkable to unwalkable residential neighborhoods would stay the same as existing conditions, and PUD developments may prioritize walkability. The development in the existing rural areas would likely be similar to Scenario A.

C) Under Scenario C there would be the greatest likelihood that variances would have little impact upon walkability as most development would occur in areas that are within the Urban Development boundary, where sidewalks are required. Being located in or near the existing sidewalk network would also help negate the request for sidewalk variances as it would be difficult to prove that the situation would be a hardship to the developer or a peculiarity to the location of the development.

Policy Review

Overview:

Adopting new and improving existing subdivision regulations, Oklahoma City can greatly impact the walkability of the city. Increased walkability could be accomplished by establishing a sidewalk network plan in which walkways are laid out in patterns which encourage pedestrian activity, implementing sidewalk improvements to ensure commercial districts are interconnected with surrounding neighborhoods for easy and convenient access and revising development standards to require sidewalks and transit stops along existing and planned transit routes.

Relevant Policies:

Sustain.Land Use Patterns.**263**

Sustain.Land Use Patterns.**273**

Sustain.Land Use Patterns.**278**

Connect.Transportation Systems.**175**

Connect.Transportation Systems.**177**

Connect.Sidewalks.**204**

Connect.Sidewalks.**206**

Connect.Transit.**209**

Play.Accessibility and Use.**367**

Strengthen.Place-making.**223**

Strengthen.Place-making.**228**

Strengthen.Employment and Opportunity.**173**

Recommendations

- Mandate sidewalks for all development in urban areas and any developments with lots less than two acres in area regardless of land-use type to ensure that future development is contiguous with the sidewalk network.
- Ensure that PUDs only enhance walkability. i.e. PUDs should never allow for a sidewalk to not be built in return for adding some other feature to the site.
- A sidewalk variance should be defined as an ineligible request of the Board of Adjustment.
- Focus efforts to improve sidewalks and walkability on key locations and connections between homes and destinations. Winning on cul-de-sacs and losing on major streets would be a net loss.
- Create an educational program that illustrates the importance and benefits of connectivity for streets, sidewalks, and bicycle routes.

strengthenokc indicators

St.1 Proportion of Jobs Paying a Livable Wage

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What is the proportion of jobs paying a livable wage?	Labor market data; Census data	Job security; employment rates; health benefits; income levels	Reduced life expectancy; chronic disease; depression; suicide; diminished mental health; early childbirth; nutritional deficiencies

St.2 Affordable Housing by Income Bracket

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
For all different income groups, what is the availability of affordable housing?	Housing studies; Population by income data	Lower access to healthy choices (food, heating, transport, health care, child care); Exposure to waste; physical hazards; having to move; job loss; long commute; isolation	Respiratory disease; lead poisoning; injuries; depression; behavioral issues with children

St.3 Homelessness

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
How many homeless individuals are in Oklahoma City?	HUD data; NHCHC data; Local data	Exposure to the elements; isolation; drug addiction; physical hazards; low access to healthy choices; lack of health insurance	Death; disability; mental health; chronic disease; infectious disease; addiction side-effects; depression; stress

II. strengthenokc Indicators

St.1 Proportion of Jobs Paying a Livable Wage

Health-based Rationale

Minimum wage mandates and the living wage movement spark highly political debates on both ends of the political spectrum, but also bring great concern to the public health community. A living wage ordinance generally specifies a minimum wage that private firms with contracts to perform municipal services must pay their employees[93].

The traditional argument for why campaigns have been successful holds that campaigns for fairness and justice are a response to cities contracting out municipal services – once provided by highly-paid unionized municipal workers – to private contractors – whose workers are non-unionized and paid considerably less – as a way of reducing their budgets. Meanwhile, the federal minimum wage has failed to keep pace with inflation, and this has all been amidst an environment of rising income inequality[94].

A recent study from the Social Science Journal assesses possible determinants of living wage rates across U.S. cities. The findings show that economic factors, particularly per capita income, cost of living, and minimum wage rates, have significant influence on the living wage. Furthermore, proximity of a city to another living wage city, as well as the date at which the living wage ordinance is enacted, contributes to the living wage rate[95]. In addition, a large body of evidence indicates that socioeconomic status (SES) is a strong predictor of school achievement, college graduation, and child outcomes in general. Better developmental and health outcomes are strongly associated with family assets, including greater wealth, more income, more years of education, steady professions, or residency in neighborhoods rich with services and supportive networks. Child health, educational attainment, and family socioeconomic status are inextricably linked[96].

Additionally, according to the New England Journal of Medicine, those who earned $15,000 each year are three times more likely to succumb to a premature death than individuals who earned $70,000[97]. Mental health impacts such as depression are often related to financial insecurity, and something as seemingly insignificant as a 1% increase in unemployment rates in the U.S. can result in 6,000 deaths, many of which come from suicide[98].

Existing Conditions

Oklahoma's minimum wage is $7.25 per hour. This is the same as the Federal Minimum Wage. The minimum wage is $7.25 per hour for most employees in Oklahoma, with exceptions for tipped employees,

[93] Levin-Walden, O. (2009). Urban path dependency theory and the living wage: Were cities that passed ordinances destined to do so?. *The Journal of Socio-Economics*, 672-683.

[94] Levin-Walden, O. (2008). Characteristics of cities that pass living wage ordinances: Are certain conditions more conducive than others?. *The Journal of Socio-Economics*, 2201-2213.

[95] Gallett, C. (2004). The determinants of living wage rates. *The Social Science Journal*, 661-666.

[96] Shanks, T. a. (2013). Assets, economic opportunity and toxic stress: A framework for understanding child and educational outcomes. *Economics of Education Review*, 154-170.

[97] Isaacs S, Schroeder S. Class—The Ignored Determinant of the Nation's Health. *New England Journal of Medicine*. 2004, 351(11):1137-1142.

[98] Jin RL, Shah CP, Svoboda TJ. The impact of unemployment on health: a review of the evidence. *The Journal of the Canadian Medical Association*. 1995;153:529–540.

some student workers, and other exempt occupations[99]. The minimum wage is based on federal and state laws, while the living wage is a social justice concept. In addition, the living wage hourly rate is higher than the minimum wage. The living wage is based on the cost of living or consumer price index in a local area[100].

The living wage shown is the hourly rate that an individual must earn to support their family, if they are the sole provider and are working full-time (2080 hours per year). The state minimum wage is the same for all individuals, regardless of how many dependents they may have. The poverty rate is typically quoted as gross annual income. For the sake of comparison the poverty wage has been converted to an hourly rate. Wages that are less than the living wage are shown in red[101].

Hourly Wages	1 Adult	1 Adult, 1 Child	1 Adult, 2 Children	1 Adult, 3 Children	2 Adults	2 Adults, 1 Child	2 Adults, 2 Children	2 Adults, 3 Children
Living Wage	**$8.19**	**$16.96**	**$21.63**	**$27.64**	**$13.26**	**$16.14**	**$17.52**	**$20.62**
Poverty Wage	$5.21	$7.00	$8.80	$10.60	$7.00	$8.80	$10.60	$12.40
Minimum Wage	$7.25	$7.25	$7.25	$7.25	$7.25	$7.25	$7.25	$7.25

Although specific historical data is unavailable on the percentage of jobs paying a living wage, census and department of labor trending data can provide an estimate or range of data in which inferences can be made. In the State of Oklahoma, 1,720,428 individuals were employed, on average within the past year (November 2012-October 2013) according to US Bureau of Labor Statistics. The Oklahoma City region accounts for 583,900 of those employed individuals. Of the employed individuals in Oklahoma City, the median hourly wage is $15.15, the mean hourly wage is $19.98 and the annual mean wage is $41,550[102].

Occupation code	Occupation title	Employment	Employment RSE	Employment per 1,000 jobs	Location quotient	Median hourly wage	Mean hourly wage	Annual mean wage	Mean wage RSE
00-0000	**All**	583,900	2.2%	1000.000	1.00	$15.15	$19.98	$41,550	2.1%

[99] Bureau of Labor Statistics. (2012). Retrieved 1 12, 2014, from May *2012 Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates*: http://www.bls.gov/oes/current/oes_36420.htm
Mimimum-Wage.Org. (2013). Retrieved 1 12, 2014, from Oklahoma Minimum Wage 2013-2014: http://www.minimum-wage.org/states.asp?state=Oklahoma
[100] eHow Money. (2014). Retrieved 1 12, 2014, from *Minimum Wage vs. Living Wage*: http://www.ehow.com/info_7798109_minimum-wage-vs-livable-wage.html#ixzz2qDeLi9xp
[101] Poverty In America. (2014). Retrieved 1 12, 2014, from *Living Wage Calculator*: http://livingwage.mit.edu/places/4002755000
[102] Bureau of Labor Statistics. (2012). Retrieved 1 12, 2014, from May 2012 *Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates*: http://www.bls.gov/oes/current/oes_36420.htm

When considering that living wage can be viewed as $8.19 per hour for an individual and up to $20.62 for a family of 2 adults plus 3 children for Oklahoma City, to pinpoint the exact amount of jobs available would be daunting. Therefore, by looking at the median hourly wage for Oklahoma City we can assume that this median reflects the separation point between the lowest hourly wage and the highest hourly wage, and any occupation with a median hourly wage of less than $20.62 would be considered less than living wage for the largest family group. Of the occupational groups, 448,740 jobs have a median hourly wage of less than $20.62, resulting in 77% of Oklahoma City's employment being possibly considered as less than living wage. You will also notice that the occupational categories with the largest number of employees, such as food preparation & service related occupations and office & administrative support occupations, are earning less than $14 per hour on a median range[103].

Occupation code	Occupation title	Employment	Median hourly wage	Mean hourly wage	Annual mean wage
35-0000	Food Preparation and Serving Related Occupations	53,730	$8.80	$9.30	$19,340
39-0000	Personal Care and Service Occupations	12,550	$9.07	$10.56	$21,970
37-0000	Building and Grounds Cleaning and Maintenance Occupations	16,570	$9.63	$10.77	$22,410
31-0000	Healthcare Support Occupations	16,990	$11.14	$12.09	$25,140
41-0000	Sales and Related Occupations	61,470	$11.33	$16.43	$34,170
45-0000	Farming, Fishing, and Forestry Occupations	760	$12.16	$17.38	$36,150
53-0000	Transportation and Material Moving Occupations	37,050	$13.17	$15.51	$32,260
43-0000	Office and Administrative Support Occupations	103,340	$13.71	$15.13	$31,460
51-0000	Production Occupations	30,860	$13.76	$15.43	$32,080
33-0000	Protective Service Occupations	11,970	$16.33	$18.11	$37,670
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	5,530	$16.36	$19.83	$41,250
21-0000	Community and Social Service Occupations	8,130	$16.97	$18.15	$37,760
47-0000	Construction and Extraction Occupations	30,690	$17.43	$19.01	$39,540
49-0000	Installation, Maintenance, and Repair Occupations	24,020	$18.80	$19.68	$40,940
25-0000	Education, Training, and Library Occupations	35,080	$19.60	$21.77	$45,280
	Sub-Total	448,740			

[103] Bureau of Labor Statistics. (2012). Retrieved 1 12, 2014, from May 2012 *Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates*: http://www.bls.gov/oes/current/oes_36420.htm

29-0000	Healthcare Practitioners and Technical Occupations	37,480	$24.26	$30.60	$63,650
19-0000	Life, Physical, and Social Science Occupations	5,420	$26.05	$36.09	$75,060
23-0000	Legal Occupations	6,170	$26.80	$36.11	$75,120
13-0000	Business and Financial Operations Occupations	27,470	$27.42	$29.01	$60,340
15-0000	Computer and Mathematical Occupations	11,550	$27.97	$29.99	$62,380
17-0000	Architecture and Engineering Occupations	12,430	$35.44	$41.99	$87,330
11-0000	Management Occupations	34,640	$36.97	$42.91	$89,240
	Sub-Total	135,160			

Scenario Analysis

As there is no clear way to predict the percentage of jobs that will pay a livable wage, due to discrepancies with the definition of the terminology as well as the construct of any specific household, for this analysis a comparison of the scenarios related to the combined costs of housing, transportation, and energy will help to determine which scenario leaves the most money for food, clothing, health care, and other health-promoting activities. Housing, transportation and energy usage are typically the three largest expenditures of a household, and impact low-income families most dramatically with the constant fluctuations of the housing and energy markets, as well as the ever-increasing cost of transportation[104]. The table below shows the costs for each of these three categories, as well as the combined cost, for each of the three scenarios relative to existing conditions. These figures are average costs and will be compared to the median income of Oklahoma City ($45,474), which correlates well with the living wage for a one-adult, two-child household.

	Existing	Scenario A	Scenario B	Scenario C
Housing	$12,312	$14,100	$13,824	$13,260
Transportation	$13,374	$13,869	$13,160	$12,380
Energy	$6,977	$7,472	$7,067	$6,644
Total	$32,663	$35,441	$34,051	$32,284
% of Median Income	71.83%	77.94%	74.88%	70.99%
Remaining Discretionary Spending	$12,811	$10,033	$11,423	$13,189

[104] Bernstein, S., & Haas, P., et al. (2007). *Growing more affordably: Connecting the dots on housing, energy and transportation costs*. Coral Gables, Florida: Funders' Network for Smart Growth and Livable Communities. Retrieved from http://www.fundersnetwork.org/files/learn/Housing_Energy_Transportation_April_2007.pdf

This table illustrates the fact that regardless of what the livable wage is defined as, Scenario C will be more affordable because of the reduction of primary costs, particularly in the realm of transportation and energy consumption.

Conclusions

A) Scenario A would likely result in the smallest percentage of jobs offering a living wage based upon the cost of housing, transportation, and energy. Scenario A would decrease the percentage of jobs paying a living wage when compared to existing conditions.

B) Scenario B would result in a greater percentage of jobs offering a living wage than Scenario A, but would also decrease the percentage of jobs paying a living wage when compared to existing conditions.

C) Scenario C would result in the greatest percentage of jobs offering a living wage, because of the significant savings in transportation and energy costs. Scenario C is the only scenario that represents an improvement upon existing conditions with regard to the percentage of jobs paying a livable wage.

Policy Review

Overview:

Being able to live on minimum wage has becoming increasingly difficult. As the economic demands of society increase, an increase in minimum wage does not always follow. Individuals, families, and businesses are often faced with important decisions concerning basic needs such as food, rent, medical care, and transportation. To combat the rising cost lower paying jobs Oklahoma City can focus on increasing economic diversity by supporting development of industry clusters such as aerospace, aviation, defense, bioscience (and other high-technology industries), renewable energy, new-to-market company headquarters, and advanced manufacturing which will bring additional workforce opportunities with higher pay rates. Additional tactics to combat rising costs of basic needs include expanding financing options for mixed-income housing projects, developing workforce housing, and focusing revitalization efforts to areas with low economic opportunity or poor health outcomes.

Relevant Policies:

Sustain.Landuse.**336**

Live.Housing.**450**

Live.Housing.**455**

Live.Housing.**459**

Live.Housing.**467**

Live.Neighborhood Stability.**491**

Strengthen.Employment and Opportunity.**171**

Recommendations

- Promote strategies to control costs that can undermine a "living wage".
  - Provide education on the availability of affordable housing, affordable transportation options, and affordable energy costs for all residents.
  - Promote affordable grocery options.
- Create job-training programs to have a workforce that is skilled/prepared for jobs that pay livable wages
- Continue to attract employers that pay their employee's a livable wage and provide affordable health insurance, and employer's that support community development.
- Encourage coordination between educational institutions and employers.
- Develop workforce housing with strong transportation access to job opportunities.
- Focus revitalization efforts to areas with low economic opportunity and poor health outcomes – control surprise costs.

II. strengthenokc Indicators

St.2 Affordable Housing by Income Bracket

Health-based Rationale

Affordable housing or the lack thereof, affects all social classes and communities. Homeowners and renters alike share in the burden of the economic crisis. Public housing dilemmas can also intensify potential health disparities. Overall, 16.4 million renter households face unaffordable housing costs, with rent and basic utilities costing more than 30% of their income[105]. Additional indicators of the desperate need for public housing are the numbers of people sitting on waiting lists for public housing and the homeless who are living in shelters, on the streets, or with family and friends. For example, in the cities studied in the Right to the City report, over 250,000 applicants are on a waitlist, over 77,000 are homeless but "housed" in shelters, and another 69,000 are homeless without shelter[106]. Decisions are made by households on budgets, and often, house payments and utilities are of main concern, leaving food and other necessities to become a secondary unease.

Housing is an important social determinant of health, and the link between housing and health is widely acknowledged[107] [108]. Until recently, much of the housing and health research has focused on links between physical characteristics of housing (e.g. exposure to toxins, cold, damp) and physical health[109] [110] [111]. A study of housing affordability and mental health results suggests that private renters in households of low and mid-to-low income may be more vulnerable to mental health effects of living in unaffordable housing. Home purchasers, on the other hand, appear to be protected against such effects [112]. There is also a growing evidence base that relates unaffordable housing to more indirect "trade-offs that may harm health"[113]. For example, a recent study found a positive association between unaffordable housing and food insecurity[114].

Considerable evidence suggests that health and wealth are tightly connected and that financial strain is associated with poor health, but few studies have examined mortgage default or foreclosure, especially in the

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[105] Rice, D., & Sard, B. (2012, March 14). *President's budget not sufficient to renew rental assistance fully for low-income households: HUD budget also includes proposals that could cause serious hardship for some of nation's poorest people*. Center for Budget and Policy Priorities. <http://www.cbpp.org/files/3-14-12hous.pdf>.

[106] United States Department of Housing and Urban Development (HUD) (2009). *Resident characteristics report*. https://pic.hud.gov/pic/RCRPublic/rcrmain.asp (Retrieved 13.10.09).

[107] Braubach, M. (2011). Key challenges of housing and health from WHO perspective. *International Journal of Public Health*, 56, 579e580.

[108] Commission on Social Determinants of Health. (2008). *Closing the gap in a generation: Health equity through action on the social determinants of health*. final report. Geneva: World Health Organization.

[109] Evans, J., Hyndman, S., Stewart-Brown, S., Smith, D., & Petersen, S. (2000). An epidemiological study of the relative importance of damp housing in relation to adult health. *Journal of Epidemiology and Community Health*, 54, 677e686.

[110] Free, S., Howden-Chapman, P., Pierse, N., Viggers, H., & the Housing, Heating and Health Study Research Team. (2010). More effective home heating reduces school absences for children with asthma. *Journal of Epidemiology and Community Health*, 64, 379e386. K.E. Mason et al. / Social Science & Medicine 94 (2013) 91e97 96

[111] Lloyd, E., McCormack, C., McKeever, M., & Syme, M. (2008). The effect of improving the thermal quality of cold housing on blood pressure and general health: research note. *Journal of Epidemiology and Community Health*, 62, 793e797.

[112] Mason, K. B. (2013). Housing affordability and mental health: Does the relationship differ for renters and home purchasers? *Social Science & Medicine*, 91-97.

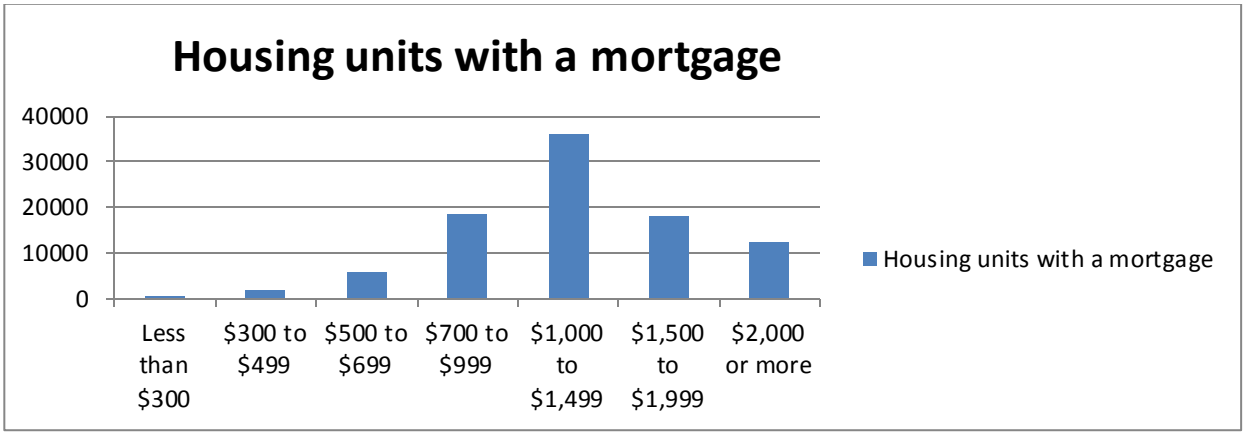
[113] Pollack, C. E., Griffin, B. A., & Lynch, J. (2010). Housing affordability and health among homeowners and renters. *American Journal of Preventive Medicine*, 39, 515e521.

[114] Kirkpartrick, S., & Tarasuk, V. (2011). Housing circumstances are associated with household food access among low income urban families. *Journal of Urban Health*, 88, 284e296.

context of the current US housing crisis[115] [116] [117]. Debt and self-reported financial strain are also associated with worse health, and difficulty making mortgage payments is associated with lower general well-being. Economic stresses such as job loss are associated with health declines and increases in depressive symptoms[118] [119] [120] [121]. One recent study demonstrated high rates of un-insurance, major depression, and unfilled prescription medications in Philadelphia-area residents undergoing mortgage foreclosure. In contrast, wealth is positively associated with health and the largest source of wealth for American families is home equity. Home ownership has been associated with greater life satisfaction, better psychological health, higher self-esteem and perceived control, and better self-rated health. Thus, people undergoing mortgage foreclosure may be more likely to experience poor health[122].

Existing Conditions

According to the US Census Bureau 2008-2012 American Community Survey 5-Year Estimate, Oklahoma City is expected to have total occupied housing units of 226,945. This breaks down to 136,990 owner-occupied and 89,995 renter-occupied dwellings. The average Oklahoma City resident pays between $1,000 and $1,499 on monthly mortgage, with a median mortgage cost of $1,268 per month. Oklahoma City has a slightly lower median mortgage cost, compared to the national average of $1,559. Most Oklahoma City residents that rent homes pay between $500 and $749 per month, with a median of $726 per month. Again, Oklahoma City has a slightly lower median rental cost, compared to the national average of $889 per month[123].



[115] Pollack CE, Lynch J. (2009). Health status of people undergoing foreclosure in the Philadelphia region. *Am J Public Health,* 99, 1833-1839.
[116] Nettleton S, Burrows R. (1998) Mortgage debt, insecure home ownership and health: an exploratory analysis. *Social Health Illness*, 20, 731-753.
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[119] Burgard S, Brand J, House J. (2007). Toward a better estimation of the effect of job loss on health. *J Health Soc Behav*, 48, 369-384.
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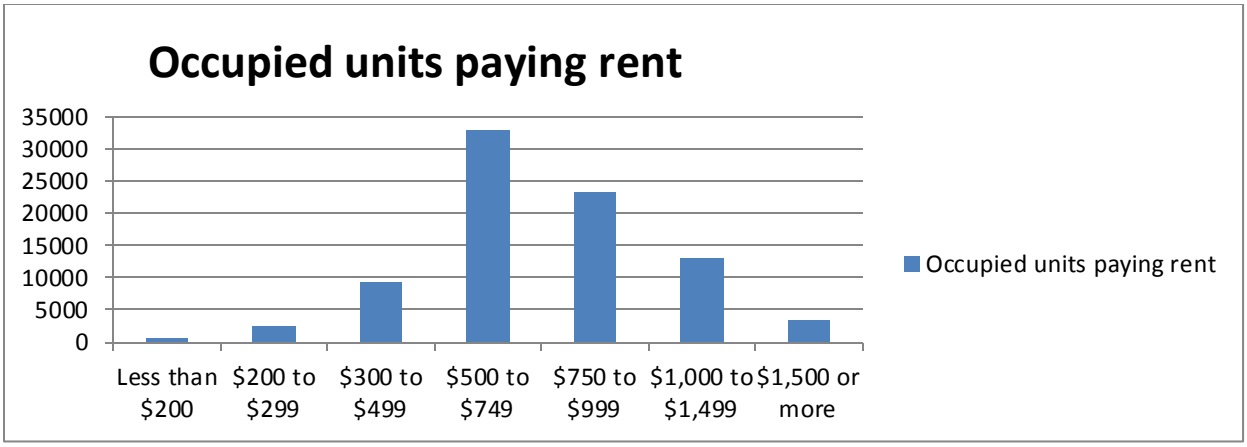
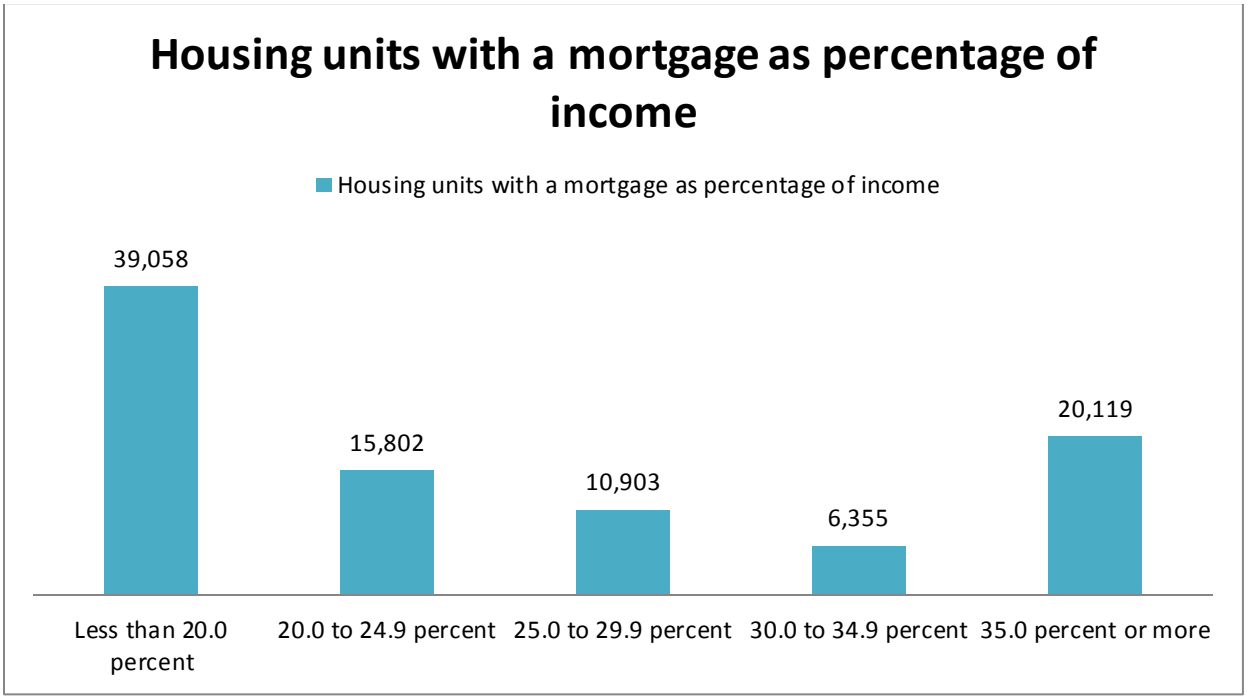
[122] Cannuscio, C. e. (2012). Housing strain, mortgage foreclosure, and health. *Nurs Outlook*, 134-142.
[123] United State Census Bureau. (n.d.). Retrieved 1 16, 2014, from American Fact Finder: http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_12_5YR_DP04

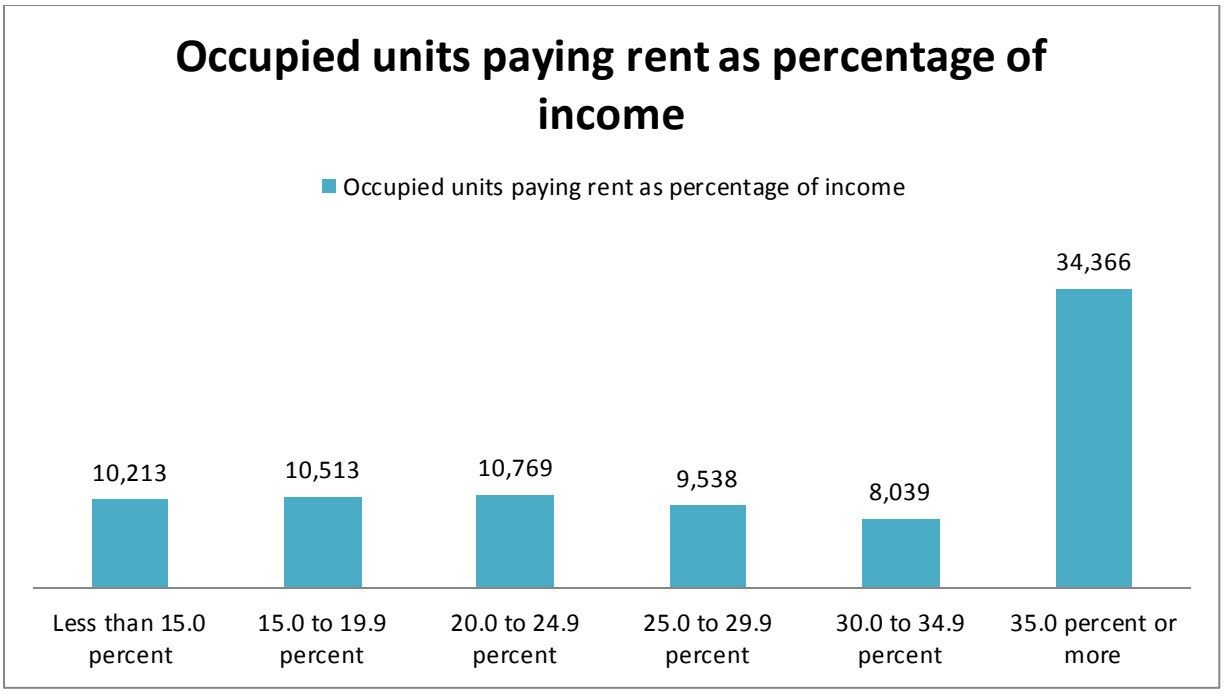


Housing expenditures that exceed 30 percent of household income have historically been viewed as an indicator of a housing affordability problem[124]. The conventional 30 percent of household income that a household can devote to housing costs before the household is said to be "burdened" evolved from the United States National Housing Act of 1937[125]. When comparing the historical maximum expenditures to Oklahoma City, numbers are sporadic. In home ownership, 42.3% pay less than 20% as a percent of household income, second is the 21.8% of homeowners whom 35% or more of income is spent on housing.

Of the households that rent 41.2% pay 35% or more for their rental properties, with all other percentages of income less than 35% spread out proportionally.



[124] Center, W. R. (1992). *Housing Affordability: Myth or Reality?* University of Pennsylvania.
[125] Schwartz, M. a. (2007). *Who Can Afford To Live in a Home?: A look at data from the 2006 American Community Survey.* US Census Bureau



A more recent market trend identifies an increase in new home closings in the Oklahoma City market in August year-over-year, but the percentage boost was less than July 2013, suggesting the market may be leveling. A total of 3,921 new homes were sold during the 12 months that ended in August, up from 3,856 for the year that ended in July. New home closings represented 13.6% of overall housing closings. From August 2012 to August 2013, the average price of newly sold homes went from $232,605 to $233,456; the average mortgage size on newly sold homes saw a drop year-over-year in contrast to new home prices. Average mortgage size sank 5.8% to $198,050 in August from a year earlier. In July 2013, average mortgage size on newly sold homes saw a 1.8% fall from a year earlier[126].

Scenario Analysis

The Envision Tomorrow tool allows for variable inputs into the housing mix of each scenario, which plays a role in the ultimate development pattern of each discrete scenario. The cost of each housing type is calculated based upon market costs per square foot multiplied by the average unit size for each housing type, applying both to mortgage and rental costs. Due to the nature of projecting housing costs to the future, it is not possible to calculate a median value, but it is possible to generate average values. These average values for each particular housing type are then compared to household income such that when a housing type value is greater than 30% of a household income, it becomes un-affordable by definition. Thusly, we can compare the three scenarios to see how they stack up in terms of affordability.

For all of the scenarios, households earning below $35k have no affordable new housing. A value for the cost to own a single-family home is generated by the Envision Tomorrow tool, giving a number to compare against existing household income figures to determine what percentage of the population would be above

[126] Builder Online. (2014, 1 1). Retrieved 1 14, 2014, from Housing Intelligence: http://www.builderonline.com/local-housing-data/west-south-central/oklahoma-city-ok.aspx

the 30% affordability figure if living in an average single-family home. Additionally, a figure for what it would costs to rent a home in each scenario is generated by the Envision Tomorrow tool, and a similar comparison of existing household income levels can be conducted.

Affordability of New Housing (Own/Rent)						
	Scenario A		Scenario B		Scenario C	
What percentage can afford to purchase a home?	HH Income Needed for Owning	% earning Income Needed	HH Income Needed for Owning	% earning Income Needed	HH Income Needed for Owning	% earning Income Needed
	$73,173	29.60%	$71,964	30.50%	$71,605	30.70%
What percentage can afford to rent a home?	HH Income Needed for Renting	% earning Income Needed	HH Income Needed for Renting	% earning Income Needed	HH Income Needed for Renting	% earning Income Needed
	$47,000	49.34%	$46,080	50.27%	$44,200	52.20%

What this table shows us is that a relatively small percentage of the population will be able to afford to own any of the housing that will result from new development, as the majority of the population does not meet the minimum income needed to spend less than 30% of their income on housing. A greater percentage of the population will be able to afford to rent new properties developed in each scenario. There is a slight lean in favor of Scenario C in terms of the affordability of both owning and renting. This is likely due to the types of housing that are projected into each of the scenarios. While Scenario A may have cheaper costs per square foot, the number of large-lot single-family homes drives the average cost for homes upward.

Housing Mix				
	Existing	Scenario A	Scenario B	Scenario C
Multifamily	29%	22%	26%	26%
Townhome	2%	5%	5%	5%
Small Lot Single Family	2%	2%	11%	12%
Conventional Lot Single Family	54%	43%	47%	47%
Large Lot Single Family	10%	25%	9%	8%
Mobile Home	3%	3%	2%	2%

Caveats: These calculations assume that housing in existing conditions remains constant despite the implications of each of the three scenarios' development pattern.

It is likely that with the density of development in Scenario C, as well as the proximity to useful community amenities, home values and thereby rent and mortgage prices would increase, offsetting the difference of price with Scenario A. This would also occur to a lesser extent with Scenario B.

Conclusions

A) Scenario A results in the least affordable new housing mix of the three scenarios. Fewer households could afford to purchase new homes, but those who can, would likely have larger lots.

B) Scenario B results in more affordable new housing than Scenario A, but less than Scenario C. Scenario B's housing mix is very similar to Scenario C, but is less affordable.

C) Scenario C results in the most affordable new housing mix of the three scenarios. More households could afford to purchase new homes; those homes would likely have smaller lots than in Scenario A.

Policy Review

Overview:

Unaffordable housing can cripple a family or an individual's budget. By ensuring a stable, affordable housing market, citizens can make better spending decisions on other basic necessities such as eating healthier, healthcare needs, safety and general well-being. One way Oklahoma City can contribute to affordable housing is to encourage development by requiring a percentage of units in all new apartment and condominium developments to be affordable to working households with incomes of 80 to 100 percent of the area median family income as defined by the U.S. Department of Housing and Urban Development. Additional ways to fight unaffordable housing is to establish a program that significantly improves the quality, appearance, and perception of rental housing throughout the city and by maximizing the use of all appropriate state, federal, local, and private funding for the development, preservation, and rehabilitation of housing affordable to a variety of income groups.

Relevant Policies:

Sustain.Landuse.**336**

Live.Housing.**436**

Live.Housing.**438**

Live.Housing.**444**

Live.Housing.**446**

Live.Housing.**455**

Live.Housing.**479**

Live.Housing.**481**

Live.Housing.**487**

Recommendations

- Provide incentives for compact, accessible and visitable* multi-family development at sufficient densities.
- Require development to include a mix of housing types.
- Encourage rental unit development for a variety of income levels.
- Encourage unbundling of parking requirements from housing in the urban.
- Increase the number of incentives for first-time homebuyers available through municipal sources.
- Provide education opportunities for home-owners to avoid foreclosure.
- Provide Single-Residency Occupancy Structures through the incentivization of construction of and repurposing of buildings such as hotels.
- Support the development and implementation of a Housing Trust Fund or similar community development programs.
- Effectively market and fund existing programs that assist the homeless, those in transition, and those on public assistance with finding secure housing.
- Explore opportunities to incentivize retrofitting abandoned properties, such as temporary tax discounts or tax rebates.
- Encourage the development of affordable senior housing.
- Ensure that housing in proximity to schools is affordable to many different income groups.

* There are three main features that meet the requirements of "visitability":

1. At least one zero-step entrance on an accessible route leading from a driveway or public sidewalk,
2. All interior doors providing at least 31 3⁄4 inches (81 cm) of unobstructed passage space and
3. At least a half bathroom on the main floor

II. strengthenokc Indicators

St.3 Homelessness

Health-based Rationale

Homelessness affects many groups of individuals, rarely discriminating against women, children, or men. Identifying the number of people who are homeless in a given year in the United States is estimated to be as high as 3.5 million people, with approximately one-third being children according to the National Coalition for the Homeless. In addition, it has been estimated that 80% of all homeless people are "hidden homeless"[127]. The hidden homeless are not visible to the public as they may have temporary housing, but they lack the stability of having a permanent address, and they are not staying with family or friends out of choice[128]. The unstable nature of this group presents an array of health risks for not only the individual, but also the communities in which they exist in. Homelessness may be caused from individual factors such as adverse childhood experiences, low educational attainment, and mental illness, as well as societal factors like poverty, racism and labor market conditions[129]. It has been said that adequate shelter should be a basic prerequisite for health[130][131].

The majority of people experiencing homelessness are male[132], and their life expectancy is approximately 39 years of age[133]. Individuals experiencing homelessness have numerous health concerns, including; arthritis and other musculoskeletal disorders; hypertension, respiratory tract infections, skin and foot problems, venous stasis disease, scabies and body lice. Other health concerns include: foot disorders such astinea pedis, usually caused from prolonged exposure to moisture; inadequate footwear and long periods of walking and standing[134]. Homeless individuals have an increased risk of contracting tuberculosis, HIV/Hepatitis C and other sexually transmitted diseases. Homelessness has a detrimental effect on existing comorbidities; causing decreased quality of life, increased disability burden, and increased healthcare use and costs from higher mortality rates[135]. Unintentional injuries and deaths due substance abuse, mental illness, and other psychosocial concerns are common[136]. People experiencing homelessness have poor nutrition and often lack nutrients essential for growth and development[137].

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[127] The Homeless Hub. (2008). *Population: hidden homeless*. Available at: http://www.homelesshub.ca/Topics/Hidden-Homeless-260.aspx
Canadian Homelessness Research Network. *Canadian definition of homelessness*. Available at: http://www.homelesshub.ca/ResourceFiles/06122012CHRNhomelessdefinition.pdf

[129] Frankish CJ, Hwang SW, Quantz D. (2005). Homelessness and health in Canada: research lessons and priorities. *Can J Public Health,* 96,S23e9.

[130] Registered Nurses Association of Ontario. *Policy statement on homelessness*, n.d. Available at: http://www.rnao.org/Storage/28/2283_RNAO_Policy_Statement_Homelessness.pdf

[131] Crowe C. (2007). *Dying for a home: homeless activists speak out*. Toronto: Between the Lines.

[132] Chin CN, Sullivan K, Wilson SF. (2001). A 'snapshot' of the health of homeless people in inner Sydney: St Vincent's hospital. *Aust Health Rev*,35, 52e6.

[133] Trypuc B, Robinson J. (2009). Charity Intelligence Canada. *Homeless in Canada*. Available at: http://www.charityintelligence.ca/images/Ci-Homeless-in-Canada.pdf

[134] Registered Nurses Association of Ontario. *Policy statement on homelessness*, n.d. Available at: http://www.rnao.org/Storage/28/2283_RNAO_Policy_Statement_Homelessness.pdf

[135] Khandor E, Mason K. (2007). *Street health and Wellesley Institute e Toronto. The street health report*. Available at:, http://www.streethealth.ca/downloads/the-street-health-report-2007.pdf

[136] Hwang SW. (2001). Homelessness and health. *Can Med Assoc J,*164, 229e33.

[137] Tarasuk V, Dachner N, Li J. (2005). Homeless youth in Toronto are nutritionally vulnerable. *J Nutr,* 135, 1926e33.

Women and children are not exempt from the homeless population statistics and bring an additional set of health concerns to light. Dental problems have been reported as a frequent condition of homeless children, with tooth decay in homeless children being several times higher than that in children of low income who live in houses[138] [139]. Poor oral health affects diet and nutrition, which can lead to growth problems in children, speech problems, lack of self-esteem, behavioral problems, learning problems, and pain problems, which affect many areas of daily living[140] [141] [142] [143]. Homeless children experience health problems such as ear infections, asthma, vision difficulties, and behavior disorders and suffer disproportionately from the consequences of these health problems[144] [145] [146]. In addition, obesity is an issue for homeless children. In a seminal work, findings show that although homeless children may experience insufficient calorie intake, many homeless children were obese[147]. In a study designed to capture maternal health behaviors and infant health outcomes of homeless mothers, results indicate that accessing WIC (Women, Infants & Children) during pregnancy was associated with positive health behaviors, such breastfeeding initiation, prenatal care use, and improved infant health outcomes. However, 24% of homeless pregnant women in our study did not access WIC[148]. Barriers to breastfeeding among WIC participants have included sore nipples and pain, perceptions of inadequate milk supply, and social support networks' attitudes about breastfeeding[149]. It is possible that these barriers would be heightened for homeless women because of inadequate access to lactation resources, concerns about inadequate milk production, or because of returning to the workforce[150] [151] [152].

Veterans, many already faced with physical, emotional and mental health obstacles, may experience increased health issues in the homeless population. As the well-being of homeless veterans is of public concern, the U.S. Department Veterans Affairs (VA) has set a national goal of ending homelessness among

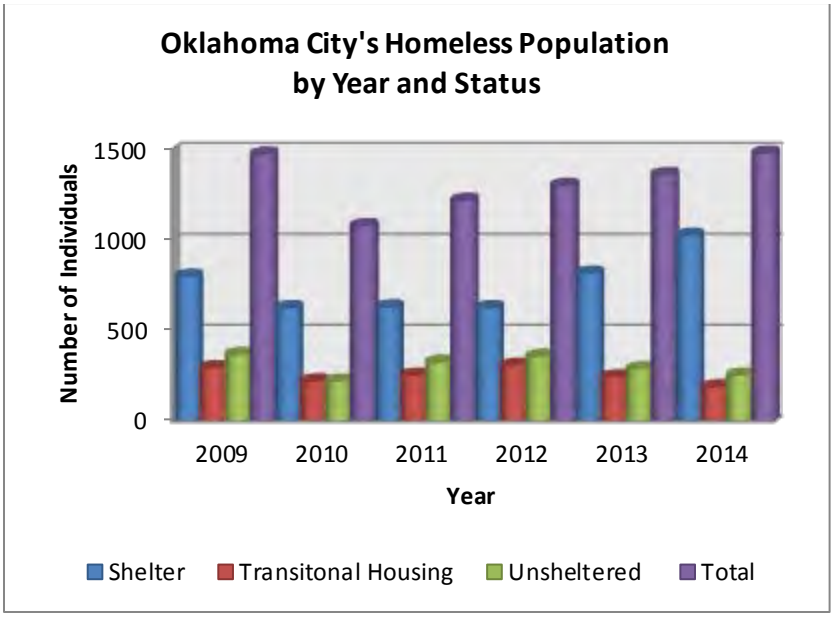
[138] Clark, M. (1999). *Homeless and oral health*. Washington, DC: National Maternal and Child Oral Health Resource Center, National Center for Education in Maternal and Child Health.
[139] Vargas, C. M., & Ronzio, C. R. (2006). *Disparities in early childhood caries* [Electronic version]. Biology Medical Central: Oral Health, 6(Suppl. 1), S3.
[140] Acs, G., Londolini, G., Kaminsky, S., & Cisneros, G. J. (1992). Effect of nursing caries on body weight in a pediatric population. *Pediatric Dentistry*, 14(5), 302-305.
[141] Dye, B. A., Tan, S., Smith, V., Lewis, B. G., Barker, L. K., Thornton- Evans, G., . Li, C. H. (2007). *Trends in oral health status: United States*, 1988–1994 and 1999–2004. Vital Health Statistics 11, Apr(248), 1–92.
[142] Kanellis, M. J. (2000). The impact of poor health on children's ability to function. *Journal of Southeastern Social Pediatric Dentistry*, 6, 12-13.
[143] Schelter, N. (2000). The impact of acute pain and chronic pain on child development. *Journal of Southeastern Society of Pediatric Dentistry*, 6, 16-17.
[144] DiMarco, M. A., Ludington, S. M., & Menke, E. M. (2010). Access to and utilization of oral health care by homeless children/families. *Journal of Health Care for the Poor & Underserved*, 21(2 Suppl.), 67-81.
[145] Hatton, D., Kleffel, D., Bennett, S., & Gaffrey, E. (2001). Homeless women and children.s access to health care: A paradox. *Journal of Community Health Nursing*, 18(1), 25-34.
[146] Morris, R., & Strong, L. (2004). The impact of homelessness on the health of families. *The Journal of School Nursing*, 20(4), 221-227.
[147] Wright, J. D. (1991). Children in and of the streets. Health, social policy, and the homeless young. *American Journal of Disabled Child*, 145, 516-519.
[148] Richards, R. M. (2011). Maternal health behaviors and infant health outcomes among homeless mothers:. *Preventative Medicine*, 87-94
[149] Heinig, M.J., Ishii, K.D., Bañuelos, J.L., et al. (2009). Sources and acceptance of infant feeding advice among low-income women. *J. Hum. Lact*. 25, 163–172.
[150] Dennis, C.L. (2001). Breastfeeding initiation and duration: a 1990–2000 literature review. *JOGNN* 31, 12–32.
[151] Heinig, M.J., Follett, J.R., Ishii, K.D., et al. (2006). Barriers to compliance with infant feeding recommendations among low-income women. *J. Hum. Lact*. 22, 27–38.
[152] Kimbro, R.T. (2006). On-the-job moms: work and breastfeeding initiation and duration for a sample of low-income women. Matern. *Child Health J*. 10, 19–26.

veterans in the coming years[153]. A study conducted of alcohol and drug use disorders in homeless veterans concluded that compared to other homeless veterans, those with both alcohol and drug use disorders were most likely to have comorbid psychotic or mood disorders. Homeless veterans with both alcohol and drug use disorders or only a drug use disorder were more likely to also have post-traumatic stress disorder[154].

Existing Conditions

Oklahoma City conducts its annual Point In Time count of the homeless on every year. The intention of this one-day survey is to determine the total number of people experiencing homelessness in Oklahoma City and gather information about their characteristics and needs. It should be noted that a one-day count is only a snapshot and is not designed to be a complete analysis of the issues surrounding homelessness.

The point in time study defines homelessness as "an individual or family that lacks a fixed, regular, and adequate nighttime residence, an individual or family who will imminently lose their primary nighttime residence, or an individual or family who is fleeing domestic violence and has no other residence or the resources and support networks to secure one." From 2009 to 2014 you can see the fairly stable trends from homeless individuals and families in shelters, transitional housing and unsheltered locations. In addition, the total homeless population decreased in 2010, but has returned to 2009 levels as of 2014; however, the percentage of these individuals living in a sheltered environment is higher than ever. While the homeless count figures are available through 2014, the latest published Point In Time report is from 2012; the following paragraphs will reference this document.

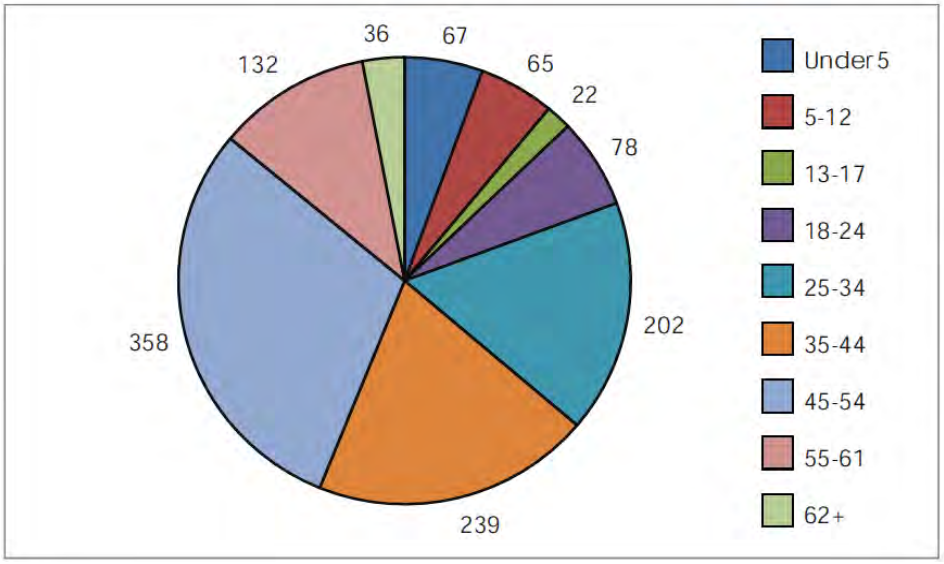


Further alarming data identifies additional vulnerable individuals such as victims of domestic violence, teenagers, veterans and special needs individuals or families. Since 2011, the percentage of homeless

[153] United States Department of Veterans Affairs (2009). *Secretary Shinseki details plans to end homelessness for veterans*. In P. a. I. Affairs (Ed.), .

[154] Tsai, J. K. (2014). Alcohol and drug use disorders among homeless veterans: Prevalence and association with supported housing outcomes. *Addictive Behaviors*, 455-460

individuals dropped in every age category above 25-34 but unfortunately the reverse is true of individuals under the age of 25. These numbers are likely higher than the actual count as well being that children under the age of 18 often do not want to be found. Both this year and in 2011 individuals ages 45-54 made up the largest group. This year they comprised 30% of all respondents.



According to the 2011 National PIT count, the number of homeless veterans in the Unites States dropped by almost 9,000, bringing the count to approximately 67,495. While Oklahoma City had also seen a reduction in vets over the previous three years, that number rose slightly from 2011 to 2012 by 26 individuals. Veterans make up approximately 12% of Oklahoma City's homeless population and 11% of the homeless population nationally.

A special needs individual or family, according to this point in time survey, may consist of a person living in an emergency shelter, transitional housing, or a place not intended for human habitation who has one or more disabling conditions. Homeless who were victims of domestic violence saw the most significant increase over the past year. The number of cases increased by 105 (from 97 to 202), more than doubling those reported in the 2011 PIT[155].

Special Needs Total Count, 2009-2012

SPECIAL NEEDS	2009	2010	2011	2012
Severe Mental Illness	327	261	235	304
Substance Abuse	397	356	519	473
HIV/AIDS	17	17	20	21
Domestic Violence	38	53	97	202
Unaccompanied Youth (under 18)	0	0	10	21

[155] Department, O. C. (2012). 2012 Point-in-Time: *A Snapshot of Homeless in Oklahoma City*. Oklahoma City: Oklahoma City Planning Department.

Scenario Analysis

Qualitative Analysis:

Though there are some homeless individuals who choose to be homeless, many are not homeless by choice and are unable to afford housing for various reasons. Having access to organized resources as well as affordable housing can help to reduce the numbers of the homeless population. In each of the three scenarios various policy steps could be taken to include resources such as homeless shelters, transitional housing, rehabilitation services that cater to the homeless, as well as affordable housing options. But, existing conditions suggest that a denser growth pattern would better support the homeless, as all of the homeless services are within the existing urbanized area, much of them within the downtown region of the city. In addition, a sprawling growth pattern would require a greater percentage of City funds to be allocated to public works and utilities projects in order to maintain infrastructure, which would reduce the potential funding available to offer services and affordable housing to the homeless population.

Cost of housing and transportation are key limiting factors when shifting out of a homeless situation. The more expensive it is to acquire housing or to travel to job opportunities, the less likely a willing homeless individual is to be able to successfully move out of their situation. The growth pattern of Scenario A and Scenario B (to a lesser extent) locate housing and jobs relatively distantly to the current locations of homeless resources, making accessibility more difficult. The cost of public transportation is higher when buses have to travel greater distances, and it is less likely that a single bus route will access the same number of housing units or jobs when they are dispersed across the entire city area as opposed to being consolidated into a denser area. Additionally, in Scenario A the majority of new housing is large-lot single-family homes, which are prohibitively expensive for most people (and especially the homeless), and the cost to rent is 2% higher than Scenario B and 6% higher than in Scenario C. A denser growth patterns often includes a greater proportion of more affordable properties, including a greater number of rental properties, which provide a much greater opportunity for someone to transition out of being homeless.

Scenario A or B may not result in more individuals becoming homeless, but increasing the distance between housing and jobs will make it more difficult for the homeless who utilize services in the central area of the city to transition out of their present situation.

Conclusions

A) Scenario A would likely have the greatest number of homeless individuals of the three scenarios due to the multitude of added limitations. Higher costs of housing and transportation, less accessibility to jobs, housing, and homeless services, and less available public funds would all contribute to a larger homeless population than Scenario B or Scenario C would foster.

B) Scenario B would likely have less homeless individuals than Scenario A, but a greater number than Scenario C. This is because the limiting factors of housing and transportation costs, job accessibility, and housing options are less severe than Scenario A, but more severe than Scenario C.

C) Scenario C would likely have the least number of homeless individuals of the three scenarios. This is due to the fact that the majority of housing and jobs would be located more closely to existing homeless assistance facilities. More affordable transportation options such as public transit would be more effective, and the higher percentage of rental properties would provide more options to get into a more permanent residence.

Policy Review

Overview:

As detrimental and dangerous to the individual as homelessness is, homelessness also adversely affects the city as a whole. By increasing housing opportunities for homeless individuals and families, ranging from emergency shelters to transitional housing, Oklahoma City has the opportunity to enhance eye appeal for visitors, travelers, and every day on-lookers. Enhancing the eye appeal on busy intersections can create a sense of security and positively impact the walkability of the city. Through early identification of risk factors of homelessness such as unemployment and mental health challenges and the implementation of interventions such as rent assistance and counseling homeless rates could decline dramatically.

Relevant Policies:

Live.Housing.**450**

Live.Housing.**451**

Recommendations

- See recommendations from St.2 Affordable Housing
- Effectively market existing programs that assist the homeless, those in transition, and those on public assistance with finding secure housing. In addition to state and federal funding, seek out more local funding.
- Ensure that alternative transportation options are accessible from homeless resource centers (shelters, food banks, etc.).
- Market existing programs that connect the homeless population to education, healthy foods, rehabilitation, and physical activity.
- Increase access to healthcare opportunities, with an emphasis on access to mental health resources.
- Strengthen relationships with faith-based, private, public and other community organizations to provide services for the homeless.
- In addition to shelters & transitional, increase permanent supportive housing and case management resources for chronically homeless individuals.
- Improve discharge planning for homeless leaving medical facilities and foster care.
- Increase access to resources for homeless youth.
- Increase access to employment training and placement resources.

enrichokc indicators

E.1 Number and Location of Vacant and Abandoned Buildings

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
Where are the vacant and abandoned buildings located throughout the city?	GIS land use data	Safety; property values; community strength	Injury; mental health, community health, economic health

E.2 Residential Proximity to Landmarks, Cultural Elements and Public Art

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What percentage of the population lives in proximity to culturally stimulating public elements?	GIS proximity mapping	Community strength; cultural understanding	Social isolation; mental health; depression

III. enrichokc Indicators

E.1 Number and Location of Vacant and Abandoned Buildings

Health-based Rationale

Large numbers of vacant and abandoned buildings are symptomatic of a housing system in need of adjustments. There are negative impacts upon neighbors in terms of appearance, economics, health, and safety. By rehabilitating or redeveloping properties to meet modern codes and standards, the vitality of communities can be returned to what they used to be or improved to levels not yet seen.

Vacant and abandoned buildings are a threat to their surroundings because of a higher chance of catching fire and burning out of control. Each year in the U.S. there are more than 12,000 fires in vacant structures, causing $73 million of property damage[156]. Response time is hindered due to the lack of a person responsible for the property[157]. These buildings are often selected for arson, or are set ablaze accidentally by fires started by homeless for warmth, or by botched drug-making methods. This not only presents a danger to surrounding houses in terms of safety and property damage, but can lead to injury, disability or death for those who accidentally allow a fire to get out of control.

Buildings left untouched for decades often have lead-based paints and other biological and chemical contaminants[158]. These can proliferate through neighborhoods as normal deterioration occurs, or if a fire releases the chemical and biological agents into the air. This leads to higher rates of asthma and lead poisoning, particularly in children, in areas with high concentrations of vacant or abandoned buildings[159]. Rates of cardiovascular disease and stress-related diseases correlate with the location of abandoned buildings, but there is little evidence to suggest that these health outcomes are the direct result of vacant or abandoned buildings.

The economic impact upon neighbors within a certain distance of an abandoned property can be significant. In particular there is a degenerative effect on home value. The recent vacant and abandoned buildings study for Oklahoma City has determined that homes within 150' of a vacant or abandoned property have a 29% loss in value, 21% for those between 151' and 300', and 12% for those between 300' and 600'[160]. Demolition costs and the lack of appropriate taxation methods are both aspects that perpetuate the lack of improvements by property owners of their vacant properties. Vacant and abandoned properties cost municipalities unnecessarily as well. Because these properties are more likely to catch on fire, harbor transient

[156] National Vacant Properties Campaign. (2005). *Vacant properties: the true costs to communities*. Washington D.C. Retrieved from http://www.smartgrowthamerica.org/documents/true-costs.pdf
[157] Botts, S. M. U.S. Fire Administration, Federal Emergency Management Agency. (2010). *Analyzing the problem of abandoned, vacant and unoccupied buildings in Middletown, Ohio*. Retrieved from website: http://www.usfa.fema.gov/pdf/efop/efo44528.pdf
[158] Botts, S. M. U.S. Fire Administration, Federal Emergency Management Agency. (2010). *Analyzing the problem of abandoned, vacant and unoccupied buildings in Middletown, Ohio*. Retrieved from website: http://www.usfa.fema.gov/pdf/efop/efo44528.pdf
[159] Bashir, S. (2002). Home is where the harm is: inadequate housing as a public health crisis. *American Journal of Public Health*, 92(5), 733-738. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3222229/
[160] GSBS Richman Consulting. (2013). Addressing vacant and abandoned buildings in Oklahoma City: prevalence, costs and program proposal. Retrieved from http://www.okc.gov/planning/plans+studies/resources/addressing%20vabs%20cc%20presentation.pdf

criminals, or be home to animal infestations, fire, police and animal services are disproportionately needed to address these issues[161].

Finally, vacant and abandoned properties have an intuitive impact upon community cohesion. These properties leave literal gaps in neighborhood social fabrics, and the higher rates of criminal activity and decreased safety degrade the likelihood of neighbors socializing with each other outdoors or after dark.

Existing Conditions

Vacant and Abandoned Building Study:

A vacant and abandoned buildings study was completed for Oklahoma City during 2013, discussing in great detail the impact of these properties on surrounding properties as well as the City of Oklahoma City as a public entity. Properties that are most detrimental are those that have been vacant for 6 months or more and/or abandoned. Single-family homes make up the majority of these properties as multi-family rental properties have lower-than-average vacancy rates, as well as rising rent prices. Single-family properties have very low costs associated with the simple act of holding the property, and no major incentives to improve property or attract tenants exists. In fact, the average annual property tax cost for a long-term vacant property is only $112[162]. This leads to the number of vacant and abandoned properties we see in the city today.

The map below illustrates the density of vacant and abandoned buildings by Ward:

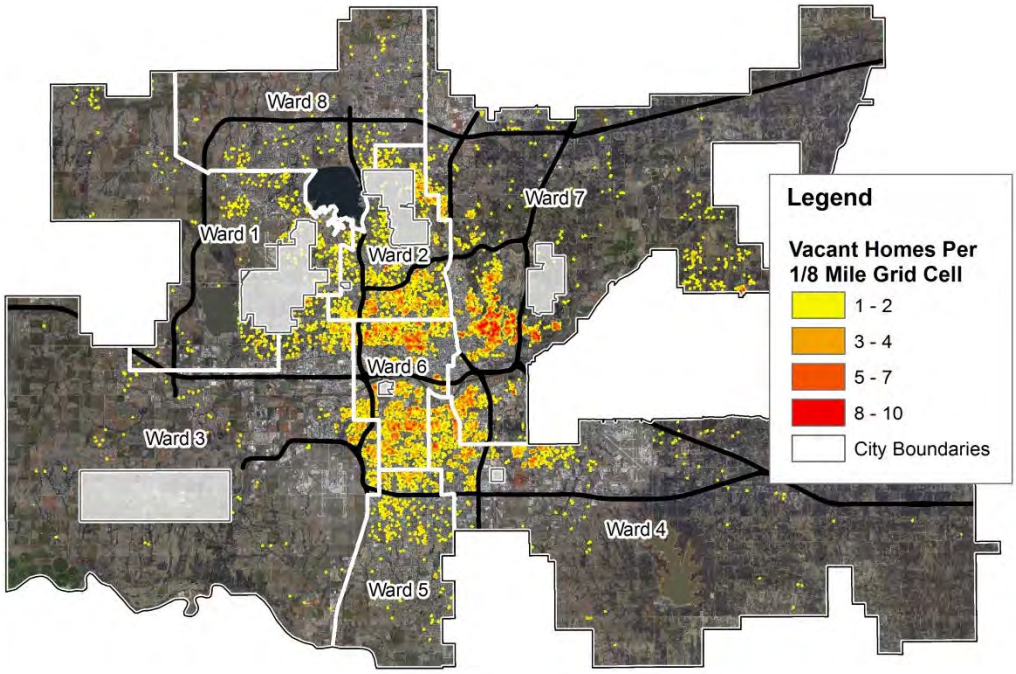


Figure 3: Vacant and Abandoned Buildings by Ward

[161] GSBS Richman Consulting. (2013). *Addressing vacant and abandoned buildings in Oklahoma City: prevalence, costs and program proposal*. Retrieved from http://www.okc.gov/planning/plans+studies/resources/addressing%20vabs%20cc%20presentation.pdf

[162] GSBS Richman Consulting. (2013). *Addressing vacant and abandoned buildings in Oklahoma City prevalence, costs and program proposal*. Retrieved from http://www.okc.gov/planning/plans+studies/resources/addressing%20vabs%20cc%20presentation.pdf

This map illustrates the widespread nature of the vacant and abandoned building problem in the city, with obvious need for a closer look at the southwest section of Ward 7, as well as the majority of Ward 6 and Ward 2.

The map and table below illustrate the percentage of total properties that are vacant or abandoned for each of the eight wards in the city.

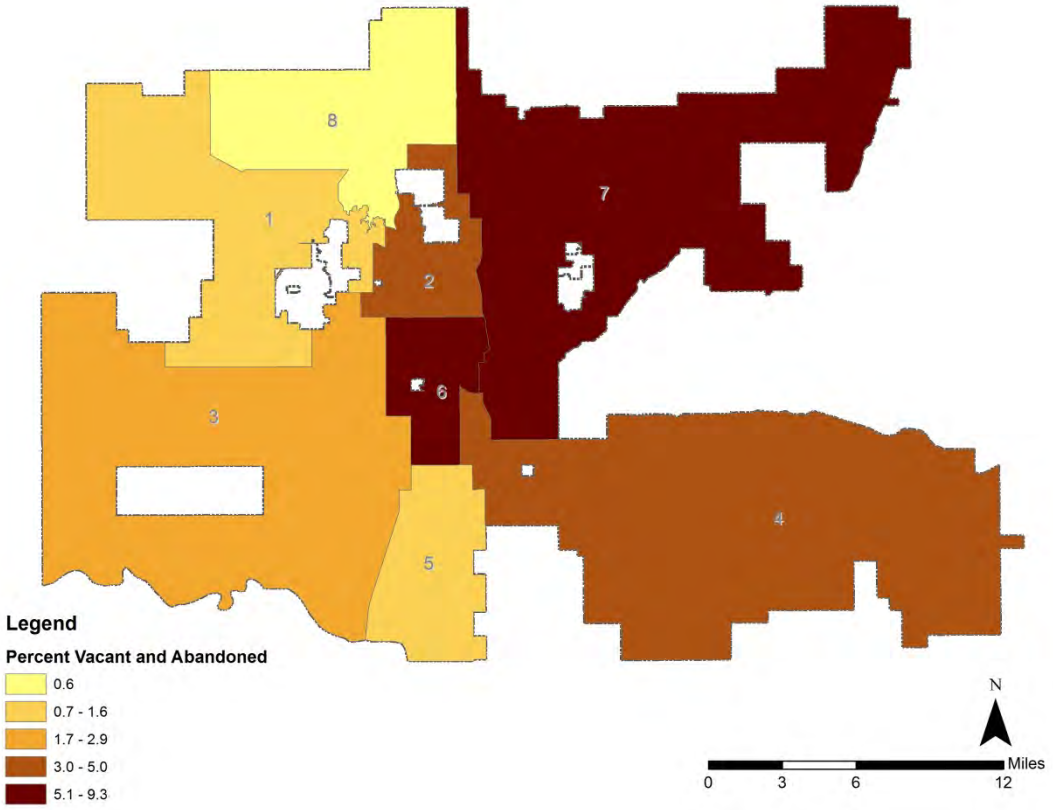


Figure 4: Percentage of Properties that are Vacant or Abandoned by Ward

Percentage of Properties that are Vacant or Abandoned							
Ward 1	**Ward 2**	**Ward 3**	**Ward 4**	**Ward 5**	**Ward 6**	**Ward 7**	**Ward 8**
1.6%	4.8%	2.9%	5%	1.6%	9.3%	9.1%	0.6%

Census Vacancy data:

The Census calculates vacancy in a much broader sense than what was considered under the Vacant and Abandoned Building Study, to include properties that have been vacant for less than six months. While a property that has been vacant for three or four months can have negative impacts upon a neighborhood, those that have been vacant for six months or more tend to have the greatest negative impact.

There are two ways in which to look at the Census vacancy data for Oklahoma City:

1. The number of vacant properties in a given area (ZIP codes)

2. The percentage of properties per ZIP code that are vacant

These two ways of looking at the data speak to different concepts; areas that require the most work in terms of addressing individual properties, and areas that are suffering the greatest impacts of vacancy in their neighborhoods, respectively.

In the maps below, notice the difference between the top 5 in the previously mentioned two categories:

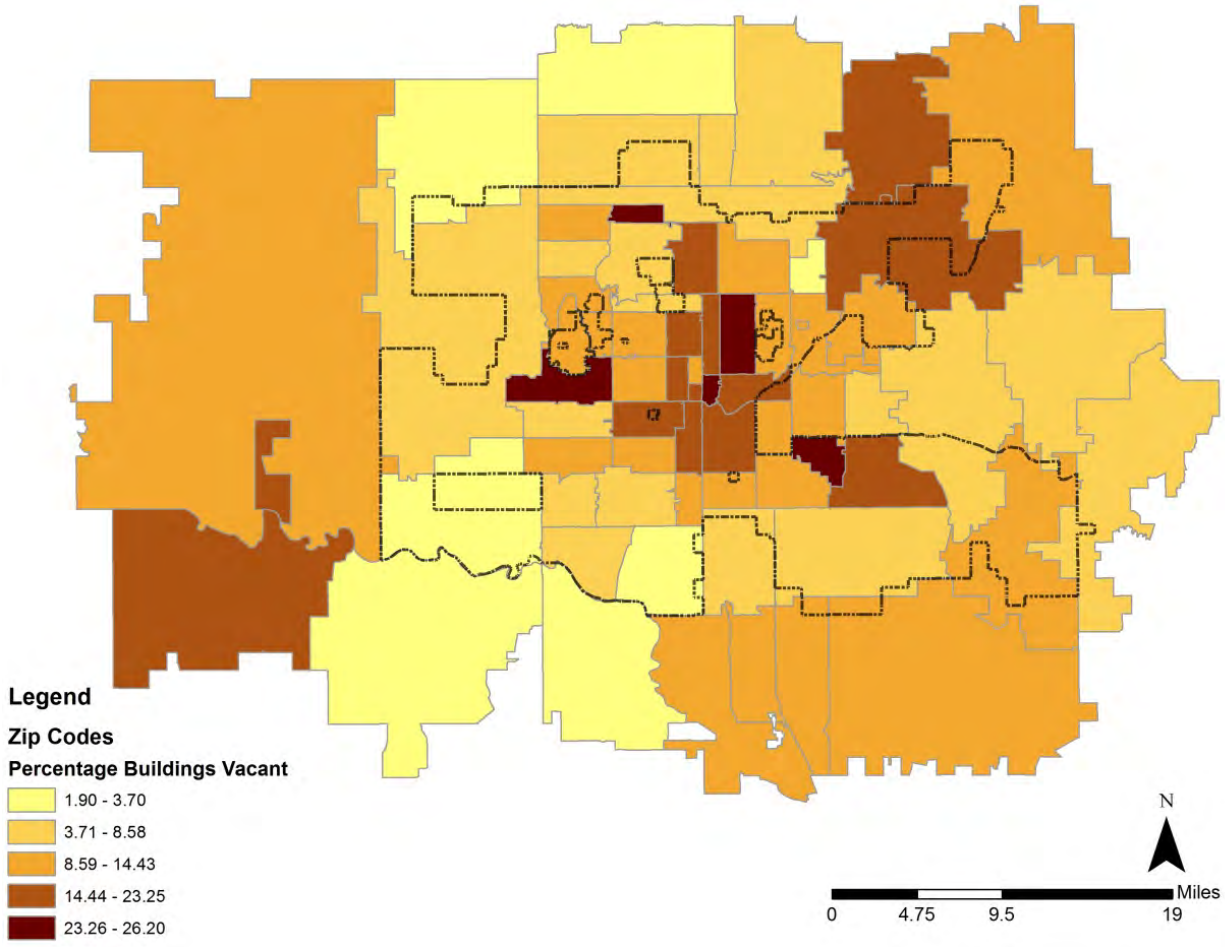


Figure 5: Percentage of Properties that are Vacant by ZIP Code

Top Five - Percentage of Buildings Vacant				
73104	**73145**	**73111**	**73127**	**73134**
26.2%	24.6%	24.5%	23.4%	23.2%

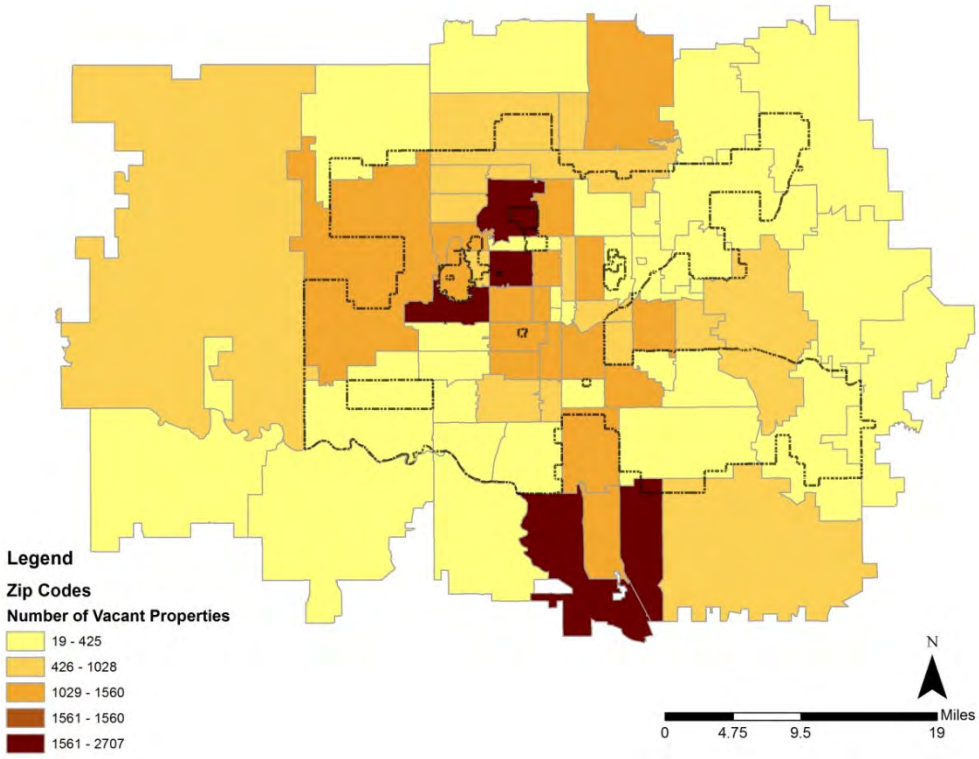


Figure 6: Number of Vacant Properties by ZIP Code

Top Five – Number of Vacant Properties				
73127	**73072**	**73112**	**73071**	**73120**
2707	2019	1914	1844	1565

Only ZIP code 73127 appears in both tables, indicating that a great deal of work to mitigate the negative impacts of vacant properties will need to be focused in this area. The other ZIP codes in the percentage category are somewhat scattered, but 73104 and 73111 are inner-city areas needing improvement that could be essential in creating a cohesive city. Not surprisingly, the top five for number of vacant properties are ZIP codes in high population ZIP codes.

Caveat: A vacancy rate that is too low can have negative impacts upon a community as there is constricted mobility in the housing market.

Scenario Analysis

The Envision Tomorrow tool allows for prediction of the total number of vacant and abandoned buildings for the city by polygrids, from which existing numbers can be subtracted to result in a net new vacant and abandoned building number by which to compare the three scenarios.

Scenario A:

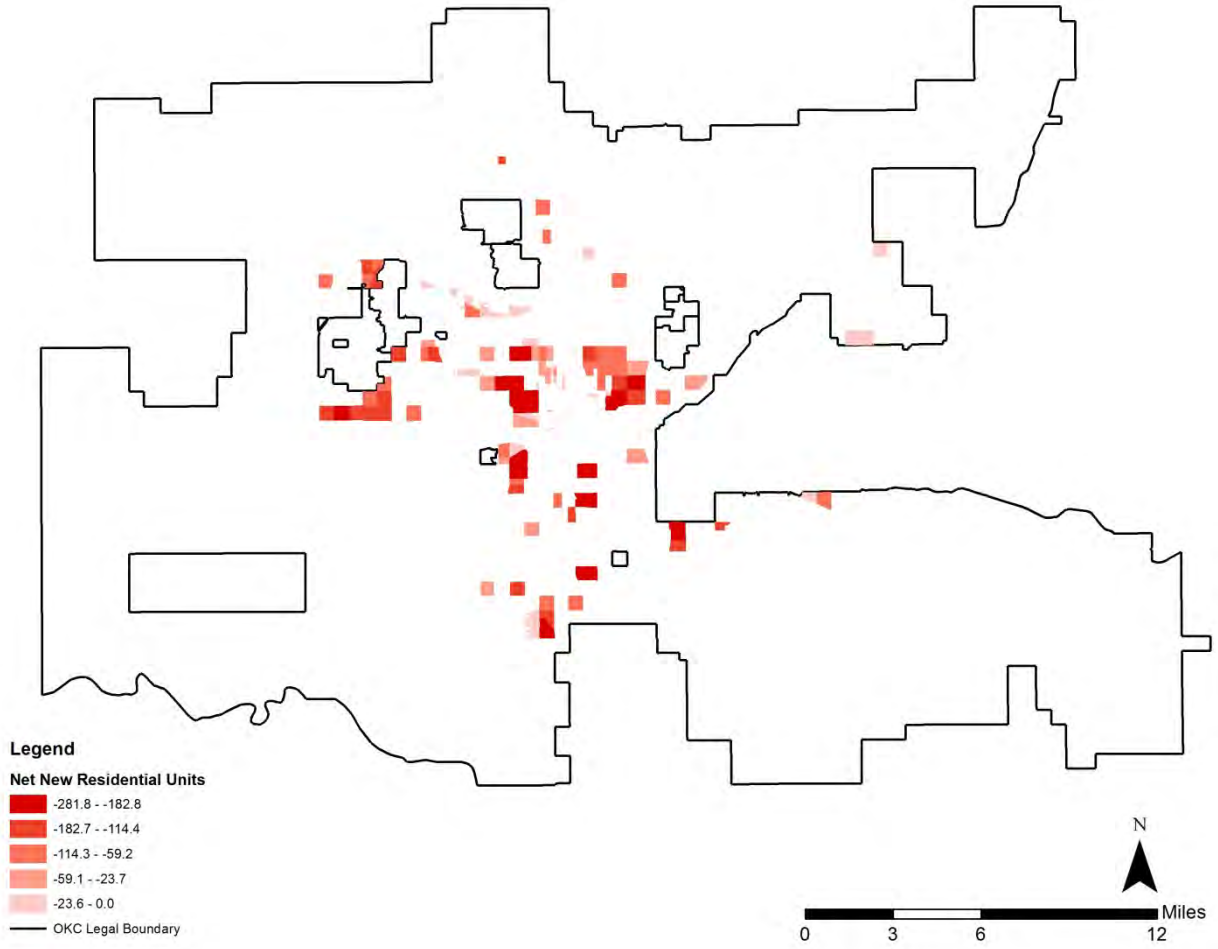


Figure 7: Scenario A - New Vacant and Abandoned

Scenario A -Top Five – Net New Vacant and Abandoned				
73127	**73106**	**73111**	**73107**	**73117**
-1,365	-1,341	-1314	-951	-866

Scenario A has the greatest amount of new vacant and abandoned properties with a total of 9,209 covering 35 of the 63 ZIP codes in the city. ZIP codes 73127 and 73111, which are currently suffering the ill effects of numerous vacant and abandoned properties, rank first and third respectively in terms of the number of new vacant and abandoned homes. This will further deteriorate conditions of all kinds in these areas. Additionally, ZIP codes 73106, 73107, and 73117 are at risk to have steep increases in the number of vacant and abandoned buildings with the development pattern of Scenario A. The pattern of the population and employment flocking to the suburbs and exurbs causes greater rates of blight in more urban areas of the city.

Scenario B:

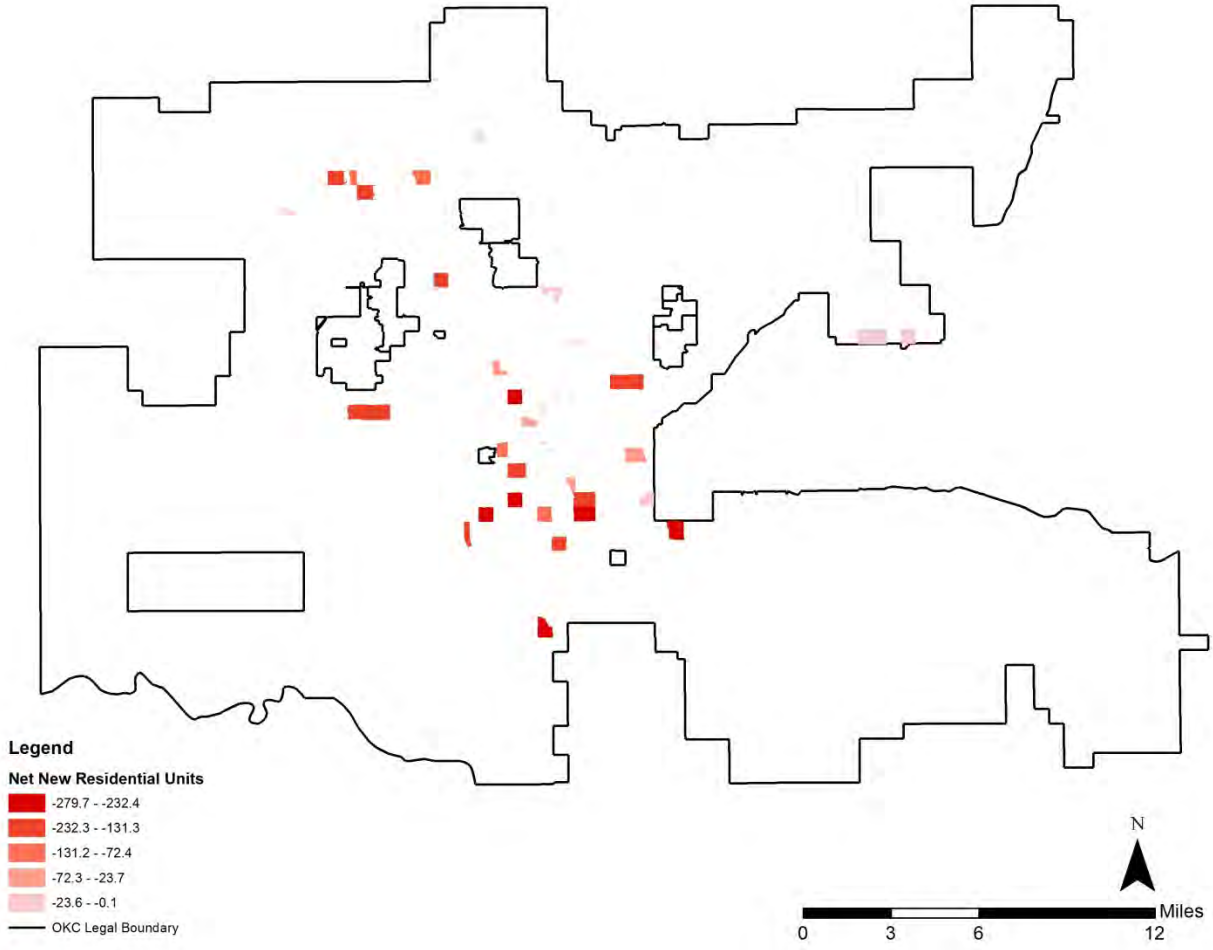


Figure 8: Scenario B - New Vacant and Abandoned

Scenario B -Top Five – Net New Vacant and Abandoned				
73119	**73129**	**73162**	**73127**	**73109**
-707	-537	-518	-461	-459

Scenario B will bring 4,079 new vacant and abandoned buildings with its development pattern, having a strong negative impact on ZIP codes south of the river and along Reno Avenue. 26 out of 63 ZIP codes will be impacted by the vacant and abandoned buildings added in Scenario B. The only ZIP code in the five most negatively impacted by Scenario B that is in the five most impacted for existing conditions is 73127, which is the area between Reno Avenue to the south and Bethany/Warr Acres to the north.

Scenario C:

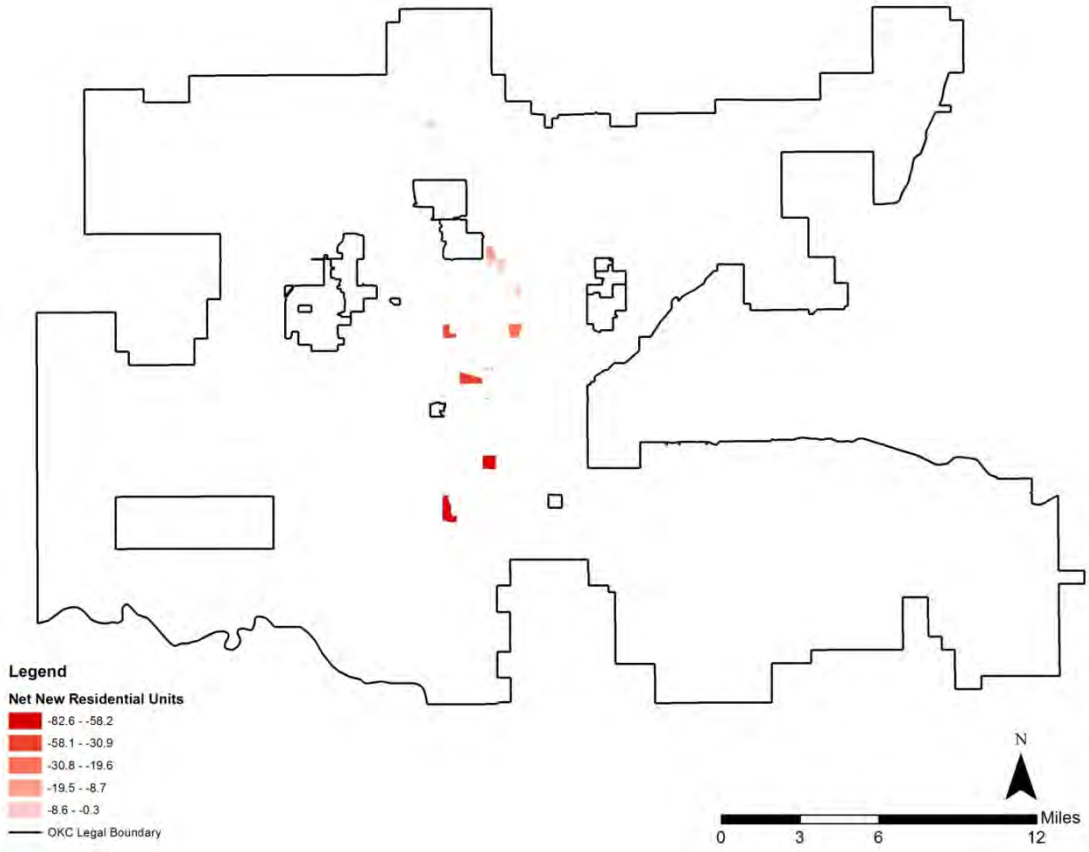


Figure 9: Scenario C - New Vacant and Abandoned

Scenario C -Top Five – Net New Vacant and Abandoned				
73109	**73106**	**73119**	**73159**	**73107**
-97	-78	-58	-58	-38

Scenario C impacts far fewer ZIP codes negatively than Scenarios A and B, with less than 500 new vacant and abandoned buildings city-wide. This combined with rates of redevelopment make the impact of these new vacant and abandoned buildings negligible.

Conclusions

A) Scenario A results in the greatest number of new vacant and abandoned buildings in the city due to the outward migration to the suburbs and exurbs.
B) Scenario B results in less new vacant and abandoned buildings than Scenario A, but significantly more than in Scenario C.
C) Scenario C results in the lowest amount of new vacant and abandoned buildings in the city, with negligible amounts in any given area.

Policy Review

Overview:

Vacant and abandoned buildings around the city are more than just an eye sore, they can have a negative impact on public health. Physical hazards such as dilapidated materials can be dangerous for pedestrians. If gone un-noticed these buildings can serve as an attraction for criminal behavior, homeless individuals, and animals. The rodents that often reside inside can carry harmful diseases to subsequent neighborhoods, and even into other homes. Oklahoma City can lessen the impact of vacant and abandoned buildings by assessing the feasibility of potential reuse options such as identifying buildings that are too far gone and/or too costly to feasibly rehabilitate, and consider a coordinated demolition program for those buildings, developing policies, regulations, and guidelines for a Vacant and Abandoned Buildings program, and increasing property tax revenues by strengthening property values.

Relevant Policies:

Sustain.Land Use Patterns.**259**

Sustain.Land Use Patterns.**337**

Live.Housing.**448**

Enrich.Preservation/Conservation.**84**

Enrich.Community Appeal.**520**

Enrich.Arts and Culture.**137**

Strengthen.Fiscal Stability.**704**

Recommendations

- Create incentives to encourage the development of abandoned properties.
- Focus efforts in areas where the rates of VAB are the highest.
- Increase educational outreach about how to report code violations.
    - Start a smartphone application to report problems.
- Increase funding for rehabilitation, façade improvements, landscaping, and streetscaping.
    - Focus on lots that could be particularly productive.
    - Amenitize blighted neighborhoods.
- Programmatically encourage neighborhood clean-up events.
- Develop and implement a self-sustaining program to address abandoned properties
    - Enact penalties on VAB properties that are tax delinquent or have active, unresolved code enforcement cases.
- Work with financial institutions to develop positive financial incentives (i.e. bridge the risk gap) for productive re-use of vacant or abandoned properties.
- Programmatically increase efforts to utilize vacant lots for community betterment efforts such as gardens and park space.
- Create an educational program to illustrate the benefits related to rehabilitation and revitalization.

III. enrichokc Indicators

E.2 Residential Proximity to Landmarks, Cultural Elements and Public Art

Health-based Rationale

Public art, landmarks and other cultural elements give our cities identity. They help to connect current residents and outsiders to the essence of a place, a sense of place, and they often become gathering spaces. There are documented economic, community, and health benefits related to the existence of these cultural elements.

The non-profit arts and culture industry generated $135.2 billion of economic activity in 2010. $61.1 billion of this was by arts and culture organizations within the U.S., while the remaining $74.1 billion came from event-related expenses from audience members[163]. This illustrates the economic generator that arts events provides for cities, bringing business to local transportation systems, eateries, museums, retail shops and more. In addition, public art programs provide jobs that foster a creative class of artists, who often are able to positively influence their counterparts in the public art structure: planners, engineers, developers, community groups and elected officials[164].

The impact of tourism for a city cannot be understated. "Cultural tourists" tend to spend more and stay longer than the average U.S. traveller, and constitute upwards of 200 million person-trips per year[165]. Travelers to Oklahoma in 2008 spent $6.1 billion, making it Oklahoma's third largest industry[166]. Investments in public art, cultural elements and landmarks create places that people want to be, and places that residents are proud of.

Public art also helps communities overcome obstacles such as crime and blighted properties. In Philadelphia the Mural Arts Program has produced 3,600 murals in the city, which have become a point of civic pride, most importantly because they were designed and painted by local Philadelphians. Each year the Mural Arts Program serves 1,800 at-risk youths, teaching valuable lessons about creativity, teamwork, and citizenship[167]. Other organizations around the country, such as Better Block, build community through temporary urban installations or events to support local businesses. The City of Norfolk, Virginia had great success in hiring the Better Block team; the iconic Texaco Building was sold for $1.1 million one week after their organized events after having sat on the market for many years[168].

There is research that shows that access to arts programs, activities and installations helps to decrease depression and anxiety, particularly when arts are introduced through a rehabilitative communal exercise[169]. There is also evidence that art can be a therapeutic mechanism for military veterans who suffer from post-traumatic stress disorder (PTSD). The National Intrepid Center of Excellence (NICOE) uses "art therapy" to

[163] Americans for the Arts. (2011). *Arts and economic prosperity: Summary report IV*. Washington, DC: Americans for the Arts.
[164] Americans for the Arts. (2010). *Public art network council: Green paper.* Washington, DC: Americans for the Arts.
[165] National Assembly of State Arts Agencies. (2003). *Cultural Visitor Profile*. Washington, DC. Retrieved from http://www.nasaa-arts.org/Research/Key-Topics/Creative-Economic-Development/Cultural-Visitor-Profile.php
[166] Oklahoma Tourism and Recreation Department, (2010).*Tourism's impact on Oklahoma's economy*. Retrieved from website: http://www.travelok.com/files/Impact_of_Travel_2010.pdf
[167] City of Philadelphia Mural Arts Program. (no year). *History*. Retrieved from http://muralarts.org/about/history
[168] Team Better Block. (2013). *Norfolk Better Block: Rapid urban revitalization*. Norfolk, VA.
[169] Stuckey, H. L. (2010). The connection between art, healing and public health: A review of current literature. *American Journal of Public Health*, *100*(2), 254-263. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2804629/

treat veterans with PTSD, giving them an emotional outlet that has helped to reduce cognitive dissonance and bring clarity to the duality of returning to life as a citizen when compared to their military service[170].

Existing Conditions

In order to determine residential access to cultural elements, it is first important to determine what the definition of a cultural element is. Objects and buildings listed on MuseumWithoutWalls.com that were sourced from the City of Oklahoma City staff were mapped according to their location in the city. This list is far from comprehensive, and is difficult to put a defined boundary around as many things are of cultural significance to many different people. For this study cultural elements are broken into several different groups:

Unique Architecture	Historic Buildings	Murals, Mosaics	Sculpture, Relief	Cultural Districts	Landmarks
23	41	5	62	7	45

These elements are distributed around the city, but the highest concentration and significant majority is within the downtown area. Very few of these elements are located within residential areas and are often located in areas with very specific functions like the river district or the airport.

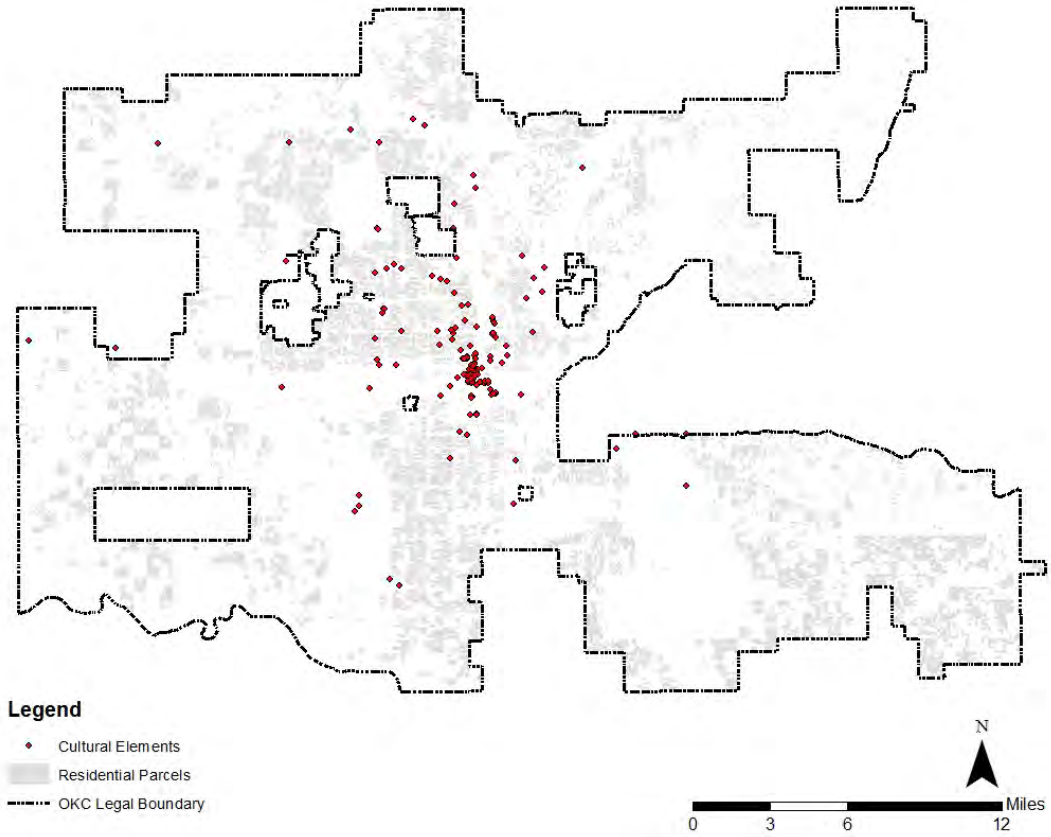


Figure 10: Location of Cultural Elements

[170] Briggs, B. (2013, May 26). *Unmasking the agony: Combat troops turn to art therapy*. NBC News. Retrieved from http://usnews.nbcnews.com/_news/2013/05/26/18471262-unmasking-the-agony-combat-troops-turn-to-art-therapy

Cultural elements could be things that are visited once a year, or something that a person passes on the way to work every day. Regardless of the frequency of visit, these elements give character to areas of town. People who live in proximity to cultural elements are more likely to have these interactions and reap the potential communal and personal benefit. Thusly, proximity for this study has been defined as ¼-mile and ½-mile, both manageable distances on foot, and of a high likelihood to be observed on a regular basis.

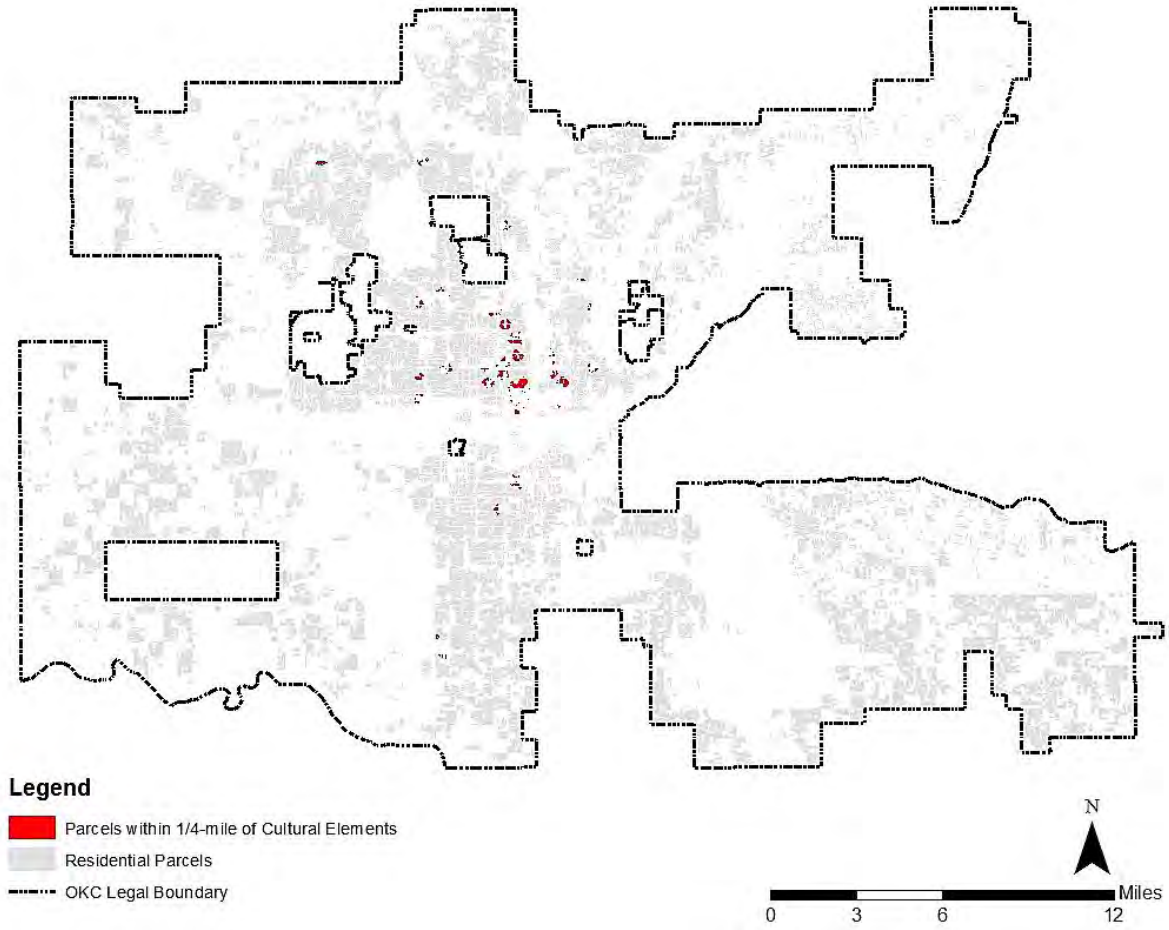


Figure 11: Residential Parcels within 1/4-Mile of Cultural Elements

In the map above it becomes obvious that very few cultural elements are located in residential areas. 7,300 households or roughly 18,250 individuals live within ¼-mile of a cultural element. The vast majority of these parcels is located north of the river and is relatively near to the downtown and Midtown regions.

When the scope is extended to include residential parcels within ½-mile of these 183 cultural elements, we see that 27,412 households or roughly 65,583 individuals have access. This figure represents about 11% of the City of Oklahoma City's population, which leaves much to be desired in terms of providing public art and cultural significance to citizens. And as noted in the previous map, there are very few areas that benefit from cultural elements south of the Oklahoma River relative to the north.

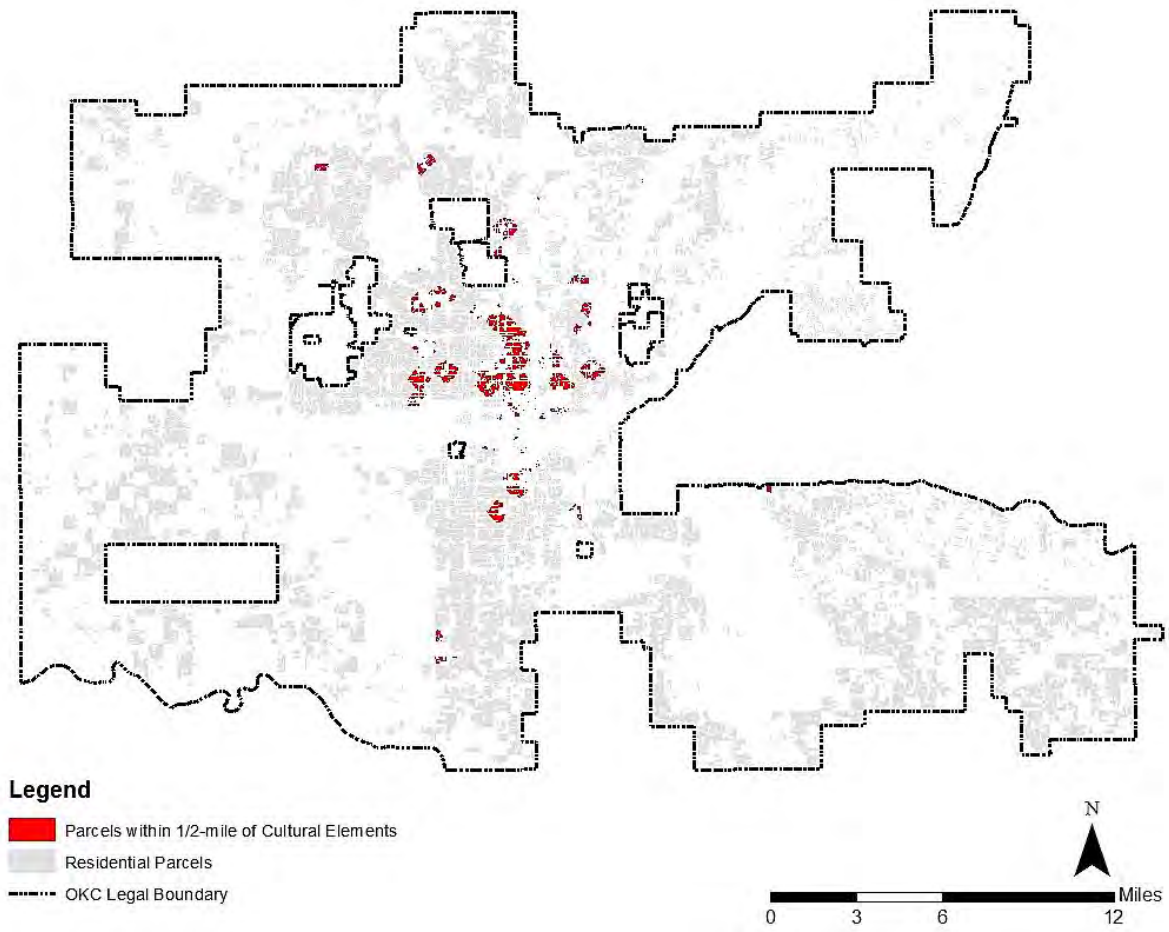


Figure 12: Residential Parcels within 1/2-Mile of Cultural Elements

Scenario Analysis

As there is no way to make predictions regarding future placement of cultural elements throughout the city, each scenario has been compared to existing cultural elements at both the ¼-mile and ½-mile service area distances.

Number and Percent of Households Within ¼-Mile and ½-Mile of Cultural Elements				
	Existing	**Scenario A**	**Scenario B**	**Scenario C**
Cultural Elements ¼-Mile	7,300	6,454	9,516	11,168
Percent of Total Population	*2.9%*	*1.8%*	*2.7%*	*3.1%*
Cultural Elements ½-Mile	27,412	21,276	28,623	32,073
Percent of Total Population	*11%*	*6%*	*8%*	*9%*

Based upon the numbers generated through the scenario analysis Scenarios B and C increase the total number of households within ¼-mile and ½-mile of cultural elements, but only Scenario C increases the percentage of the total population with access, and only for the ¼-mile service area distance. With the addition of cultural elements it is likely that these figures will trend upward, particularly in Scenario C.

Caveat: Parcels that have high numbers of residential units such as apartment complexes can skew the relationship between the scenarios and existing conditions as the scenarios evenly spread population over poly grids, which are geometric areas that are significantly larger than the average parcel.

Conclusions

A) Under Scenario A there is a steep decline in the number and percentage of households that would live within a ¼-mile or ½-mile distance of a cultural element as compared to existing conditions. Scenario A has the lowest figures and percentages when compared with Scenario B and C.

B) Under Scenario B both the number of households that would live within a ¼-mile or ½-mile distance of a cultural element increases, but the percentage of total population decreases; however, not as much as in Scenario A. Scenario B performs better than Scenario A in all categories, but not as well as Scenario C.

C) Under Scenario C the number of households within ¼-mile and ½-mile of a cultural element increases. There is an increase in the percentage of total population that live within ¼-mile of a cultural element, but the percentage of total population for a ½-mile distance decreases relative to existing conditions.

Policy Review

Overview:

The cultural elements of a city identify the historical relevance of the past and project a cohesiveness of legacy. By incorporating landmarks, cultural elements and public art into residential proximity it encourages historical growth and pride in accomplishment, and promotes walkability of the city. Oklahoma City can encourage healthy behaviors and promote educational opportunities through developing a Cultural Heritage Plan with the objective of reviving, explaining, commemorating, and integrating the City's cultural history through its cultural districts, landmarks, and facilities. In addition, a Comprehensive Public Art Master Plan will enable Oklahoma City to promote public art "districts" for key areas, including the Riverfront, downtown, the airport and provide a centralized area(s) for artists to live and work (e.g. Paseo, Film Row) by targeting districts within the City that have become centers for all types (performing, visual, literary, etc.) of art.

Relevant Policies:

Enrich.Preservation/Conservation.**84**

Enrich.Heritage of the City.**96**

Enrich.Heritage of the City.**98**

Enrich.Arts and Culture.**124**

Enrich.Arts and Culture.**126**

Enrich.Arts and Culture.**127**

Enrich.Urban Design and Form.**658**

Play.Safety and Design.**379**

Strengthen.Place-making.**231**

Recommendations

- Consider locations for donated public art in public spaces that are not in the downtown area.
- Continue efforts to create an "art walk" for residents and tourists. Expand program as needed into the future.
    - Consider the inclusion of audio tours and other creative experiential tours.
- Create and disseminate materials regarding public art at events and through social media.
- Explore opportunities and create a plan to encourage and commission neighborhood art projects.
- Locate public art in parks and along trails to encourage usage and physical activity.
- Encourage community art programs as ways to help build community among all different groups: schools, neighborhoods, veterans, City employees, businesses, convicts, the homeless, etc.
- Reclassify murals to be excluded from the sign code.
- Identify further funding sources for community arts programs.

playokc indicators

P.1 Access to Public Parks

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What percentage of the population lives in proximity of a public park?	GIS public parks proximity mapping data	Physical activity; cohesive community; safety; vehicle collisions; self-rated health	Obesity; depression; disability; death; mental health; ADHD

P.2 Access to Private Parks

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What percentage of the population lives in proximity of a private park?	GIS public parks proximity mapping data	Physical activity; cohesive community; safety; vehicle collisions; self-rated health	Obesity; depression; disability; death; mental health; ADHD

P.3 Access to Trails Network

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What percentage of the population lives in proximity of the trails network?	GIS public parks proximity mapping data	Physical activity; cohesive community; safety; vehicle collisions; self-rated health	Obesity; depression; disability; death; mental health; ADHD

IV. playokc Indicators

P.1 Access to Public Parks

P.2 Access to Private Parks

P.3 Access to Trails Network

Health-based Rationale

Having access to public recreation facilities provides individuals and the community with a variety of potential health benefits. People of all ages can benefit from park facilities, as well as people from a variety of socio-economic upbringings.

Proximity can be indicative of greater access to parks, but this is relative to a potential user's mobility and the quality of the local pedestrian, bicycle, and vehicular network. The Federal Highway Administration gives direction on suitable sidewalks and trails that provide equal access for all users[171]. In general, however, studies show that with an increase in access and outreach, physical activity rates increase by a median percentage of 48.4%[172]. The U.S. Department of Health & Human Services suggests that adults need an average of two and a half hours of moderate-to-vigorous physical activity each week, and that children need more; one hour per day at a minimum[173].The health benefits for this type of activity include lower risk of premature death, coronary heart disease, stroke, hypertension, type 2 diabetes, and depression. As a person increase from two and a half hours to five hours, the benefits increase with a lesser risk of colon and breast cancer, and prevention of unhealthy weight gain, decreasing obesity rates.

In addition to increased physical activity, people report a more positive emotional effect of participating in specific outdoor activity than when the same or similar activities were completed in a synthetic environment[174]. Similarly, studies show that exposure to greenspace can produce an improvement in children with behavioral conditions, specifically Attention Deficit Hyperactivity Disorder (ADHD)[175]. There is not much concrete scientific evidence supporting the idea that access to park space causes greater social cohesion, but there is a correlation with the concept of a walkable neighborhood, in which access to parks is considered a daily activity. Communities with greater opportunities for social interaction are more likely to have social and community ties that strengthen bonds between neighbors[176].

Well-managed parks have a positive impact upon environmental health, including air quality and stormwater management. Trees that live to 50 years of age generate more than $30,000 worth of oxygen, and

[171] Axelson, P. W. et al. U.S. Department of Transportation, Federal Highway Administration. (1999).*Designing sidewalks and trails for access*. Retrieved from website: http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalks/
[172] Kahn, E. B. et al. (2002). *The effectiveness of interventions to increase physical activity: A systematic review*. Retrieved from http://www.thecommunityguide.org/pa/pa-ajpm-evrev.pdf
[173] U.S. Department of Health and Human Services, (2008).*2008 physical activity guidelines for Americans* (U0036). Retrieved from ODPHP website: http://www.health.gov/paguidelines/pdf/paguide.pdf
[174] Bowler, E. A. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, *10*(456), Retrieved from http://www.biomedcentral.com/content/pdf/1471-2458-10-456.pdf
[175] Bell, S. (2008). *Greenspace and quality of life: a critical literature review* .Retrieved from http://www.openspace.eca.ac.uk/pdf/appendixf/OPENspacewebsite_APPENDIX_F_resource_9.pdf
[176] Leyden, K.M. (2003). Social capital and the built environment: The importance of walkable neighborhoods. *American Journal of Public Health*, 93(9), Retrieved from http://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.93.9.1546

have a significant effect in reducing the amount of pollutants in the air[177]. Large healthy trees, 30" diameter or greater, are approximately 70 times more effective at removing air pollution (3.1 lbs/yr) than small healthy trees, less than 3.5" in diameter (0.04 lbs/yr)[178]. Impervious surfaces in parks, coupled with significant tree coverage can reduce stormwater demands upon municipal systems. Conifer trees over impervious surfaces reduce stormwater runoff by up to 30%[179]. These measures represent a lower risk of disease in humans, animals and vegetation due to contaminated air and water.

Existing Conditions

With the recent completion of the Oklahoma City Parks Master Plan, access to parks has been addressed quite significantly, particularly in terms of the scale of each park. The parks were divided into local parks and regional parks. Local parks include neighborhood and community parks, as well as schools with accessible facilities. Regional parks include district and metropolitan parks. Rather than repeat the work completed in the parks master plan, this study will look at public vs. private parks and citizen access.

In order to better understand the character of access to public parks, existing access points for each public park have been mapped, and Network Analyst within GIS has been used to map 5-minute and 10-minute walk distances along the pedestrian network, and 1 mile along the street network to create a service area. Residential parcels that fall within this service area have been matched to U.S. Census blocks in order to extract a population that is serviced by a public park within each of the distance levels.

There are 162 park facilities within the city limits. There are varying figures for the total acreage due to the high amount of water acres, but this study will look at access to land acres (4465 acres) of public park space.

This first map illustrates the residential parcels that are within a 5-minute walk of a public park. The total number of residents came out to be 67,815 or 10.9% of the population of Oklahoma City.

[177] Sherer, P.M. The Trust for Public Land.(2006*). The benefits of parks: Why America needs more city parks and open space* (The Trust for Public Land). San Francisco, California

[178] Nowak, D. J. USDA Forest Service, (n.d.). *The effects of urban trees on air quality*. Retrieved from website: http://www.ncufc.org/uploads/nowak_trees.pdf

[179] Herrera Environmental Consultants, Inc. Seattle Public Utilities, (2008). *The effects of trees on stormwater runoff*. Retrieved from: http://www.psparchives.com/publications/our_work/stormwater/lid/dearing_grading/Effect_of_Trees_on_Stormwater_Lit_Review-Herrera.pdf

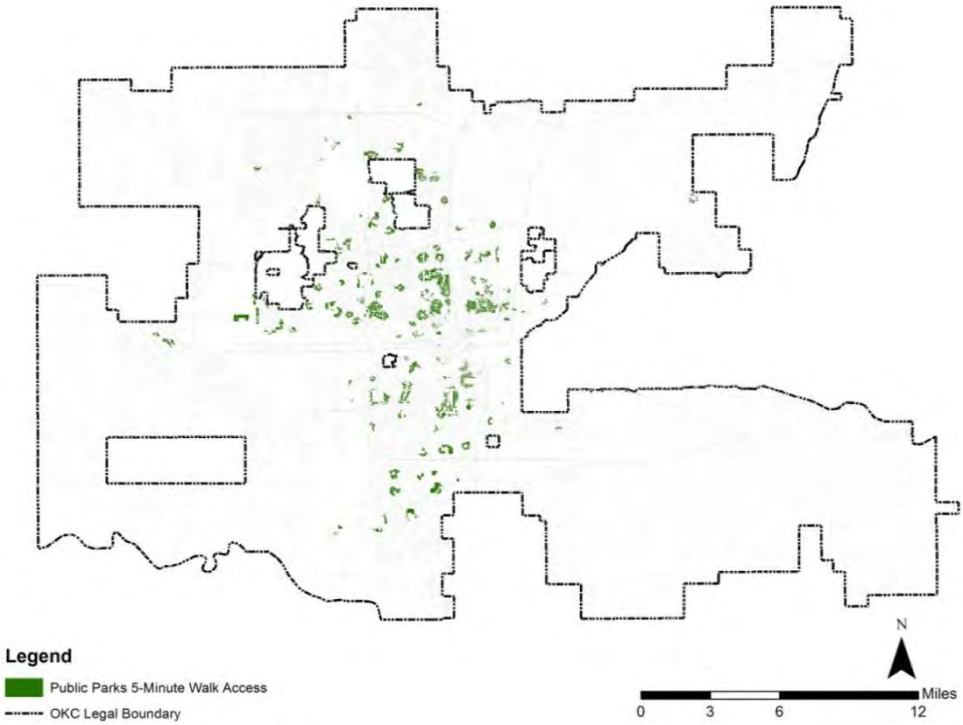


Figure 13: Residential Parcels within a 5-Minute Walk of a Public Park

The second map illustrates the residential parcels that are within a 10-minute walk of a public park. The total number of residents came out to be 156,130, or 25.1% of the population of Oklahoma City.

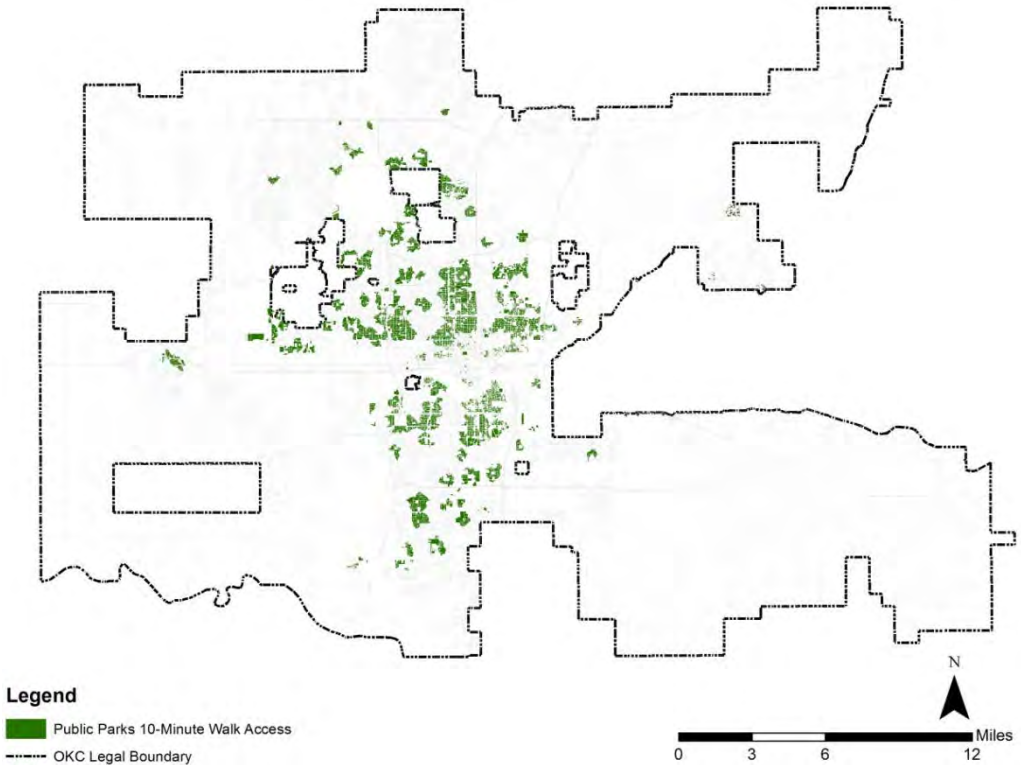


Figure 14: Residential Parcels within a 10-Minute Walk of a Public Park

This last map illustrates the residential parcels that are within 1 mile of a public park. The total number of residents came out to be 400,071, or 64.2% of the population of Oklahoma City.

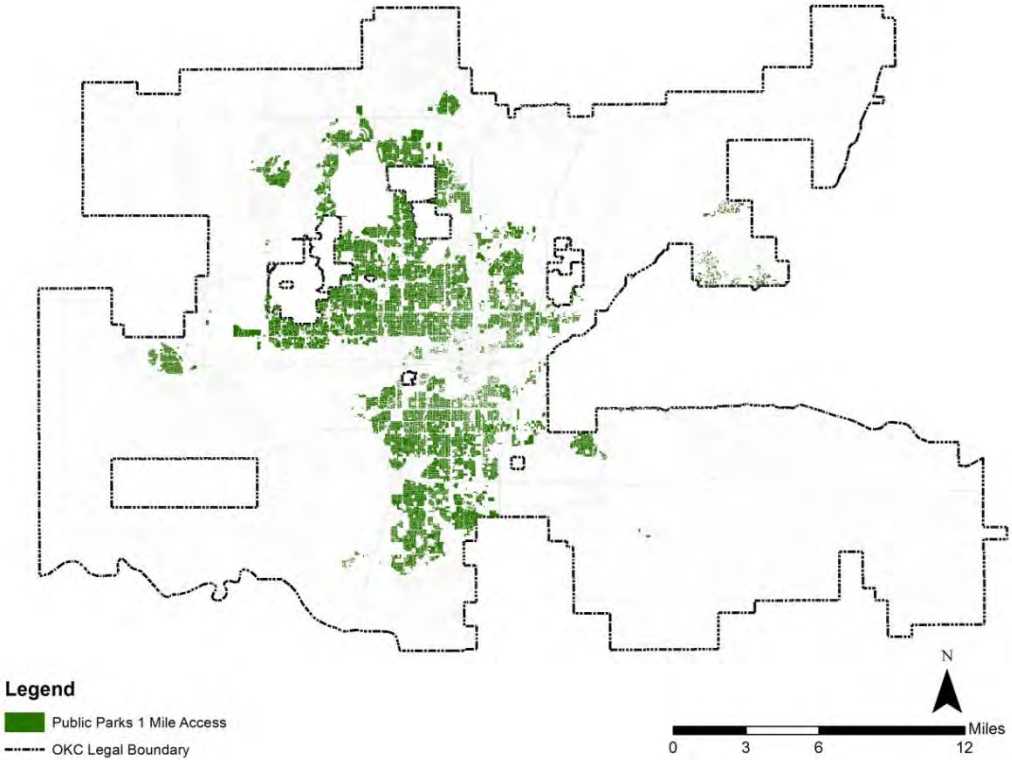


Figure 15: Residential PArcels within 1 Mile of a Public Park

Service Area	Population Served	Per-capita by Service Area (acres per 1,000 residents)
5 min. walk	67,815	65.84
10 min. walk	156,130	28.60
1-mile	400,076	13.65
Citywide	599,199 - 624,000	7.45

These numbers illustrate a disparity in the access to public parks based upon proximity. A relatively small group of citizens live within a five-minute walk of a public park, which is, admittedly, a very short distance; however, this could imply many things:

a. Land use adjacent park spaces tend to not be residential in nature.
b. The sidewalk network around the parks is sub-standard.
c. There is not enough park space to accommodate the needs of the many neighborhoods in the city.

But, when the radius increases to a ten-minute walk, we see an increase of access by 130.22%. Roughly one quarter of the residents of Oklahoma City live within this ten-minute walk service area of public parks. By increasing the service area to 1 mile and including the street network for driving, we now can account for two thirds of the total population of the city. It is most important to increase the number of residents who live

within a walkable distance to the parks, so measures that increase access in the five-minute and ten-minute walk ranges are most beneficial for public health improvements.

The per capita figures in the above table show that each park fails to serve enough people, but also that for the entire city there is inadequate acreage of park space. This is why the per-capita figures are so high within a short distance and so low for the whole city.

Of course, there are other public facilities that can be used for recreation purposes besides public parks. There are 52 schools within the city limits that have open access to their recreation facilities in some capacity. Schools tend to be spaced more evenly and in residential areas, thereby potentially increasing access to recreational facilities. In the table below you can see the total people served by these 52 schools with open facilities as well as how they complement the access to park space (correcting for those that fall within both service areas).

Service Area	Pop. Served – School	Pop. Served Parks	Total Pop. Served
5 min. walk	20,018	67,815	80,947
10 min. walk	37,687	156,130	181,756
1 mile	166,645	400,076	473,200

Adding the schools in increases the 5-minute walk access by 19.4%, the 10-minute walk access by 16.4%, and the 1-mile access by 18.3%. Encouragingly, these 52 schools represent around ¼ of the total schools in the city that could potentially provide access to recreation facilities. There is a great opportunity for increasing access without building a single park.

Scenario Analysis

In order to determine the future access to public parks each of the three scenarios will be compared to existing parks, plus new parks located in areas recommended by the Parks Master Plan. Using the polygrid layout that is the basis of the scenario analysis all existing parks' service areas, plus new estimated service areas for the parks outlined in the Parks Master Plan, are overlaid to determine what the new population of each scenario is for the corresponding 5-minute, 10-minute, and 1-mile service areas. 30 parks were added to the analysis as seen in the map below.

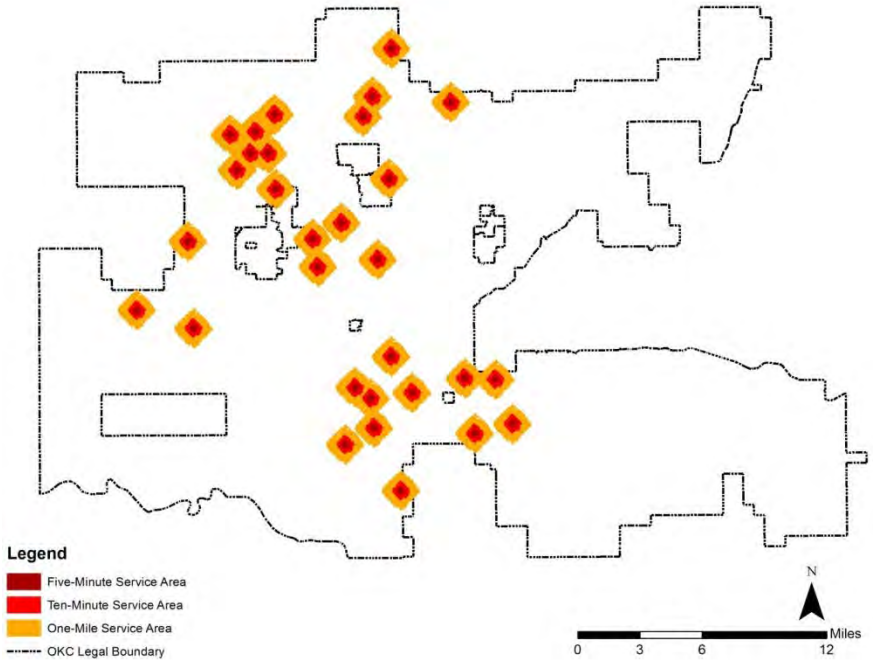


Figure 16: Park Service Areas Added from Parks Master Plan

Based upon this methodology, a GIS model was utilized to generate the population numbers for each scenario, as described in the table below:

	Existing	Scenario A	Scenario B	Scenario C
5 min. walk	67,815	63,196.02	72,816.04	86,278.18
Percent of Total Population	**10.88%**	**7.09%**	**8.17%**	**9.67%**
10 min. walk	156,130	187,931.6	211,394.5	247,554.7
Percent of Total Population	**25.06%**	**21.07%**	**23.73%**	**27.76%**
1 Mile	400,076	458,730.5	494,748.4	571,550
Percent of Total Population	**64.21%**	**51.43%**	**55.54%**	**64.09%**

Conclusions

A) Under Scenario A there would be a lower percentage of the population within a 5-minute walk, 10-minute walk, and 1-mile distance from a public park than in existing conditions. Also, Scenario A has the lowest percentage in all categories when compared with Scenario B and C.

B) Under Scenario B there would be a lower percentage of the population within a 5-minute walk, 10-minute walk, and 1-mile distance from a public park than in existing conditions. Scenario B performs better than Scenario A in all three categories, but not as well as Scenario C.

C) Under Scenario C there would be a lower percentage of the population within a 5-minute walk and a 1-mile distance from a public park than in existing conditions; however, there would be a greater percentage of the population living within a 10-minute walk. Scenario C performs better than Scenario A and B in all three categories.

Policy Review

Overview:

Public parks bring physical and emotional enjoyment to local residents, as well as, visitors. Oklahoma has an abundance of public parks for people to enjoy which promote a healthy mind and body through providing outlets for physical activities, sports, and community involvement. Although there are many parks within the city limits, several obstacles tend to discourage intended park use including lack of transportation or connection modes, safety, and park maintenance. Oklahoma City can increase public park use and encourage a healthy lifestyle by locating new parks in areas that are highly visible and accessible from surrounding residential streets and utilize trails to increase activity and visibility in parks and utilizing Crime Prevention through Environmental Design principles (includes controlled access, visibility, lighting, etc.) for new parks and retrofitting/redesign of existing parks. By increasing participation in the OKC Beautiful's "Adopt a Park" program, participants can include nearby businesses, neighborhood associations, churches, schools, and nonprofit groups which will allow everyone to become involved in changing Oklahoma City's health status.

Relevant Policies:

Connect.Sidewalks.**207**

Green.Biological Resources.**379**

Green.AgricultureForestry.**312**

Green.AgricultureForestry.**314**

Live.Neighborhood Safety.**423**

Live.Schools.**428**

Enrich.Urban Design and Form.**627**

Enrich.Urban Design and Form.**630**

Play.Fundraising,Maintannce, Operations.**352**

Play.Fundraising,Maintannce, Operations.**353**

Play.Levels of Service and Programming Needs.**360**

Play.Levels of Service and Programming Needs.**364**

Play.Accesibility and Use.**367**

Play.Accessibility and Use.**376**

Play.Safety and Design.**378**

Recommendations

- Coordinate with schools to encourage access to recreation facilities for community use.
- Continue to expand the park & trail networks completed in the Oklahoma City Parks Master Plan.
- Prioritize and increase maintenance funding for public parks.
- Increase connectivity by implementing sidewalks, trails, and bike paths.
- Collect year-over-year data to keep track of the quality of all public parks
    - Utilize partnerships with universities, schools, neighborhoods, and other volunteer groups to conduct field work in order to keep City expenses focused on the improvement of parks.
- Adopt policies which keep public parks safe, environmentally stable, and health equitable.
- Ensure parks are multi-use destinations by collectively deciding what will make the space a destination. Choose uses based upon a cross-section of potential users (neighborhood associations, schools, businesses, etc).
- Encourage and/or organize "park mobs" and other impromptu or regular events in the park to increase usership.
- Require adjacent housing to face parks.

IV. playokc Indicators

P.1 Access to Public Parks

P.2 Access to Private Parks

P.3 Access to Trails Network

Health-based Rationale

Having access to public recreation facilities provides individuals and the community with a variety of potential health benefits. People of all ages can benefit from park facilities, as well as people from a variety of socio-economic upbringings.

Proximity can be indicative of greater access to parks, but this is relative to a potential user's mobility and the quality of the local pedestrian, bicycle, and vehicular network. The Federal Highway Administration gives direction on suitable sidewalks and trails that provide equal access for all users[180]. In general, however, studies show that with an increase in access and outreach, physical activity rates increase by a median percentage of 48.4%[181]. The U.S. Department of Health & Human Services suggests that adults need an average of two and a half hours of moderate-to-vigorous physical activity each week, and that children need more; one hour per day at a minimum[182].The health benefits for this type of activity include lower risk of premature death, coronary heart disease, stroke, hypertension, type 2 diabetes, and depression. As a person increase from two and a half hours to five hours, the benefits increase with a lesser risk of colon and breast cancer, and prevention of unhealthy weight gain, decreasing obesity rates.

In addition to increased physical activity, people report a more positive emotional effect of participating in specific outdoor activity than when the same or similar activities were completed in a synthetic environment[183]. Similarly, studies show that exposure to greenspace can produce an improvement in children with behavioral conditions, specifically Attention Deficit Hyperactivity Disorder (ADHD)[184]. There is not much concrete scientific evidence supporting the idea that access to park space causes greater social cohesion, but there is a correlation with the concept of a walkable neighborhood, in which access to parks is considered a daily activity. Communities with greater opportunities for social interaction are more likely to have social and community ties that strengthen bonds between neighbors[185].

Well-managed parks have a positive impact upon environmental health, including air quality and stormwater management. Trees that live to 50 years of age generate more than $30,000 worth of oxygen, and

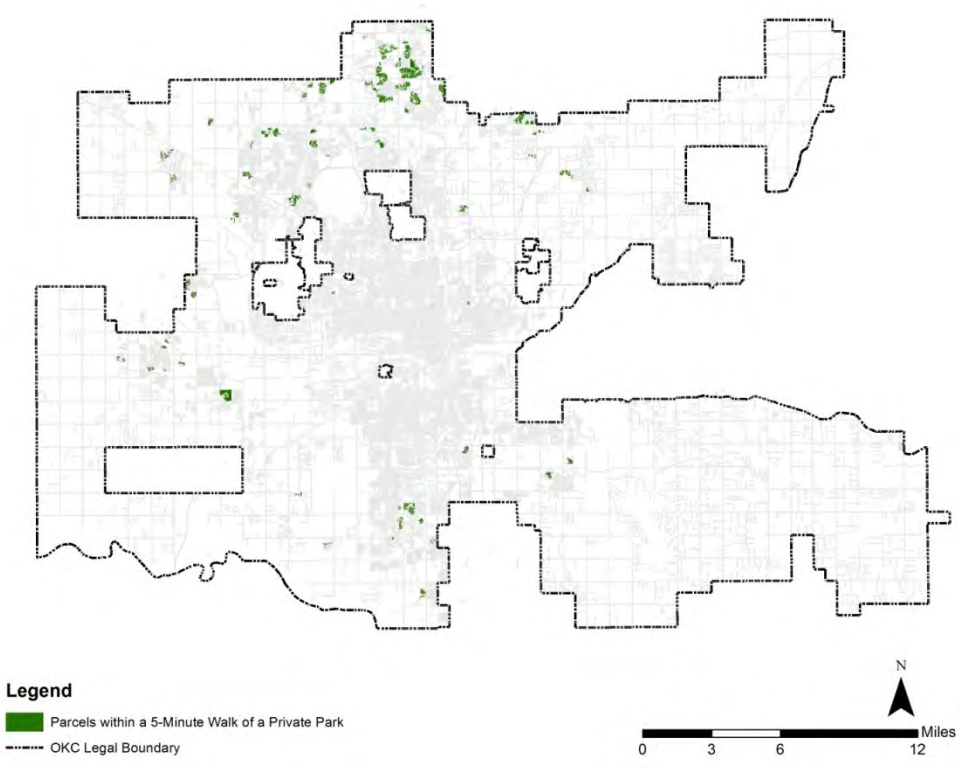
[180] Axelson, P. W. et al. U.S. Department of Transportation, Federal Highway Administration. (1999).*Designing sidewalks and trails for access*. Retrieved from website: http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalks/
[181] Kahn, E. B. et al. (2002). *The effectiveness of interventions to increase physical activity: A systematic review*. Retrieved from http://www.thecommunityguide.org/pa/pa-ajpm-evrev.pdf
[182] U.S. Department of Health and Human Services, (2008).*2008 physical activity guidelines for Americans* (U0036). Retrieved from ODPHP website: http://www.health.gov/paguidelines/pdf/paguide.pdf
[183] Bowler, E. A. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, *10*(456), Retrieved from http://www.biomedcentral.com/content/pdf/1471-2458-10-456.pdf
[184] Bell, S. (2008). *Greenspace and quality of life: a critical literature review* .Retrieved from http://www.openspace.eca.ac.uk/pdf/appendixf/OPENspacewebsite_APPENDIX_F_resource_9.pdf
[185] Leyden, K.M. (2003). Social capital and the built environment: The importance of walkable neighborhoods. *American Journal of Public Health*, 93(9), Retrieved from http://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.93.9.1546

have a significant effect in reducing the amount of pollutants in the air[186]. Large healthy trees, 30" diameter or greater, are approximately 70 times more effective at removing air pollution (3.1 lbs/yr) than small healthy trees, less than 3.5" in diameter (0.04 lbs/yr)[187]. Impervious surfaces in parks, coupled with significant tree coverage can reduce stormwater demands upon municipal systems. Conifer trees over impervious surfaces reduce stormwater runoff by up to 30%[188]. These measures represent a lower risk of disease in humans, animals and vegetation due to contaminated air and water.

Existing Conditions

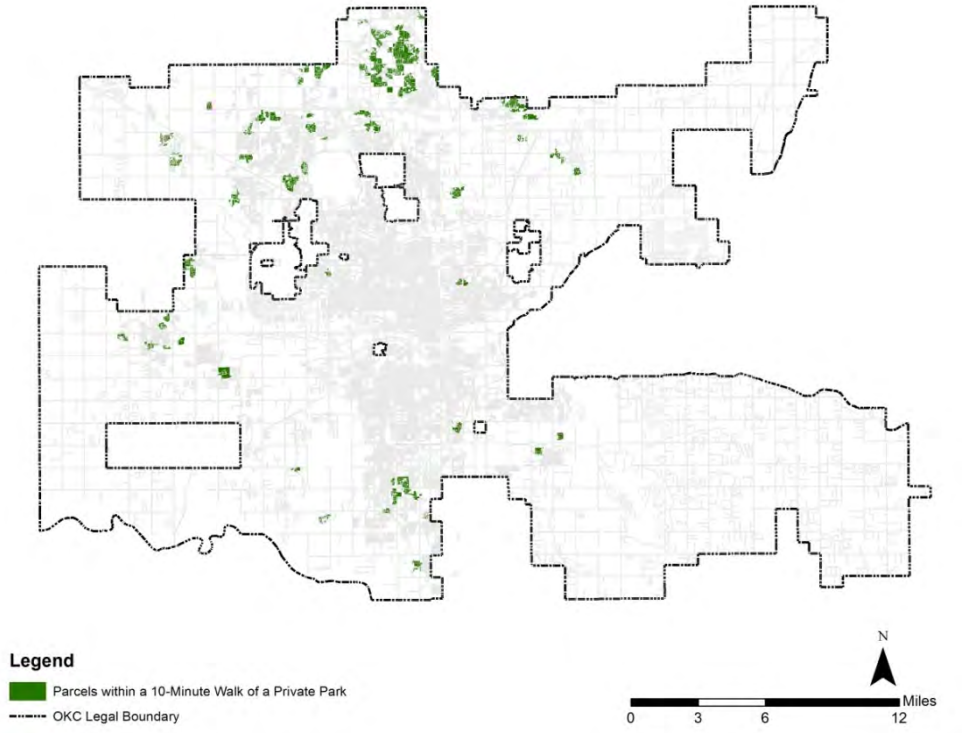
There are 99 private park facilities within the city limits, which add up to a total of 266.51 acres. The majority of these private parks are located peripherally to Oklahoma City, largely to the north toward Edmond. In this northern area there is little overlap between the public and private park access service areas, implying inefficient neighborhood street designs or lack of sidewalk infrastructure – things are more spread out in this area. These parks may only serve certain neighborhoods and not actually be accessible to all who have fallen within the designated service area. These parks are not owned by the public and therefore users are subject to the rules and regulations of whatever entity owns the park property.

This first map illustrates the residential parcels that are within a 5-minute walk of a private park. The total number of residents came out to be 23,226 or 3.7% of the population of Oklahoma City.

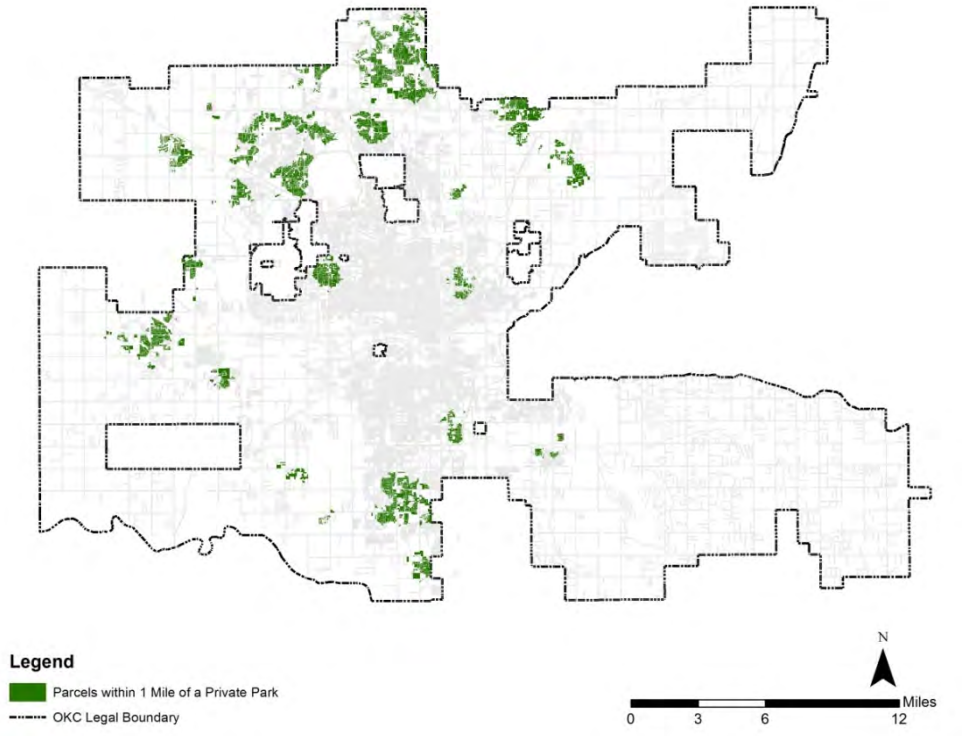


[186] Sherer, P.M. The Trust for Public Land.(2006*). The benefits of parks: Why America needs more city parks and open space* (The Trust for Public Land). San Francisco, California.
[187] Nowak, D. J. USDA Forest Service, (n.d.). *The effects of urban trees on air quality*. Retrieved from website: http://www.ncufc.org/uploads/nowak_trees.pdf
[188] Herrera Environmental Consultants, Inc. Seattle Public Utilities, (2008). *The effects of trees on stormwater runoff*. Retrieved from: http://www.psparchives.com/publications/our_work/stormwater/lid/clearing_grading/Effect of Trees on Stormwater Lit Review-Herrera.pdf

The second map illustrates the residential parcels that are within a 10-minute walk of a private park. The total number of residents came out to be 50,513, or 8.1% of the population of Oklahoma City.



This last map illustrates the residential parcels that are within 1 mile of a private park. The total number of residents came out to be 140,478, or 22.5% of the population of Oklahoma City.



Service Area	Population Served	Per-capita by Service Area (acres per 1,000 residents)
¼-mile	23,226	11.47
½-mile	50,513	5.28
1-mile	140,478	1.90

From these numbers you can see that private parks are a significant contributor to Oklahoma City's park access, particularly due to the lack of public parks in the areas served by private parks. Unfortunately, these parks spaces cumulatively add up to an insignificant total acreage; therefore, per-capita park space is very low. By breaking public and private parks apart we are able to visualize factors that could potentially skew the view of park access in this city in two ways:

1. By negating any assumptions that those who are in the service area of private parks are being serviced equally to those in the service area of public parks
2. By illustrating that per-capita park acreage at the city scale may not be a reliable measure for an area as large as Oklahoma City.

Scenario Analysis

Due to private parks being the responsibility of developers, it is not possible to conduct any sort of quantifiable projection.

Discussions with the HIA Steering Committee brought to light an understanding that in the case of continuing residential sprawl development in Oklahoma City, private parks are a necessity, as the Oklahoma City Parks and Recreation Department will not be able to provide services for such a spread-out population. Therefore, standards for creating and maintaining private parks are essential for future private park success.

Conclusions

A) Scenario A would likely increase the number of people reliant upon private parks as the greatest amount of development would occur in currently rural areas, far from existing public parks.

B) Scenario B would also likely increase the number of people reliant upon private parks but to a lesser extent than the results of Scenario A.

C) Scenario C would likely decrease the number of people reliant upon private parks as the greatest amount of development would occur in proximity to existing public parks, as well as the recommended parks from the Parks Master Plan.

Policy Review

Overview:

Private parks offer many of the same amenities that public parks offer, but are often preserved for natural beauty or historical reference and are operated by local government. There are many ways that local government can encourage the use of these parks. Creating partnerships and programs involving civic groups, business organizations, governmental entities, coalitions, and non-profits to develop or enhance parks in Oklahoma City can be an effective way to gain community support. In addition, Oklahoma City can

coordinate with school districts, local healthcare providers, and other community organizations to provide recreational programming not offered in nearby public parks or recreation centers, such as after-school fitness and education programs.

Relevant Policies:

Connect.Sidewalks.**207**

Green.Biological Resources.**379**

Green.AgricultureForestry.**312**

Green.AgricultureForestry.**314**

Live.Neighborhood Safety.**423**

Live.Schools.**428**

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Play.Fundraising,Maintannce, Operations.**352**

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Play.Levels of Service and Programming Needs.**360**

Play.Levels of Service and Programming Needs.**364**

Play.Accesibility and Use.**367**

Play.Accessibility and Use.**376**

Play.Safety and Design.**378**

Recommendations

- Ensure safe walking and biking routes to private parks.
    - Improve connectivity between neighborhoods increasing the access of residents to open space.
- Establish a new set of regulations to be included in the Subdivisions Regulations that creates an equitably accessible and sufficiently sized private park space for any new development.
    - Increase the percentage of park space required of public developers to meet a level of service comparable to public parks.
    - Create a scale by which recreational uses are selected from based upon the number of residential units in a subdivision development.
    - Put more emphasis on a private park being a contiguous space that provides the greatest level of access in a development, rather than upon the space being "centrally located".

IV. playokc Indicators

P.1 Access to Public Parks

P.2 Access to Private Parks

P.3 Access to Trail Network

Health-based Rationale

Having access to public recreation facilities provides individuals and the community with a variety of potential health benefits. People of all ages can benefit from park facilities, as well as people from a variety of socio-economic upbringings.

Proximity can be indicative of greater access to parks, but this is relative to a potential user's mobility and the quality of the local pedestrian, bicycle, and vehicular network. The Federal Highway Administration gives direction on suitable sidewalks and trails that provide equal access for all users[189]. In general, however, studies show that with an increase in access and outreach, physical activity rates increase by a median percentage of 48.4%[190]. The U.S. Department of Health & Human Services suggests that adults need an average of two and a half hours of moderate-to-vigorous physical activity each week, and that children need more; one hour per day at a minimum[191].The health benefits for this type of activity include lower risk of premature death, coronary heart disease, stroke, hypertension, type 2 diabetes, and depression. As a person increase from two and a half hours to five hours, the benefits increase with a lesser risk of colon and breast cancer, and prevention of unhealthy weight gain, decreasing obesity rates.

In addition to increased physical activity, people report a more positive emotional effect of participating in specific outdoor activity than when the same or similar activities were completed in a synthetic environment[192]. Similarly, studies show that exposure to greenspace can produce an improvement in children with behavioral conditions, specifically Attention Deficit Hyperactivity Disorder (ADHD)[193]. There is not much concrete scientific evidence supporting the idea that access to park space causes greater social cohesion, but there is a correlation with the concept of a walkable neighborhood, in which access to parks is considered a daily activity. Communities with greater opportunities for social interaction are more likely to have social and community ties that strengthen bonds between neighbors[194].

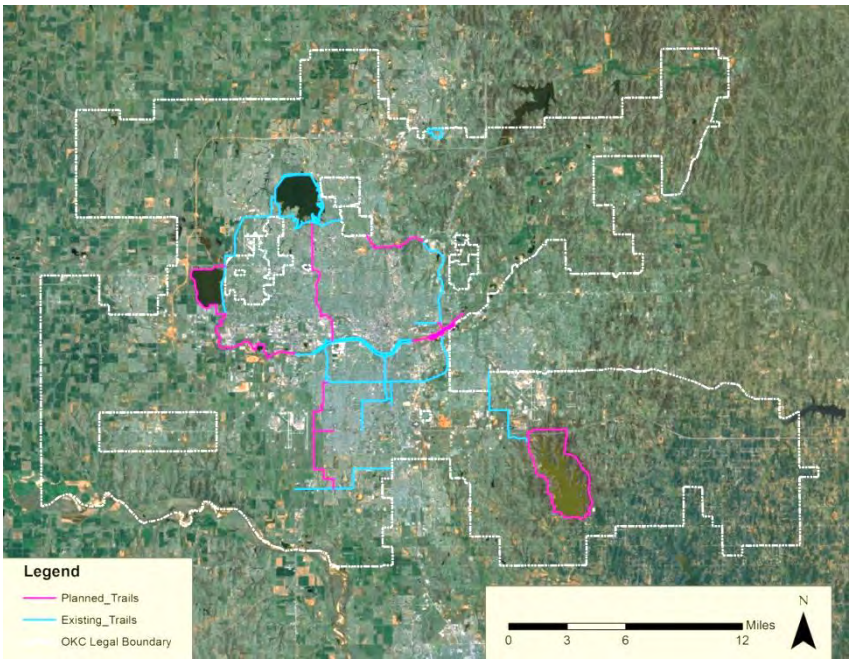
Well-managed parks have a positive impact upon environmental health, including air quality and stormwater management. Trees that live to 50 years of age generate more than $30,000 worth of oxygen, and

[189] Axelson, P. W. et al. U.S. Department of Transportation, Federal Highway Administration. (1999).*Designing sidewalks and trails for access*. Retrieved from website: http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalks/
[190] Kahn, E. B. et al. (2002). The effectiveness of interventions to increase physical activity: A systematic review. Retrieved from http://www.thecommunityguide.org/pa/pa-ajpm-evrev.pdf
[191] U.S. Department of Health and Human Services, (2008).*2008 physical activity guidelines for Americans* (U0036). Retrieved from ODPHP website: http://www.health.gov/paguidelines/pdf/paguide.pdf
[192] Bowler, E. A. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, *10*(456), Retrieved from http://www.biomedcentral.com/content/pdf/1471-2458-10-456.pdf
[193] Bell, S. (2008). *Greenspace and quality of life: a critical literature review* .Retrieved from http://www.openspace.eca.ac.uk/pdf/appendixf/OPENspacewebsite_APPENDIX_F_resource_9.pdf
[194] Leyden, K.M. (2003). Social capital and the built environment: The importance of walkable neighborhoods. *American Journal of Public Health*, 93(9), Retrieved from http://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.93.9.1546

have a significant effect in reducing the amount of pollutants in the air[195]. Large healthy trees, 30" diameter or greater, are approximately 70 times more effective at removing air pollution (3.1 lbs/yr) than small healthy trees, less than 3.5" in diameter (0.04 lbs/yr)[196]. Impervious surfaces in parks, coupled with significant tree coverage can reduce stormwater demands upon municipal systems. Conifer trees over impervious surfaces reduce stormwater runoff by up to 30%[197]. These measures represent a lower risk of disease in humans, animals and vegetation due to contaminated air and water.

Existing Conditions

For this health impact assessment the term "trail" refers to a pathway that is not specifically a sidewalk or bike route. There are 80.48 miles of existing trails in Oklahoma City, the majority of which align with the major water bodies in the city. An additional 53.57 miles of trails has already been planned to connect the existing trails into a large network.



In order to understand access to these trails it is important to look at the different possible uses of the trail. In most cases people will either be walking, running, or riding bicycles on the trails; therefore, service areas that are of reasonable distances for these modes can help understand who lives within a reasonable distance to arrive at a trail on foot, those who live within a comfortable biking distance, and those that will most likely need to drive in order to access a trail. The distances selected are for a five-minute walk, a ten-minute walk, a 1-mile distance, and a 2.5-mile distance, the first two to correspond with walking distances and the second two to correspond to biking distances.

[195] Sherer, P.M. The Trust for Public Land.(2006*). The benefits of parks: Why America needs more city parks and open space* (The Trust for Public Land). San Francisco, California.
[196] Nowak, D. J. USDA Forest Service, (n.d.). *The effects of urban trees on air quality*. Retrieved from website: http://www.ncufc.org/uploads/nowak_trees.pdf
[197] Herrera Environmental Consultants, Inc. Seattle Public Utilities, (2008). *The effects of trees on stormwater runoff*. Retrieved from: http://www.psparchives.com/publications/our_work/stormwater/lid/clearing_grading/Effect of Trees on Stormwater Lit Review-Herrera.pdf

The existing trails network, being located around natural resources is not generally in proximity to residential parcels, at least from the standpoint of comfortable pedestrian distances. Just over 20,000 residents (3.2% of the total Oklahoma City population) live within a 5-minute walk of a trail access point, and around 45,000 residents live within a 10-minute walk service area, or 7.2% of the population.

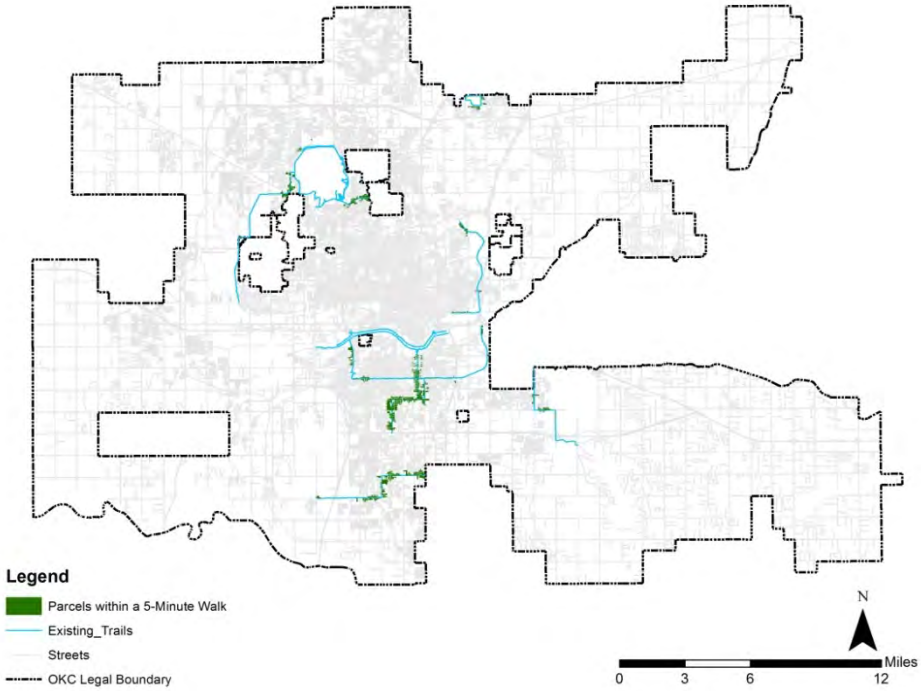


Figure 17: Parcels within a 5-Minute Walk of a Trail Access Point

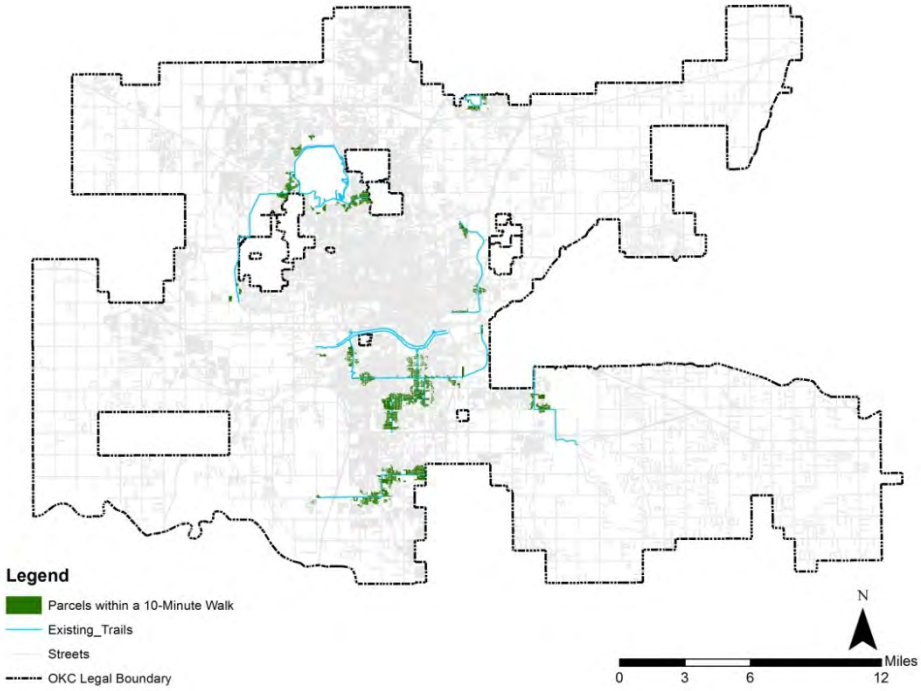


Figure 18: Parcels within a 10-Minute Walk of a Trail Access Point

The number of residents who live within a comfortable biking distance to a trail is, however, much greater. This condition lends itself to decision-making that safely connects cyclists and pedestrians to the trail system. 178,806 residents or 28.7% of the population live within 1 mile of a trail. 394,073 residents or 63.2% of the total population of Oklahoma City live within 2.5 miles of a trail.

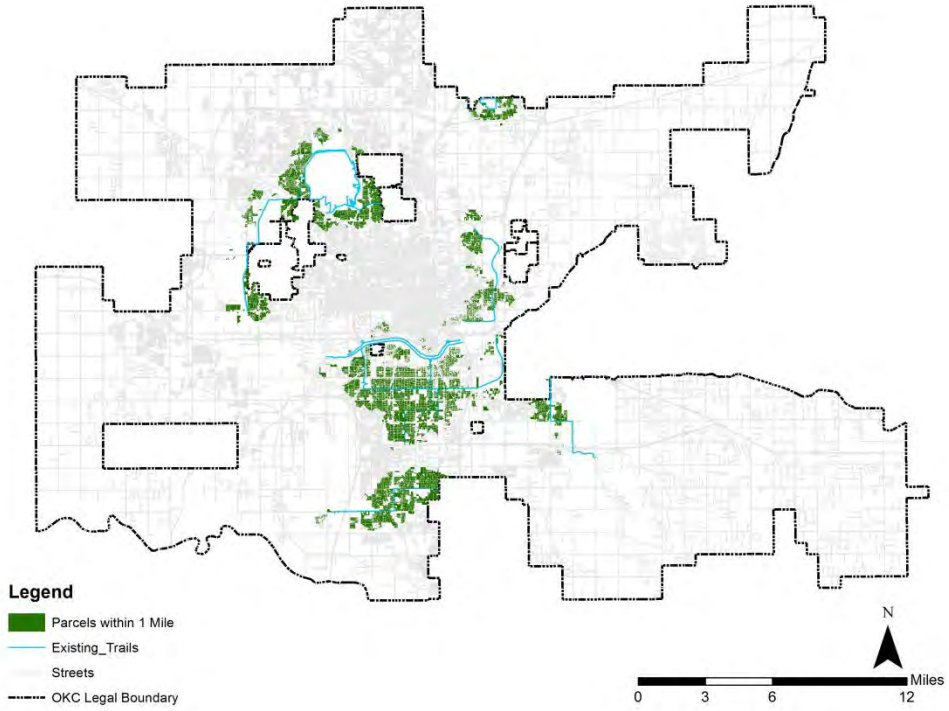


Figure 19: Parcels within 1 Mile of a Trail Access Point

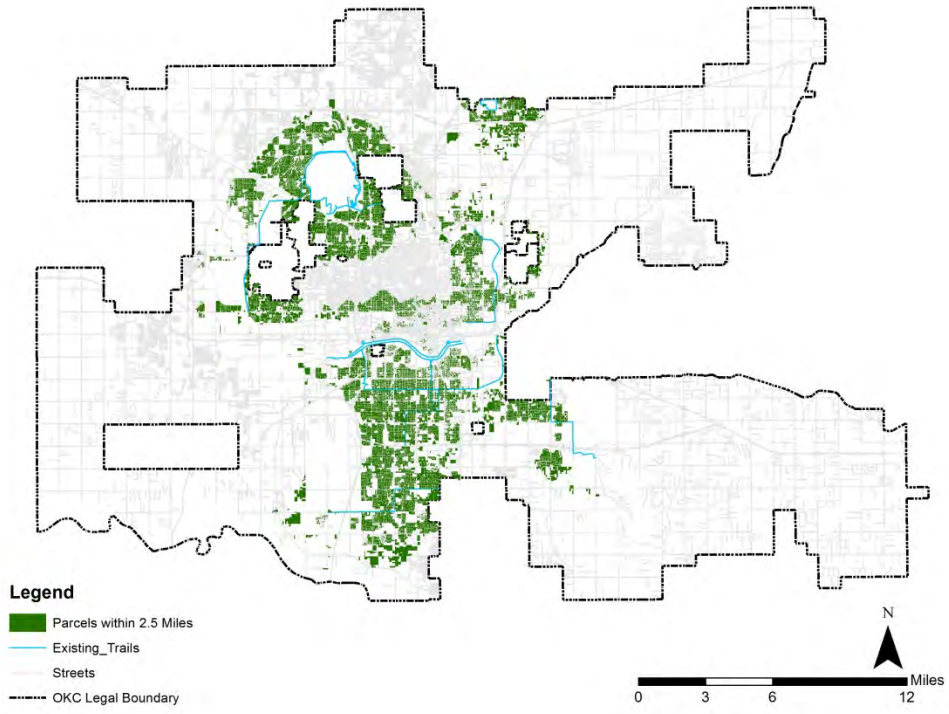


Figure 20: Parcels within 2.5 Miles of a Trail Access Point

Scenario Analysis

In order to compare the three scenarios to existing conditions service areas for existing trails plus the trails that are planned to be completed were overlaid onto each of the three scenarios to determine how many people are within each service area distance. The total distance of trails increased from 80.48 miles to 134.05 miles and includes Lake Stanley Draper, Lake Overholser and connections from the Katy Trail in east Oklahoma City to Lake Hefner.

The table below compares the three scenarios to existing conditions in terms of the number of residents that have access at each distance's service area. Each Scenario has roughly 300,000 more residents in total than in the Existing Conditions, as well as the additional "planned" trails.

	Existing	Scenario A	Scenario B	Scenario C
5 min. walk	20,092	26,766	27,826	31,560
Percent of Total Population	**3.2%**	**3%**	**3.1%**	**3.5%**
10 min. walk	44,991	63,134	65,469	74,285
Percent of Total Population	**7.2%**	**7.1%**	**7.3%**	**8.3%**
1 Mile	178,806	230,209	246,350	276,940
Percent of Total Population	**28.7%**	**25.8%**	**27.7%**	**31.1%**
2.5 Miles	394,073	472,510	517,762	561,348
Percent of Total Population	**63.2%**	**52.3%**	**58.1%**	**63%**

Conclusions

A) Under Scenario A there would be a decrease in the percentage of the population within all distance service areas from a trail access point when compared to existing conditions. Also, Scenario A has the lowest percentage in all categories when compared with Scenario B and C.

B) Under Scenario B there would be a lower percentage of the population within a 5-minute walk, and 1-mile distance and 2.5-mile distance from a trail access point, but a slight increase in the percentage of residents within a 10-minute walk. Scenario B performs better than Scenario A in all four distance categories, but not as well as Scenario C.

C) Under Scenario C there would be a greater percentage of the population within a 5-minute walk, 10-minute walk, and 1-mile distance from a trail access point than in existing conditions; however, there would be a slightly lower percentage of the population living within a 2.5-mile distance. Scenario C performs better than Scenario A and B in all four categories.

Policy Review

Overview:

Oklahoma City's trail network is impressive compared to other comparable size cities. Trails provide opportunity for an array of physical activities, such as walking, jogging, hiking, biking, rollerblading, and skateboarding. An often overlooked benefit of a trail system is the ability to connect individuals in strategic locations. Oklahoma City can increase citizens' access to jobs, housing, schools, and daily needs by increasing the quality and amount of bike lanes, sidewalks, and trails. This could be accomplished by designing a greenbelt network to provide connections between major employment centers, commercial sites, parks, and key locations within major residential neighborhoods. A secondary way to encourage the use of trail systems is to keep trails safe by adhering to "Crime Prevention Through Environmental Design" principles including lighting, identification markers, and call boxes and providing shelter structures along the trail networks and determining the appropriate spacing for such structures.

Relevant Policies:

Play.Accessability and Use.**377**

Strengthen.Employment and Opportunity.**173**

Sustain.LandUsePatterns.**263**

Connect.Transportation Systems.**177**

Connect.Trails.**199**

Connect.Trails.**201**

Connect.Trails.**202**

Recommendations

- Prioritize building quality trail connections from the current trail system to existing neighborhoods with low health indicator scores before expanding system into areas with better scores.
- Include trail connections in the design of new neighborhoods adjacent to existing or planned trails, preferably that extend the trail into open space of the new development.
- Create trail connections between areas with low health indicator scores and employment/retail centers enhancing the trail system's use as a transportation system.
- Utilize the trail network to increase confidence in active transportation:
    - Create "Complete Streets" that connect residential areas to the trail network, as well as employment areas, districts, downtown and more.
- Place public art along the trails network to encourage greater usage, as well as encouraging local artists to engage municipal art projects.
- Market the trails system as transportation and recreation system to residents and visitors.

- Ensure the safety of people using the trail system.
- Develop policies to increase access to trail networks:
    - Encourage employer-based incentive programs for use of trail networks.
    - Increase bus and paratransit routes to connect with trail networks.
    - Increase connections and opportunity for connections between trail networks.
    - Increase public education about trail networks.
    - Increase the amount of parking access to trails.

connectokc indicators

C.1 Average Vehicle Miles Traveled (VMT)

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What is the average vehicle miles traveled (VMT) per day for OKC residents?	VMT from Association of Central Oklahoma Governments	Physical activity; air quality; climate change (extreme weather); car accidents	Chronic disease Heart/respiratory Dis. Water/food/vector/rodent-borne disease; Obesity; Injury; Death

C.2 Average Commute by ZIP Code

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What is the average commute by ZIP code?	American Community Survey data	Social connectivity; civic engagement; physical activity; cost of driving ($)	Stress; lifespan; obesity; shoulder, neck, and back pain; mental health

C.3 Proportion of Commute Trips by Transit, Bicycling, and Walking

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What proportion of commute trips are made on public transit, walking, or cycling?	Census Data; transit surveys	Physical activity; social interaction; air/noise pollution; global warming; cost vs. driving ($)	Heart Disease; Chronic diseases; bone health; depression; stress; respiratory disease; lifespan; infectious disease;

C.4 Ratio of Lane Miles to Transit, Bicycle and Pedestrian Facilities (Access)

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What is the ratio of total lane miles to public transit, bike lanes, and sidewalks? What percentage of the population has access?	GIS proximity access mapping	Physical activity; social interaction; air/noise pollution; global warming; cost vs. driving ($)	Heart Disease; Chronic diseases; bone health; depression; stress; respiratory disease; lifespan; infectious disease;

C.5 Number and Rate of Bicycle and Pedestrian Injury Collisions

Health Indicators	Measure	Health Determinant	Health Outcomes
What is the number and rate of bicycle and pedestrian injury collisions?	NHTSA data; local pedestrian studies	Safety; collisions	Disability; death

C.6 Percentage of Average Income Spent on Transportation

Health Indicators	Measure	Health Determinant	Health Outcomes
What is the percentage of average income spent on transportation?	Sociological statistical data; Census data	cost ($); access to healthy choices; access to daily needs	Stress; lifespan; obesity; depression

V. connectokc Indicators

C.1 Average Vehicle Miles Traveled (VMT)

C.2 Average Commute by ZIP Code

C.3 Proportion of Commute Trips by Transit, Bicycling, and Walking

Health-based Rationale

The number of miles traveled by motor vehicle is directly correlated to the proliferation of air pollutants such as ozone and particulate matter, as well as a contributor to global warming due to the release of greenhouse gases[198]. High levels of air pollutants can result in increased risk and rates of respiratory and cardiovascular diseases, while the threat of climate change due to greenhouse gas emissions could lead to extreme weather events, an increase in heat-related death, and an increase in vector, rodent and airborne disease[199].

Locations with higher rates of vehicle miles traveled often have a higher likelihood of collisions as there is a greater amount of time being spent in motor vehicles. Higher VMT rates indicate that more people are driving personal vehicles than using alternative modes of transportation, and this can be due to a lack of sufficient access to transit options that would reduce the number of drivers on the road[200].

Higher VMT rates correlate with a lower amount of physical activity. People who walk or bike more frequently reduce their risk of developing obesity and diabetes[201]. This can be facilitated by walkable neighborhood design such that the majority of daily needs can be met without the need to use a motor vehicle. People who become accustomed to walking on a daily basis are developing a positive healthful habit[202].

Additionally, the more reliant upon motor vehicles as opposed to other modes of transportation, the more money individuals are spending on transportation costs. This is money that could be used for healthy options for food, exercise, and healthcare.

Spending long hours in the car during a commute can have negative impacts on social interactions and mental well-being as well. This is fairly intuitive as more time spent in the car is less time that can be spent with family, friends or neighbors. A large percentage of drivers consider rush hour to be the most stressful part of their day which can lead to irritability, back and neck pain, as well as depression[203]. Social isolation can

[198] U.S. Environmental Protection Agency. (1970-2013). *National emission inventory (NEI) air pollutant emissions trends data* [data set]. Retrieved from http://www.epa.gov/ttn/chief/trends/index.html#tables

[199] World Health Organization. (2011). *Air quality and health* [fact sheet]. Retrieved from http://www.who.int/mediacentre/factsheets/fs313/en/

[200] Transportation Economics Committee. (n.d.).*Transportation cost-benefit analysis: Change in accident rates*. Retrieved from http://bca.transportationeconomics.org/benefits/safety/change-in-accident-rates

[201] Booth, G. L. (2012). Unwalkable neighborhoods, poverty, and the risk of diabetes among recent immigrants to Canada compared with long-term residents. *Diabetes Care*, *36*(2), 302-308. Retrieved from http://care.diabetesjournals.org/content/36/2/302.long

[202] U.S. Department of Health and Human Services, National Institute of Diabetes and Digestive and Kidney Diseases. (2008). *Changing your habits: steps to better health* (08-6444). Retrieved from NIH Publication website: http://win.niddk.nih.gov/publications/PDFs/Changing_Your_Habits.pdf

[203] BBC. 2000. *Commuting is 'biggest stress'*. Retrieved from http://news.bbc.co.uk/1/hi/health/999961.stm.

cause more than just mental trauma and has been shown to be correlated to higher blood-pressure, cardiovascular risk factors, and premature death; people with strong social relationships on average have a 50% increased likelihood of survival than those who suffer social isolation[204].

Existing Conditions

VMT by Functional Class Group:

Between the years of 2005 and 2010 Oklahoma City and its region have seen no significant changes in the vehicle-miles traveled. In 2005 the OCARTS (Oklahoma City Area Regional Transportation Study) area daily VMT was 36,847,391. This total decreased by 2008 by 3.45%, but by 2010 had returned to within 0.2% of the 2005 figure. Of the 2005 total VMT, **36.14%** is attributed to freeway driving, **20.49%** to principal arterials, **37.03%** to minor arterials, and **6.33%** to collectors. By 2010 this ratio had changed to **39.43%** on freeways, **18.19%** on principal arterials, **36.54%** on minor arterials, and **5.84%** on collectors. While these percentages are similar, there does appear to be a trend of increased freeway usage. This is perhaps due to an increase in long-distance commute trips[205].

VMT Comparison over Time and Geography:

During the five-year period between 2005 and 2010, the population of the OCARTS area increased by **14.6%**[206] [207]**.** Therefore, per-capita VMT is decreasing presently, even as total VMT appears to be on an upward trend. Per-capita VMT 2005 would have been 34.24 miles per day (12,497.6 mi. /yr.), and decreased to 30.19 miles per day (11,019.4 mi. /yr.) in 2010. This is 14.8% greater than the U.S. average per-capita VMT for 2010 of roughly 26.3 miles per day (9,600 mi. /yr.)[208]. However, the OCARTS 2010 area per capita VMT is 13.3% lower than the State of Oklahoma's average of 34.79 miles per day (12,698 mi. /yr.)[209].

Scenario Analysis

Explanation of figures:

Vehicle-miles traveled for each scenario is generated through the Envision Tomorrow Scenario planning tool. Based upon inputs for fields including household variables such as size, employed workers, and income, as well as accessibility variables that include density of population, employment, intersections, transit stops and more, the Envision tomorrow tool generates a VMT value for each of the three scenarios that represent possible futures of development in Oklahoma City. These development patterns have important implications into the amount that people drive and the costs associated with maintaining infrastructure. In a future where development is spread wildly across the city there will almost certainly be an increase in VMT compared to a more densely developed landscape.

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[204] Windle, K., Francis, J., & Coomber, C. (2011). *Preventing loneliness and social isolation: Interventions and outcomes*. Social Care Institute for Excellence, (39), Retrieved from website http://www.scie.org.uk/publications/briefings/files/briefing39.pdf

[205] McLane, J., et al. Association of Central Oklahoma Governments, (2013). *Traffic count analysis/ vehicle miles traveled (VMT) report*. Retrieved from website http://www.acogok.org/Websites/acogok/images/Downloads2013/20131021b.pdf

[206] U.S. Census Bureau. (2000, 2010). Retrieved from DemographicsNow website http://library.demographicsnow.com/?skey=762B6127188D446590DBB5FA90E3FA17

[207] Association of Central Oklahoma Governments. (n.d.). *About: Membership*. Retrieved from http://www.acogok.org/about-acog

[208] Puentes, R. Organization for Economic Co-operation and Development, (2012). *Have Americans hit peak travel? A discussion of the changes in U.S. driving habits* (2012-14). Retrieved from The Brookings Institute website: http://www.internationaltransportforum.org/jtrc/DiscussionPapers/DP201214.pdf

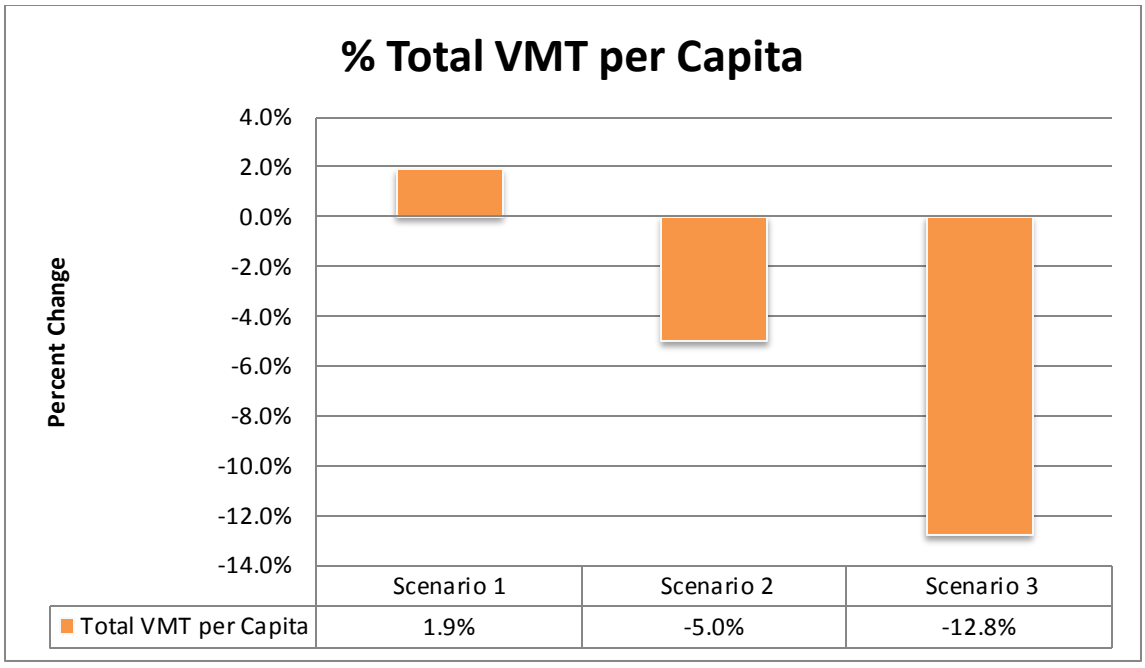
[209] U.S. Department of Transportation, Research and Innovative Technology Administration. (2011).*State transportation statistics*. Retrieved from The Bureau of Transportation Statistics website: http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/state_transportation_statistics/state_transportation_statistics_2011/pdf/entire.pdf

Figures:

According to the ET Scenario Summary, existing VMT per capita within the city limits is 34.59 miles per day (12,625 mi. / yr.) and a total of 20,065,125 miles VMT per day. The table below shows the comparison of the three scenarios and the change in VMT from present conditions.

	Existing		Scenario A		Scenario B		Scenario C	
	Miles	*% Change*	*Miles*	*% Change*	*Miles*	*% Change*	*Miles*	*% Change*
VMT	20,065,125	N/A	31,432,465	56.7%	29,297,021	46%	26,845,349	33.8%
VMT per Capita	34.59	N/A	35.24	1.9%	32.87	-5.0%	30.17	-12.8%

The population increase of roughly 300,000 residents keeps the VMT per Capita figure similar to today's number with noticeable decreases in both Scenario B and C, with the greatest reduction in per capita VMT occurring in Scenario C. All three scenarios increase overall VMT for the city.



Conclusions

A) Under Scenario A total VMT and VMT per capita would increase from the rates of existing conditions. Scenario A increases these rates more than Scenario B and much more than Scenario C.

B) Under Scenario B total VMT increases, but VMT per capita decreases. Scenario B performs better than Scenario A in both categories, but not as well as Scenario C in either category.

C) Under Scenario C total VMT increases, but VMT per capita decreases significantly. Scenario C performs the best out of the three scenarios in all categories.

Policy Review

Overview:

As the average vehicle miles traveled increases, so does the amount of automobile emissions as well as the wear and tear on roadways and vehicles. These impacts can become costly on the individual, the family and the community as a whole. Oklahoma City can lessen the impact of vehicle miles traveled by coordinating with local, regional, and State agencies to pursue initiatives and regulations that help reduce automobile emissions and improve air quality,

Relevant Policies:

Sustain.Land Use Patterns.**309**

Green.Atmosphere and Climate.**304**

Green.Atmosphere and Climate.**307**

Recommendations

- Incentivize Transportation Demand Management programs among large private sector and public sector employers.
- Conduct studies and marketing to bolster the reputation and overall perception of public transit to overcome misconceptions of danger and unreliable service.
- Create zoning regulations such that transit-oriented design (TOD) districts are more easily established and incentivized.
- Increase funding for public transit.
    - Implement Sunday service.
    - Extend hours later into the evening.
- Encourage development to occur within developed areas so as not to cause increased commute times.
    - Explore creating TOD nodes of development with incentives for businesses to locate there, including connectivity for all modes of transportation.
- Increase the rate of sidewalk and bike lane improvements.
- Encourage better connectivity between residential and other uses.
- Incentivize private and public-sector employers to allow some employees to work remotely.

V. connectokc Indicators

C.1 Average Vehicle Miles Traveled (VMT)

C.2 Average Commute by ZIP Code

C.3 Proportion of Commute Trips by Transit, Bicycling, and Walking

Health-based Rationale

The number of miles traveled by motor vehicle is directly correlated to the proliferation of air pollutants such as ozone and particulate matter, as well as a contributor to global warming due to the release of greenhouse gases[210]. High levels of air pollutants can result in increased risk and rates of respiratory and cardiovascular diseases, while the threat of climate change due to greenhouse gas emissions could lead to extreme weather events, an increase in heat-related death, and an increase in vector, rodent and airborne disease[211].

Locations with higher rates of vehicle miles traveled often have a higher likelihood of collisions as there is a greater amount of time being spent in motor vehicles. Higher VMT rates indicate that more people are driving personal vehicles than using alternative modes of transportation, and this can be due to a lack of sufficient access to transit options that would reduce the number of drivers on the road[212].

Higher VMT rates correlate with a lower amount of physical activity. People who walk or bike more frequently reduce their risk of developing obesity and diabetes[213]. This can be facilitated by walkable neighborhood design such that the majority of daily needs can be met without the need to use a motor vehicle. People who become accustomed to walking on a daily basis are developing a positive healthful habit[214].

Additionally, the more reliant upon motor vehicles as opposed to other modes of transportation, the more money individuals are spending on transportation costs. This is money that could be used for healthy options for food, exercise, and healthcare.

Spending long hours in the car during a commute can have negative impacts on social interactions and mental well-being as well. This is fairly intuitive as more time spent in the car is less time that can be spent with family, friends or neighbors. A large percentage of drivers consider rush hour to be the most stressful part of their day which can lead to irritability, back and neck pain, as well as depression[215]. Social isolation can

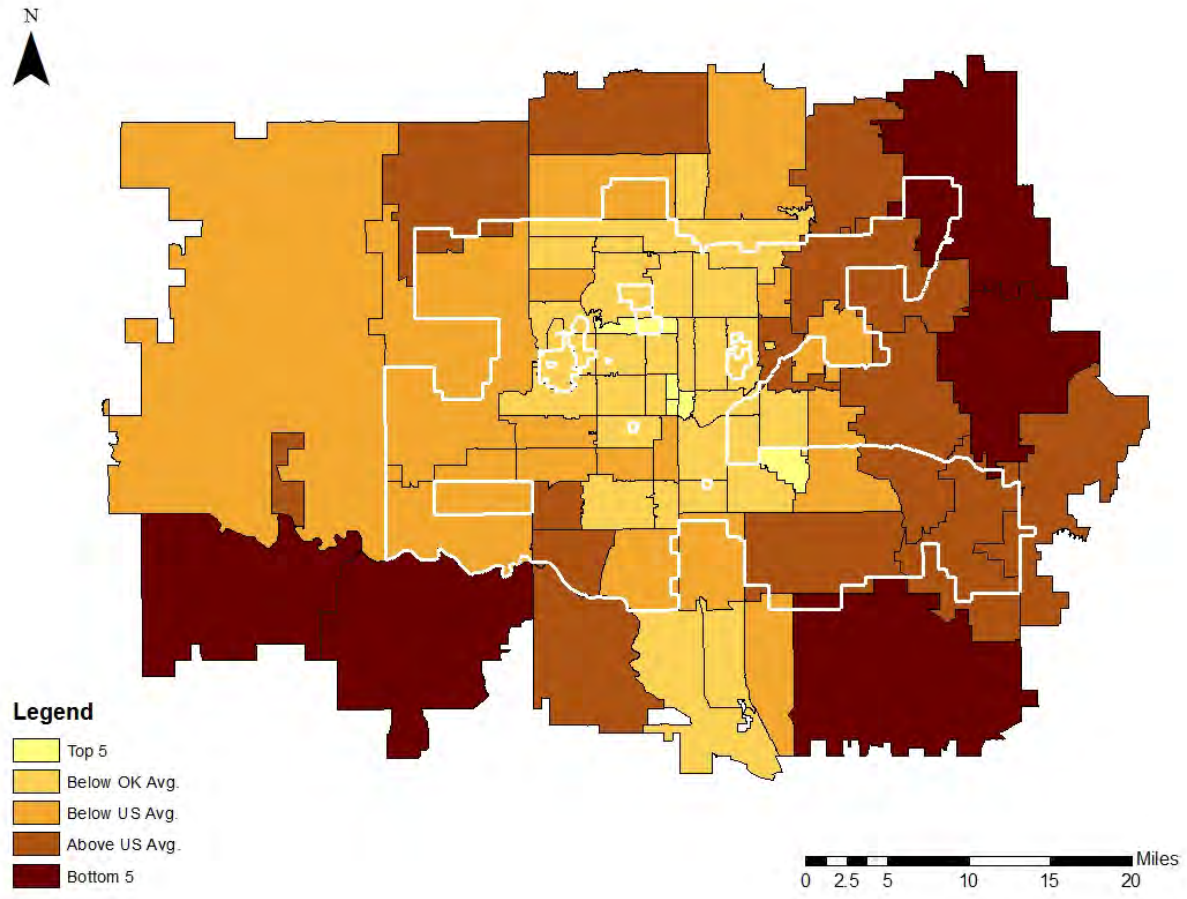
[210] U.S. Environmental Protection Agency. (1970-2013). *National emission inventory (NEI) air pollutant emissions trends data* [data set]. Retrieved from http://www.epa.gov/ttn/chief/trends/index.html#tables
[211] World Health Organization. (2011). *Air quality and health* [fact sheet]. Retrieved from http://www.who.int/mediacentre/factsheets/fs313/en/
[212] Transportation Economics Committee. (n.d.).*Transportation cost-benefit analysis: Change in accident rates*. Retrieved from http://bca.transportationeconomics.org/benefits/safety/change-in-accident-rates
[213] Booth, G. L. (2012). Unwalkable neighborhoods, poverty, and the risk of diabetes among recent immigrants to Canada compared with long-term residents.*Diabetes Care*, *36*(2), 302-308. Retrieved from http://care.diabetesjournals.org/content/36/2/302.long
[214] U.S. Department of Health and Human Services, National Institute of Diabetes and Digestive and Kidney Diseases. (2008). *Changing your habits: steps to better health* (08-6444). Retrieved from NIH Publication website: http://win.niddk.nih.gov/publications/PDFs/Changing_Your_Habits.pdf
[215] BBC. 2000. *Commuting is 'biggest stress'*. Retrieved from http://news.bbc.co.uk/1/hi/health/999961.stm.

cause more than just mental trauma and has been shown to be correlated to higher blood-pressure, cardiovascular risk factors, and premature death; people with strong social relationships on average have a 50% increased likelihood of survival than those who suffer social isolation[216].

Existing Conditions

The average commute time for the United States is around 25.5 minutes[217], while the average commute for Oklahoma is about 22.5 minutes[218]. Oklahoma City is quite normal for the State of Oklahoma with an average commute of 22.6 minutes[219]. This includes ZIP codes in surrounding cities (Moore, Norman, Yukon, El Reno, etc.) and thusly brings the average commute time up a bit, but this gives a clearer picture of the driving in the Oklahoma City area because so many people commute into and out of the city.

Though the city averages out to be the same as the state, within the city, there is great disparity in the average commute based upon ZIP code.



[216] Windle, K., Francis, J., & Coomber, C. (2011). *Preventing loneliness and social isolation: Interventions and outcomes*. Social Care Institute for Excellence, (39), Retrieved from http://www.scie.org.uk/publications/briefings/files/briefing39.pdf

[217] McKenzie, B. U.S. Census Bureau, American Community Survey Reports. (2013). *Out-of-state and long commutes: 2011*. Retrieved from website: http://www.census.gov/hhes/commuting/files/2012/ACS-20.pdf

[218] American Community Survey. (2012). *2012 ACS 5-year estimates*. Retrieved from http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t

[219] American Community Survey. (2012). *2012 ACS 5-year estimates*. Retrieved from http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t

Concentric rings can be made out from the above map, with a few aberrations due to areas with high amounts of jobs, such as Tinker Air Force Base and Oklahoma University to the south in Norman. The shortest commutes are central to the downtown area, while the longest are on the very edges of the city.

TOP 5			BOTTOM 5		
1.	73145	12.55 min.	65.	73089	31.87 min.
2.	73102	13.83 min.	66.	73045	32.53 min.
3.	72104	16.48 min.	67.	73026	33.5 min.
4.	73116	16.52 min.	68.	73059	34.34 min.
5.	73103	16.68 min.	69.	73054	39.92 min.

The weighted average for the top five shortest commute averages by ZIP code is 15.95 minutes, 70.8% of the Oklahoma average, and 63% of the U.S. average.

The weighted average for the longest five commute averages by ZIP code is 33.37 minutes, 148% of the Oklahoma average, and 131% of the U.S. average.

Scenario Analysis

Rather than attempt to predict the average commute time for each ZIP code for each scenario, this analysis looks at the impact upon the city-wide average commute time using the existing ZIP codes as constants. By comparing the population of the polygrids in each of the scenarios to the ZIP code average commute time, a new average commute time for each scenario can be generated. The table below shows the comparison of each scenario to existing conditions:

	Existing	Scenario A	Scenario B	Scenario C
Average Commute Time (minutes)	22.63	22.59	22.11	21.79
Percent Change	N/A	- 0.18%	- 2.30%	- 3.71%

Scenario A is negligibly different from the existing citywide average, while Scenarios B and C show noticeable improvement upon existing conditions. The difference in time looks small, and it is for a single trip, with just 0.8 minutes (48 seconds) separating Scenario A and Scenario C; however, when multiplied for the entire population for a year, there are significant differences in the amount of time Oklahoma City is spending behind the wheel. Scenario B results in 1,736,427 additional driving hours per year for the city, or 1.95 hours per capita; and Scenario A results in 4,341,067 additional driving hours per year for the city, or an extra 4.87 hours per capita.

Conclusions

A) Scenario A results in no change to the current average commute time of Oklahoma City. More of the negative effects of driving will be a by-product of the several million more hours of driving that will occur in Scenario A when compared to Scenarios B and C.

B) Scenario B results in a moderate improvement in average commute time for the city. Scenario B results in fewer total hours spent driving than Scenario A, but a greater amount than Scenario C.

C) Scenario C results in the most significant reduction in average commute time for the city, which means there will be the most amount of time available for other purposes, such as spending time with family or working productively, as well as fewer negative impacts of motor vehicles when compared to Scenarios A and B.

Policy Review

Overview:

The average commute for Oklahoma City residents can be impacted by alternate transit systems, quality and quantity of roads, and location of employers. Oklahoma City residents who experience longer than average drive times can be susceptible to poorer eating habits, increased stress from traffic, and additional time away from families. Oklahoma City can encourage shorter commute times by focusing on improving transit systems to encourage use, retaining large industries and companies within the city limits to discourage Oklahoma City residents to work outside the city limits, and appropriately maintaining roadways, bypasses, and interstate systems to allow a less congested travel time.

Relevant Policies:

Sustain.LandUsePatterns.**331**

Connect.Roadways.**285**

Strengthen.Employment and Opportunity.**173**

Strengthen.Employment and Opportunity.**170**

Recommendations

- Increase the rate of sidewalk and bike lane improvements.
- Incentivize and increase carpooling. Think of ACOG's Central OK GO program.
- Conduct studies and marketing to bolster the reputation and overall perception of public transit to overcome misconceptions of danger and unreliable service.
- Increase funding for public transit.
    - Implement Sunday service.
    - Extend hours later into the evening.
- Create zoning regulations such that transit-oriented design (TOD) districts are more easily established and incentivized.
- Re-evaluate regulation on businesses being run from a residence such that more people can work from home.
- Incentivize private and public-sector employers to allow some employees to work remotely.

V. connectokc Indicators

C.1 Average Vehicle Miles Traveled (VMT)

C.2 Average Commute by ZIP Code

C.3 Proportion of Commute Trips by Transit, Bicycling, and Walking

Health-based Rationale

The number of miles traveled by motor vehicle is directly correlated to the proliferation of air pollutants such as ozone and particulate matter, as well as a contributor to global warming due to the release of greenhouse gases[220]. High levels of air pollutants can result in increased risk and rates of respiratory and cardiovascular diseases, while the threat of climate change due to greenhouse gas emissions could lead to extreme weather events, an increase in heat-related death, and an increase in vector, rodent and airborne disease[221].

Locations with higher rates of vehicle miles traveled often have a higher likelihood of collisions as there is a greater amount of time being spent in motor vehicles. Higher VMT rates indicate that more people are driving personal vehicles than using alternative modes of transportation, and this can be due to a lack of sufficient access to transit options that would reduce the number of drivers on the road[222].

Higher VMT rates correlate with a lower amount of physical activity. People who walk or bike more frequently reduce their risk of developing obesity and diabetes[223]. This can be facilitated by walkable neighborhood design such that the majority of daily needs can be met without the need to use a motor vehicle. People who become accustomed to walking on a daily basis are developing a positive healthful habit[224].

Additionally, the more reliant upon motor vehicles as opposed to other modes of transportation, the more money individuals are spending on transportation costs. This is money that could be used for healthy options for food, exercise, and healthcare.

Spending long hours in the car during a commute can have negative impacts on social interactions and mental well-being as well. This is fairly intuitive as more time spent in the car is less time that can be spent with family, friends or neighbors. A large percentage of drivers consider rush hour to be the most stressful part of their day which can lead to irritability, back and neck pain, as well as depression[225]. Social isolation can

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[221] World Health Organization. (2011). *Air quality and health* [fact sheet]. Retrieved from http://www.who.int/mediacentre/factsheets/fs313/en/

[222] Transportation Economics Committee. (n.d.).*Transportation cost-benefit analysis: Change in accident rates*. Retrieved from http://bca.transportationeconomics.org/benefits/safety/change-in-accident-rates

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[224] U.S. Department of Health and Human Services, National Institute of Diabetes and Digestive and Kidney Diseases. (2008). *Changing your habits: steps to better health* (08-6444). Retrieved from NIH Publication website: http://win.niddk.nih.gov/publications/PDFs/Changing_Your_Habits.pdf

[225] BBC. 2000. *Commuting is 'biggest stress'*. Retrieved from http://news.bbc.co.uk/1/hi/health/999961.stm.

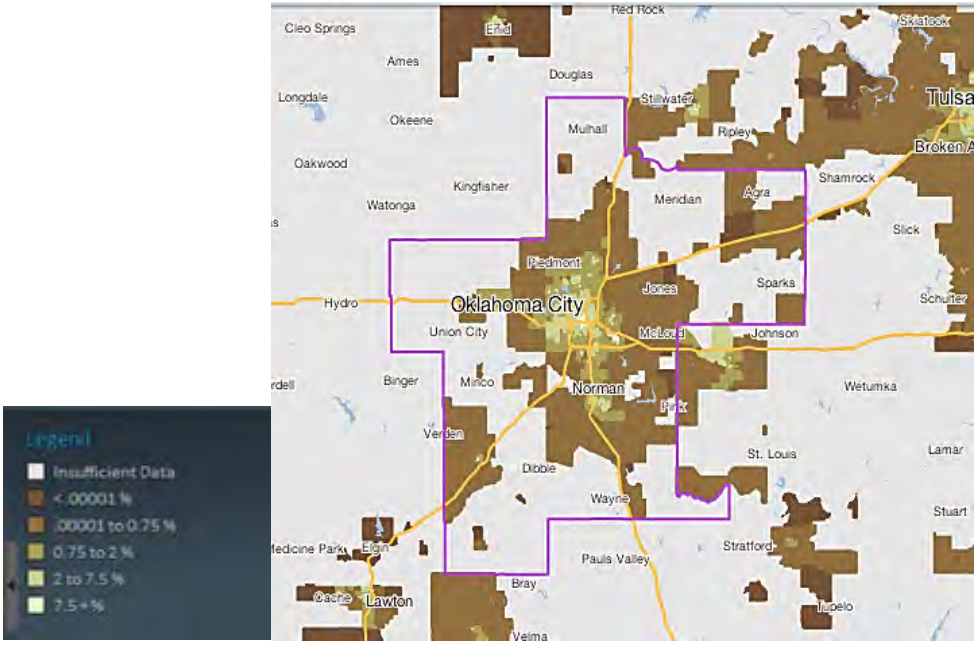
cause more than just mental trauma and has been shown to be correlated to higher blood-pressure, cardiovascular risk factors, and premature death; people with strong social relationships on average have a 50% increased likelihood of survival than those who suffer social isolation[226].

Existing Conditions

According to National Household Travel Survey, US Department of Transportation, Bureau of Transportation Statistics the total number of commuters in the US total 128.3 Million. Of those commuters, 6.16% travel by bus, walk, or bike[227].

5 Min	67815
Percent	10.88%
10 **Min**	156130
Percent	25.06%
One **Mile**	400076

Transit Ridership refers to the percentage of workers who utilize public transportation (Transit) as their primary mode of transportation to work, as modeled for the typical household. In the Oklahoma City region, the average percentage of the population for each Census block that utilizes public transportation for their commute is 1.9%[228]. As seen by the map below, the households that utilize public transportation more often are closer to the downtown area.

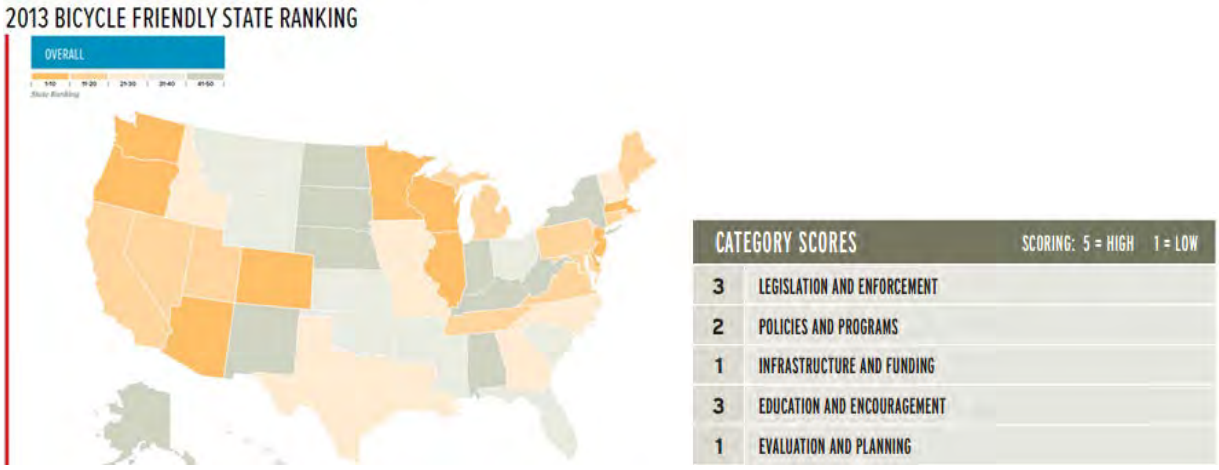


[226] Windle, K., Francis, J., & Coomber, C. (2011). *Preventing loneliness and social isolation: Interventions and outcomes*. Social Care Institute for Excellence, (39), Retrieved from http://www.scie.org.uk/publications/briefings/files/briefing39.pdf

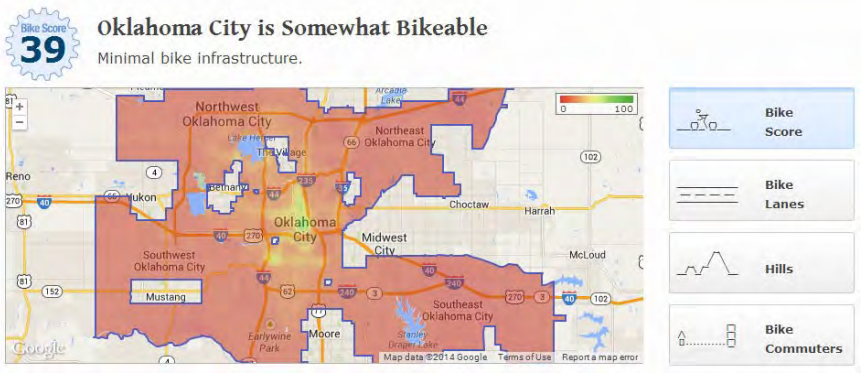
[227] Statistic Brain. (2014). Retrieved 01 18, 2014, from Commute Statistics: http://www.statisticbrain.com/commute-statistics/

[228] Center for Neighborhood Technology. (2014). Retrieved 1 18, 2014, from H&T Affordability Index: http://htaindex.cnt.org/map/

The League of American Bicyclists reports that the State of Oklahoma has more than 1% of the population commuting by bicycle ranking the State of Oklahoma ranks #38 on Bicycle Friendly composite state scores. Additional critiques on the State report card indicate Oklahoma has lowest scoring categories in evaluation & planning and infrastructure & funding[229]. The 2010 American Community Survey Bicycle Commuting Rates indicates that 690 Oklahoma City residents commute by bicycle to work, which relates to .3% of the workforce. This number does not reflect the entire bicycling commuters' population. Bicycle advocates question the validity of this response suggesting that this figure is an underestimate of the bicycling population, as many riders also bike outside of commuting[230].



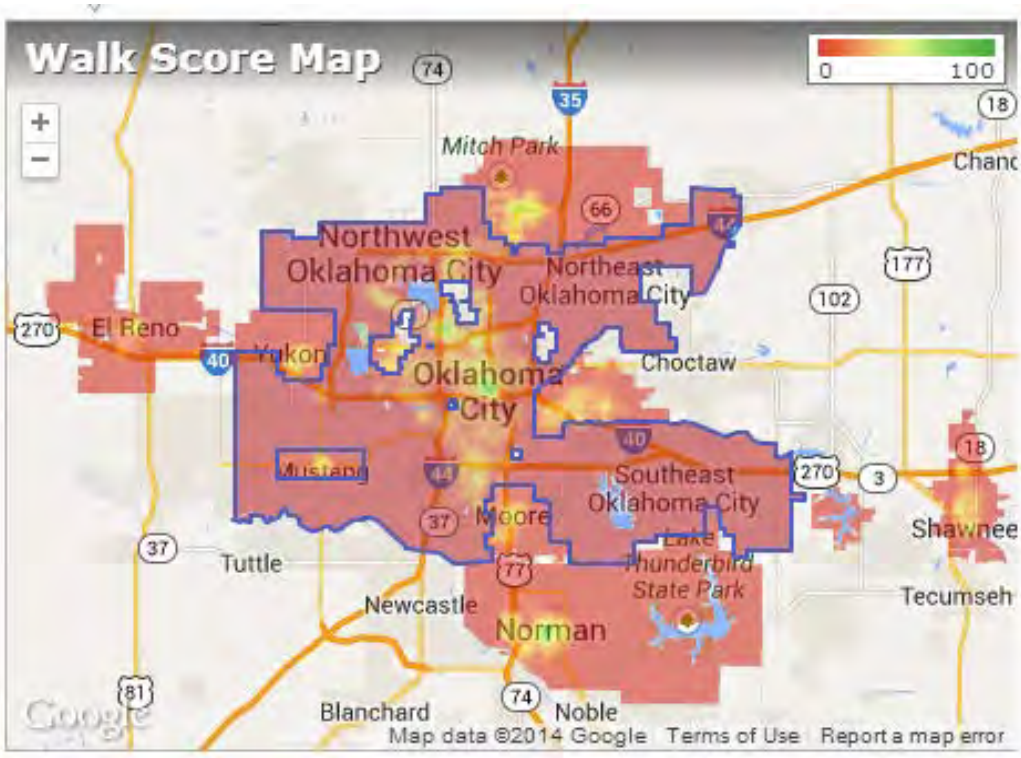
One deciding factor for bicycle commuters in choosing commuting method is whether the city is easily navigable and bicycle friendly. When looking at the Walk Score report for Oklahoma City, the Bike Score was 39[231].



On a National level 3.26% of the population commute to work by walking[232]. The 2008-2012 American Community Survey estimates that 4,464 individuals in Oklahoma City commute to work by walking, which is

[229] The League of American Bicyclists. (2013). Retrieved 1 19, 2014, from 2010 American Community Survey Bicycle Commuting Rates, All Cities: http://www.bikeleague.org/reports
[230] The League of American Bicyclists. (2013). Retrieved 1 19, 2014, from Bike Friendly State Report Card: http://www.bikeleague.org/sites/bikeleague.org/files/bikeleague/bikeleague.org/programs/bicyclefriendlyamerica/bicyclefriendlystate/bfs_report_cards/bfs2013_reportcard_oklahoma.pdf
[231] Walk Score. (2014). Retrieved 1 19, 2014, from Walk Score for Oklahoma City: http://www.walkscore.com/OK/Oklahoma_City
[232] Statistic Brain. (2014). Retrieved 01 18, 2014, from Commute Statistics: http://www.statisticbrain.com/commute-statistics/

1.6% of the workforce[233]. According to Walk Score, Oklahoma City ranks 43rd out of the 50 largest cities in the US in terms of walkability. The most walkable Oklahoma City ZIP codes are73102, 73103 and 73106 and Oklahoma City has an average Walk Score of only 32[234].



Top 5 Oklahoma City Neighborhoods

Rank	Name	Walk Score	Population
1	73102	73	2,825
2	73103	71	4,371
3	73106	65	14,570
4	73118	54	13,812
5	73109	51	20,530

[233] The United States Census Bureau. (2014). Retrieved 1 19, 2014, from 2008-2012 American Community Survey 5-Year Estimates: http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_12_5YR_DP03
[234] Walk Score. (2014). Retrieved 1 19, 2014, from Walk Score for Oklahoma City: http://www.walkscore.com/OK/Oklahoma_City

Scenario Analysis

Assumptions:

Any prediction of the future suffers from unforeseen conditions. For this analysis, technological advances in the transportation sector were disregarded in order to effectively compare development patterns.

Analysis:

The Envision Tomorrow Travel Application generates numbers for each scenario for the total number of trips made for each mode of transportation (vehicle, walk, bicycle, transit), from which a percentage of modal share can be generated. The table below illustrates the relationship between each of the scenarios and existing conditions.

	Existing		Scenario A		Scenario B		Scenario C	
Vehicle Trips	1,833,278	96.63%	2,779,635	96.90%	2,826,136	94.56%	2,851,604	92.59%
Walk	40,460	2.13%	54,668	1.91%	96,550	3.23%	133,719	4.34%
Bicycle	8,622	0.45%	12,164	0.42%	16,401	0.55%	21,143	0.69%
Transit	14,820	0.78%	21,977	0.77%	49,499	1.66%	73,356	2.38%
Total	**1,897,180**		**2,868,444**	51.2%	**2,988,586**	57.5%	**3,079,822**	62.3%

The total number of trips taken increases from Scenario A to Scenario C somewhat unintuitively, which becomes less intuitive still when compared to the VMT results from each scenario.

	Existing	Scenario A	Scenario B	Scenario C
Vehicle Trips	1,833,278	2,779,635	2,826,136	2,851,604
VMT	20,065,125	31,432,465	29,297,021	26,845,349
Miles per Trip	10.95	11.31	10.37	9.41
% Change	N/A	+ 3.3%	- 5.3%	- 14%

This relationship between vehicle trips and VMT generates figures that show how Scenarios B and C reduce the average distance per vehicle trip as development is more densely arranged, requiring shorter drives. In addition, because development is dense, large-scale developments, such as big-box stores, are less viable, creating a situation where one-stop shopping (food, clothes, and more at one location) is less likely to occur. This has the added benefit of potentially leveling the economic playing field for local businesses who may not be able to compete against large-scale one-stop shopping facilities.

Similarly, in Scenarios B and C, where the average miles per trip are lower, the percentage of trips made by transit, bicycle or walking increases. This is intuitively linked to the fact that when many land use types are more densely located within a short distance of residential and work uses, people will be more likely to use alternative modes of transportation out of convenience.

Caveat: Envision Tomorrow does not make predictions of modal share specific to workforce commute, therefore overall modal share figures have been analyzed.

Conclusions

A) Under Scenario A the percentage of vehicle trips increases relative to existing conditions, and walking, biking and transit trips all decrease. Scenario A has a higher percentage of vehicle trips and a lower percentage of walking, biking and transit trips than Scenario B and C.

B) Under Scenario B the percentage of vehicle trips decreases relative to existing conditions, while walking and bicycling increase slightly, and transit increases significantly. Scenario B has a lower percentage of vehicle trips than Scenario A, but higher than Scenario C. Scenario B has a higher percentage of walking, bicycling and transit trips than Scenario A, but a lower percentage than Scenario C.

C) Under Scenario C the percentage of vehicle trips decreases relative to existing conditions, while walking, bicycling and transit increase significantly. Overall, the number of trips increases the most in Scenario C, however, total VMT decreases the most; the population is taking shorter trips, but more of them. Scenario C has the lowest percentage of trips made by vehicles, and has the highest percentage of trips made by walking, bicycling, or transit when compared to Scenarios B and C.

Policy Review

Overview:

Using public transit, bicycling, and/or walking as an alternative for automobile commuting can be beneficial to the environment and health. Reducing automobile emissions by bicycling and walking to work, events, or school can provide a positive health aspect to daily routine and it can benefit the environment. Although public transit also emits dangerous chemicals into the air, this mode of transportation allows for more passengers to travel at the same time and less vehicles to be out on the roadway. Oklahoma City can encourage public transit commutes by improving the performance of pedestrian, bicycle, and transit facilities, increasing the frequency and time of transit operations to ensure adequate, convenient and safe service for visitors, employees, and residents and focusing on transit improvements in high density areas.

Relevant Policies:

Sustain.LandUsePatterns.**252**

Sustain.LandUsePatterns.**263**

Sustain.LandUsePatterns.**331**

Connect.TransportationSystems.**175**

Connect.TransportationSystems.**181**

Connect.Transit.**213**

Connect.Transit.**214**

Strengthen.Employment and Opportunity.**173**

Strengthen.Placemaking.**222**

Strengthen.Placemaking.**223**

Recommendations

Transit:

- Conduct studies and marketing to bolster the reputation and overall perception of public transit to overcome misconceptions of danger and unreliable service.
- Increase funding for public transit.
  - Implement Sunday service.
  - Extend hours later into the evening.
- Increase paratransit services into non-urban areas to extend further than the present ¾-mile buffer from a fixed transit route.
- Support the development of a regional transit authority (RTA).
- Consider a variety of vehicle types to serve different types of needs.
- Develop standards for transit shelter amenities (seating, schedules, etc.) tailored to local conditions/resources.
- Improve amount and awareness of employer-based incentives for taking transit, including programs to purchase transit from before-tax income and employer-subsidized public transportation.
- Support a tax-funding source for public transit.

TOD and Walkable/Bikeable Areas:

- Create zoning regulations such that transit-oriented design (TOD) districts are more easily established and incentivized.
- Develop transit-oriented streetscape and building design standards for key transit nodes and corridors, partially funded through private resources.
- Incentivize development to occur within urbanized areas and businesses to locate in these developments.
- Increase the rate of sidewalk and bike lane improvements.
- Improve connectivity throughout the city for all modes of transportation, particularly between neighborhoods and subdivisions.
- Implement educational program for residents regarding walking/safe routes to work and schools.

Parking:

- Evaluate parking requirements for new developments to find ways to lower the required amounts.
- Unbundle cost of parking from housing units, freeing up parking to become profitable for the owner.

V. connectokc Indicators

C.4 Ratio of Lane Miles and Access to Public Transit, Bicycle and Pedestrian Facilities

C.5 Number and Rate of Bicycle and Pedestrian Injury Collisions

Health-based Rationale

Using public transit increases individuals' physical activity levels, as they typically walk to and from the transit option. Increased physical activity lowers the risk of obesity, cardiovascular disease, diabetes, improves bone health, and decreases the risk of cancer and depression[235].

The ratio of vehicle lane miles to alternative transportation facilities is a strong indicator of how many people will choose to not drive to things within a reasonable distance[236]. A strong network of bicycle, pedestrian, and transit modes, coupled with sufficient access, reduces the number of motor vehicles on the road. This leads to a reduction in noise and air pollution. Excessive noise pollution degrades the quality of sleep that people get at night, and increases levels of mental stress during the day[237]. The more cars there are on the road, the greater the proliferation of air pollutants such as ozone and particulate matter, as well as greenhouse gases that contribute to global warming[238]. High levels of air pollutants can result in increased risk and rates of respiratory and cardiovascular diseases, while the threat of climate change due to greenhouse gas emissions could lead to extreme weather events, an increase in heat-related death, and an increase in vector, rodent and airborne disease[239].

A more balanced ratio of modes provides a safer environment for pedestrians and bicyclists, who are especially susceptible to life-altering injury in the event of a collision. While the national trend of pedestrian crash deaths is decreasing in the last few decades, pedestrians are still more likely to be fatally injured in a collision than the driver who hits them[240]. A large percentage of pedestrian collisions do not occur in crosswalks. In addition to a more balanced ratio of transportation modes, facilities that are designed specifically with the intention to protect pedestrians and bicyclists greatly reduce the likelihood of a fatal injury collision with a motor vehicle. This, coupled with signage (in several languages) that educates drivers, bicyclists and pedestrians on how to safely share the road, can reduce the number of injury collisions[241].

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[235] Booth, G. L. (2012). Unwalkable neighborhoods, poverty, and the risk of diabetes among recent immigrants to Canada compared with long-term residents. *Diabetes Care*, *36*(2), 302-308. Retrieved from http://care.diabetesjournals.org/content/36/2/302.long

[236] Moreno, L., Morency, P., & El Geneidy, A. (2011). The link between built environment, pedestrian activity and pedestrian vehicle collision occurrence at signalized intersections. *Accident Analysis and Prevention*, 43(5), 1624–1634

[237] London Health Commission. (2003). *Noise and health: making the link.* Retrieved from http://www.phel.gov.uk/hiadocs/noiseandhealth.pdf

[238] U.S. Environmental Protection Agency. (1970-2013). *National emission inventory (NEI) air pollutant emissions trends data* [data set]. Retrieved from http://www.epa.gov/ttn/chief/trends/index.html#tables

[239] World Health Organization. (2011). *Air quality and health* [fact sheet]. Retrieved from http://www.who.int/mediacentre/factsheets/fs313/en/

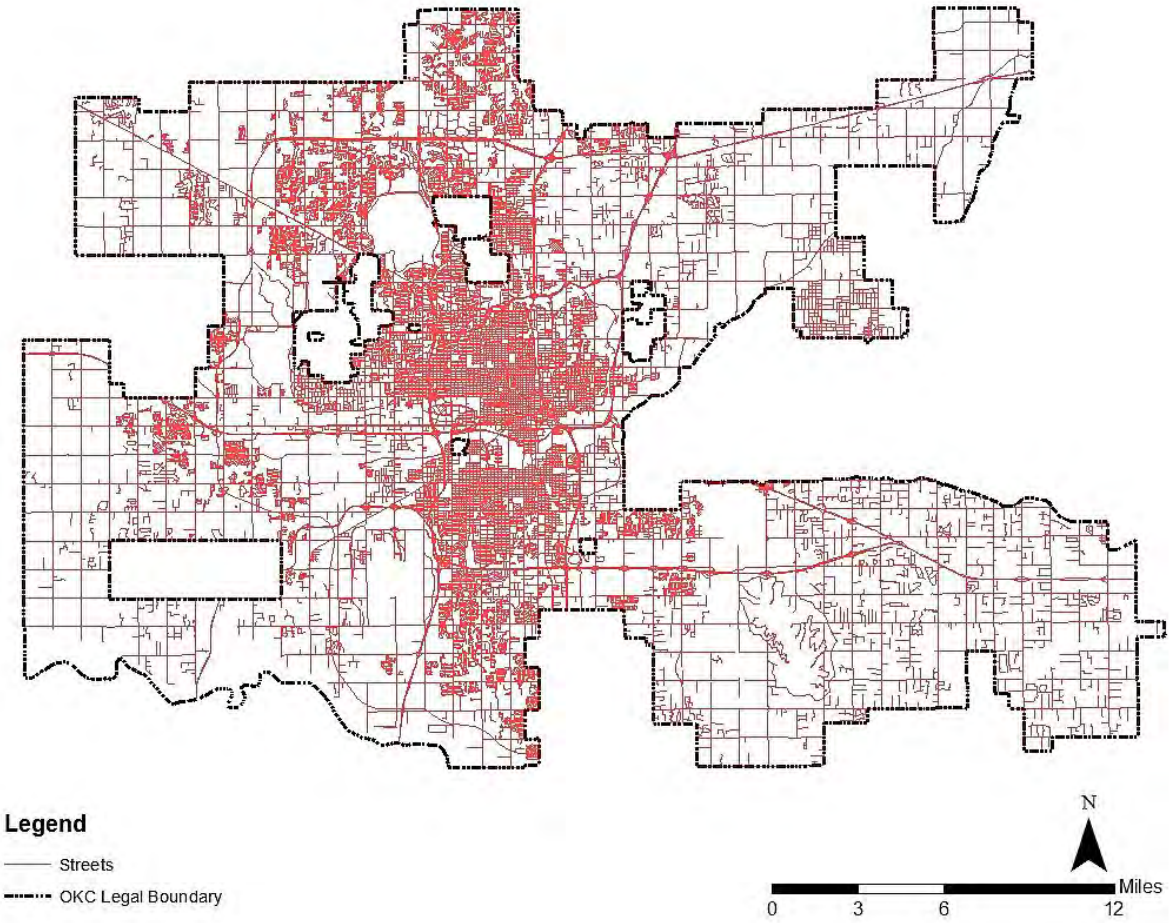
[240] U.S. department of Transportation, National Highway Traffic Safety Administration. (2008). *National pedestrian crash report*. Retrieved from NHTSA website: http://www-nrd.nhtsa.dot.gov/Pubs/810968.PDF

[241] Zeeger, C. V. Massachusetts Highway Department, Traffic Engineering Council Committee. (1998). *Design and safety of pedestrian facilities* (RP-026A). Retrieved from Institute of Transportation Engineers website: http://safety.fhwa.dot.gov/ped_bike/docs/designsafety.pdf

Existing Conditions

Streets – Cars:

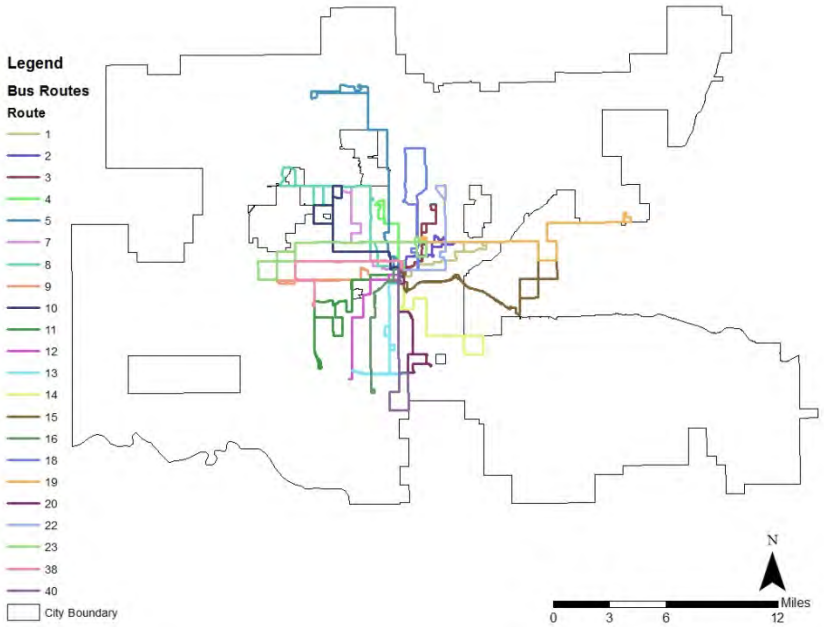
There are 4811.63 linear miles of streets within the Oklahoma City boundaries, of which 366 are highway, leaving 4,446 miles of city roads. Also, there are roughly 14,000 lane miles[242], which imply that the average street is slightly more than 3 lanes wide; about 40 feet in width. There is little sense in calculating the number of households that have access to roads, because every household has access. This allows us to use the amount of road miles as our denominator for comparing the amount of alternative transportation modes. Cars are able to use the full street network, but what infrastructure is in place for pedestrians, bicyclists, and what the existing bus routes are will help us get a better picture of the relationship among all the modes. The map below illustrates the reach of the street grid within the city limits.



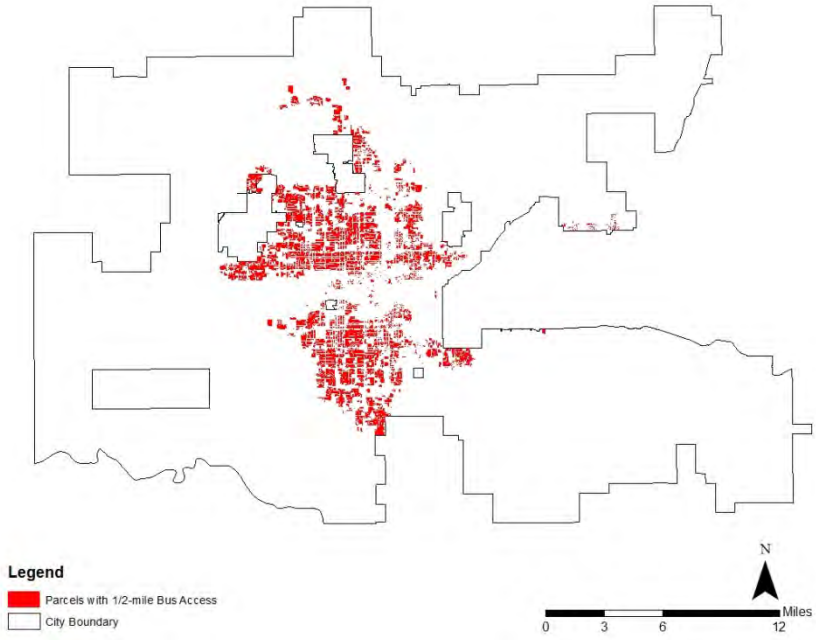
Streets – Transit:

The Metro Transit bus system in Oklahoma City has 22 standard routes within the city. There are other busses that leave the city, but these are not considered in this analysis. These routes combine for a total of 324.5 miles of travel, and currently people can hail the bus like a taxi cab, therefore any point along the bus line could be considered a "stop". In the map below you can see the service area of the different bus lines; note that bus service does extend out of the city limits (number of households excludes these areas).

[242] Retrieved from http://www.okc.gov/about/



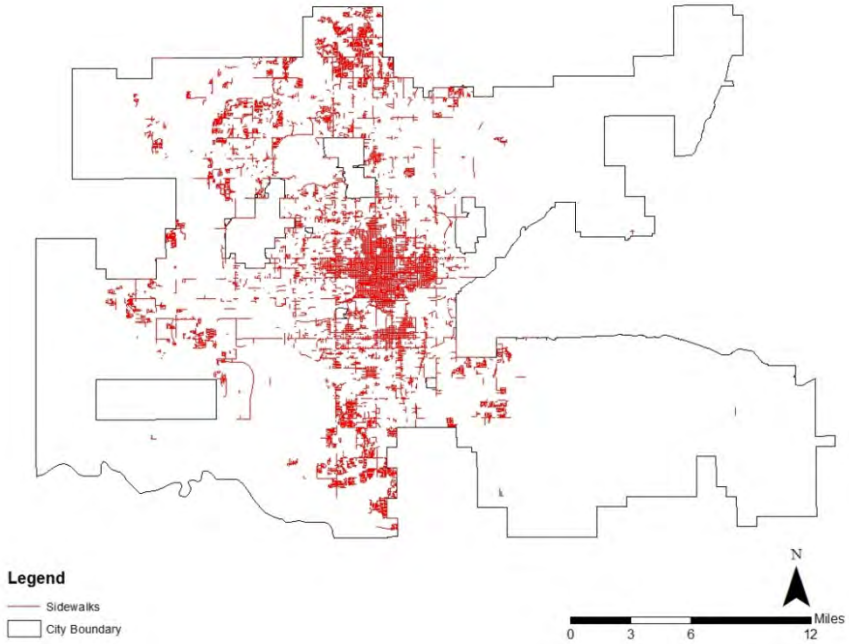
Those who live within ½-mile of a bus line could potentially walk to gain access to the bus system. Note that this does not take into account the quality of sidewalks or the convenience of wait times, or actual ridership figures. This figure is as optimistic as possible to understand what our current system can support. Currently, around 130,630 households live within ½-mile of at least one bus line. This accounts for 52.4% of the total population of Oklahoma City.



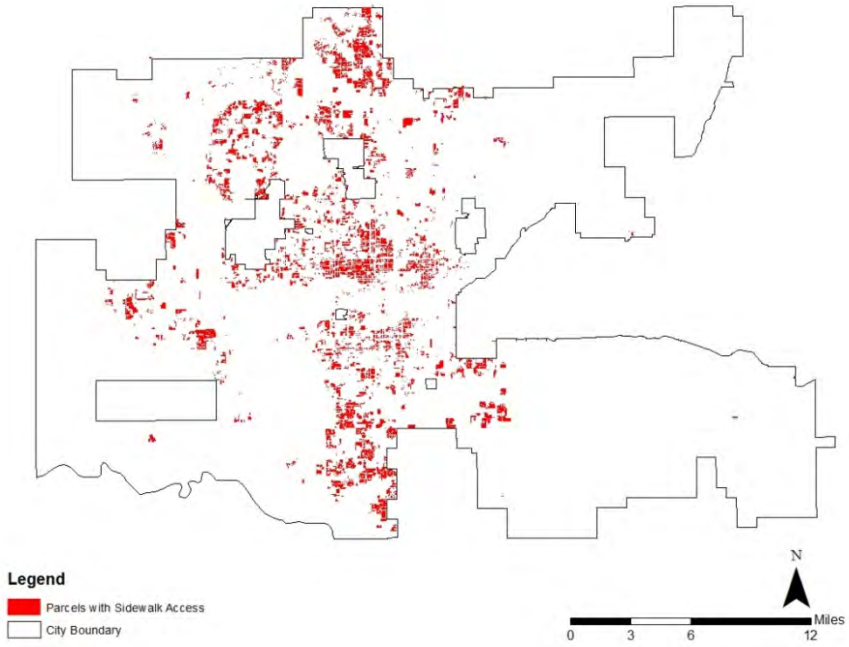
Sidewalks – Pedestrians:

Oklahoma City's sidewalks do not match the street grid due to lax regulation which allowed development to forgo the inclusion of sidewalks, resulting in a fragmented network for pedestrians. There are sidewalks on 1,368 linear road miles, which totals 2,567 linear miles (note: this figure derives from aerial photography where sidewalk-type areas around private commercial buildings are included). In order to determine who has

access to sidewalks, a 75' buffer was created around the sidewalk feature class in GIS in order to intersect with parcels that abut the sidewalk.



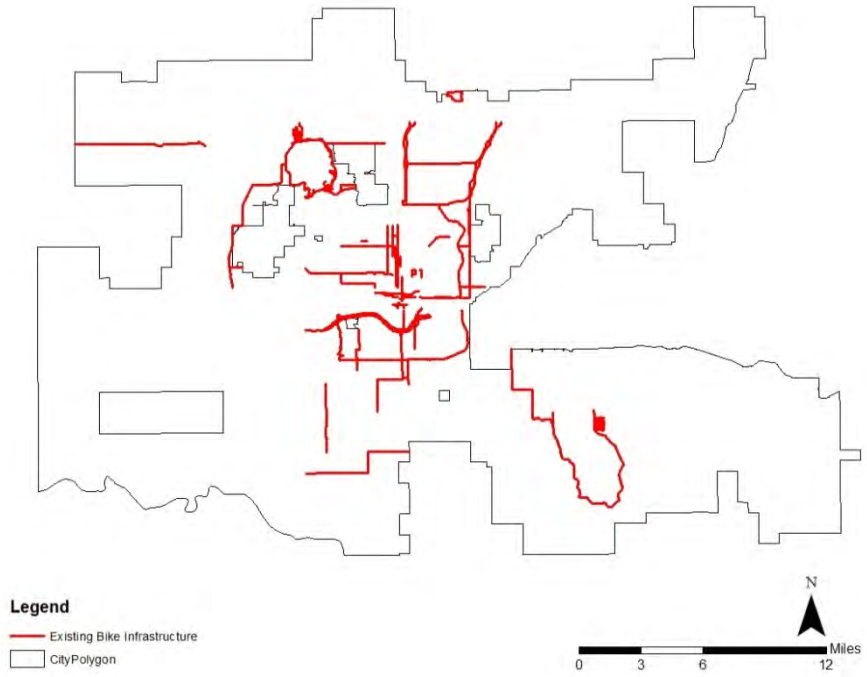
The sidewalk network covers a greater overall area than the bus network; however, roughly the same amount of households is within their service areas. 129,195 households have sidewalks on their street, which is 51.8% of the total number of households in the city.



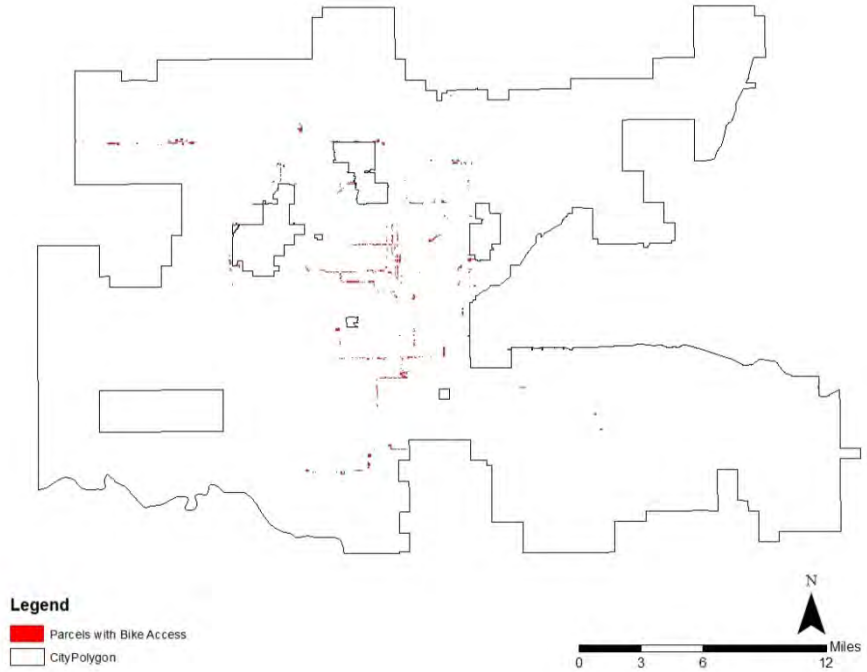
Bicycle Infrastructure – Cyclists:

Recently, bicycle infrastructure has become something that an outspoken segment of the Oklahoma City population would like to see more of in the city. Unfortunately, current numbers can be misleading if a cyclist plans to use on-street facilities, rather than biking on trails that are off of the road. In total, there are 194

miles of bicycle facilities; however 99 miles of this are off-road trail lanes, leaving 95 miles of on-street bicycle infrastructure. Of this 95 miles, a mere 4.88 miles is actual bike lane, while the remaining 90.12 is comprised of sharrow lanes, which do not afford the protections granted by dedicated bicycle lanes.



The bicycle network reaches much fewer households than the other modes of transportation. A total of almost 8,250 households are on streets with bicycle infrastructure, or 3% of the total households in the city.



	Streets	Bus Routes	Sidewalks	Bike Facilities
Miles (linear)	4,811.63	324.5	1,368	95 (on-street)
Ratio (by Streets)	1/1	1/14.83	1/3.52	1/50.65

Scenario Analysis

The polygrids utilized to make predictions about the future of development patterns with the Envision Tomorrow tool are not so detailed as to predict exact parcel or street locations, nor were bus routes, sidewalks and bike facilities projected in each of the scenarios. Therefore, the scenarios were compared to the existing networks of bus routes and sidewalks, as well as the proposed bicycle network which has been planned and is entering the implementation phase. From this comparison an amount of additional bus routes, sidewalk, or bicycle facility was derived to determine what is necessary to accommodate the population of the scenarios to the present levels of service based upon the percentage of total households served by each mode of transportation.

Access to Transit				
	Existing	**Scenario A**	**Scenario B**	**Scenario C**
Households within ½-Mile	130,630	140,818	154,582	176,403
% of total population	52.4%	39.5%	43.3%	49.4%
Miles to Meet Present Level of Service	N/A	106.4 miles	67.9 miles	19.5 miles

Access to Sidewalks				
	Existing	**Scenario A**	**Scenario B**	**Scenario C**
Households served	129,118	146,350	155,525	170,258
% of total population	51.8%	41.0%	43.6%	47.7%
Miles to Meet Present Level of Service	N/A	336.1 miles	242.8 miles	109.7 miles

Access to Bicycle Infrastructure				
	Existing (plus proposed)	**Scenario A**	**Scenario B**	**Scenario C**
Households served	23,014	25,836	29,699	32,665
% of total population	9.2% (9.23)	7.24%	8.32%	9.2% (9.16)
Miles to Meet Present Level of Service	N/A	112.4 miles	44.6 miles	3.4 miles

Regardless of the scenario or mode of transportation, current systems will serve a lower percentage of the future population in a meaningful way. This means that between today and the eventual arrival of the 300,000 additional people predicted to reside in Oklahoma City by the comprehensive plan, significant initiatives must be undertaken to improve services, as the pace of improvements today may not provide substantial results with a significantly larger population. In particular, sidewalk infrastructure will need major attention in order to accommodate the future population.

Conclusions

A) Scenario A requires the greatest increase in transit miles, sidewalk miles, and bicycle infrastructure miles to meet present percentages. This means that the development pattern of Scenario A will lower the percentage of the population with access to the alternative transportation options unless major improvements are undertaken in order to maintain current levels, and even greater initiatives would be necessary to increase the level of service that exists today. It is unlikely that this would be possible to fund and/or maintain.

B) Scenario B requires less of an increase in transit miles, sidewalk miles, and bicycle infrastructure than Scenario A, but a greater amount than Scenario C.

C) Scenario C requires the smallest increase in transit miles, sidewalk miles, and bicycle infrastructure miles to meet present percentages. The amount of increase required to meet present bicycle infrastructure is quite manageable, as is the amount of increase required for transit; however, Scenario C still requires a great deal of additional sidewalk to meet current levels of service.

Policy Review

Overview:

Access to public transit, bicycle paths, and pedestrian walkways is a key feature to encourage use. By providing alternate transit options to residents, individuals, and families can reduce the number of total road miles consumed each year. Reducing total road miles can positively affect the environment, road conditions, and residents' health. Oklahoma City can reduce the total road miles by increasing access to public transit, creating a safer bicycle network system, and improving the walkability of the city for pedestrians.

Relevant Policies:

Sustain.LandUsePatterns.**263**

Sustain.LandUsePatterns.**278**

Sustain.LandUsePatterns.**317**

Sustain.LandUsePatterns.**332**

Connect.Transit.**214**

Connect.TransportationSystems.**175**

Enrich.Urban Design and Form.**628**

Play.Accessibility and Use.**369**

Strengthen.Employement and Opportunity.**173**

Strengthen.Placemaking.**223**

Recommendations

- Improve connectivity throughout the city for all modes of transportation, particularly between neighborhoods and subdivisions.
- Increase the rate of sidewalk and bike lane improvements.
- Incorporate concepts from Complete Streets into standard road construction practice.
    - Resurfacing projects should include restriping to include bike lanes.
- Partner with ACOG and nearby municipalities to increase transit service to all surrounding areas.
- Support the formation of a regional transit authority (RTA).

V. connectokc Indicators

C.4 Ratio of lane miles and access to public transit, bicycle and pedestrian facilities

C.5 Number and rate of bike and pedestrian injury collisions

Health-based Rationale

Using public transit increases individuals' physical activity levels, as they typically walk to and from the transit option. Increased physical activity lowers the risk of obesity, cardiovascular disease, diabetes, improves bone health, and decreases the risk of cancer and depression[243].

The ratio of vehicle lane miles to alternative transportation facilities is a strong indicator of how many people will choose to not drive to things within a reasonable distance[244]. A strong network of bicycle, pedestrian, and transit modes, coupled with sufficient access, reduces the number of motor vehicles on the road. This leads to a reduction in noise and air pollution. Excessive noise pollution degrades the quality of sleep that people get at night, and increases levels of mental stress during the day[245]. The more cars there are on the road, the greater the proliferation of air pollutants such as ozone and particulate matter, as well as greenhouse gases that contribute to global warming[246]. High levels of air pollutants can result in increased risk and rates of respiratory and cardiovascular diseases, while the threat of climate change due to greenhouse gas emissions could lead to extreme weather events, an increase in heat-related death, and an increase in vector, rodent and airborne disease[247].

A more balanced ratio of modes provides a safer environment for pedestrians and bicyclists, who are especially susceptible to life-altering injury in the event of a collision. While the national trend of pedestrian crash deaths is decreasing in the last few decades, pedestrians are still more likely to be fatally injured in a collision than the driver who hits them[248]. A large percentage of pedestrian collisions do not occur in crosswalks. In addition to a more balanced ratio of transportation modes, facilities that are designed specifically with the intention to protect pedestrians and bicyclists greatly reduce the likelihood of a fatal injury collision with a motor vehicle. This, coupled with signage (in several languages) that educates drivers, bicyclists and pedestrians on how to safely share the road, can reduce the number of injury collisions[249].

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[243] Booth, G. L. (2012). Unwalkable neighborhoods, poverty, and the risk of diabetes among recent immigrants to canada compared with long-term residents. *Diabetes Care*, *36*(2), 302-308. Retrieved from http://care.diabetesjournals.org/content/36/2/302.long

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[245] London Health Commission. (2003). *Noise and health: making the link.* Retrieved from http://www.phel.gov.uk/hiadocs/noiseandhealth.pdf

[246] U.S. Environmental Protection Agency. (1970-2013). *National emission inventory (NEI) air pollutant emissions trends data* [data set]. Retrieved from http://www.epa.gov/ttn/chief/trends/index.html#tables

[247] World Health Organization. (2011). *Air quality and health* [fact sheet]. Retrieved from http://www.who.int/mediacentre/factsheets/fs313/en/

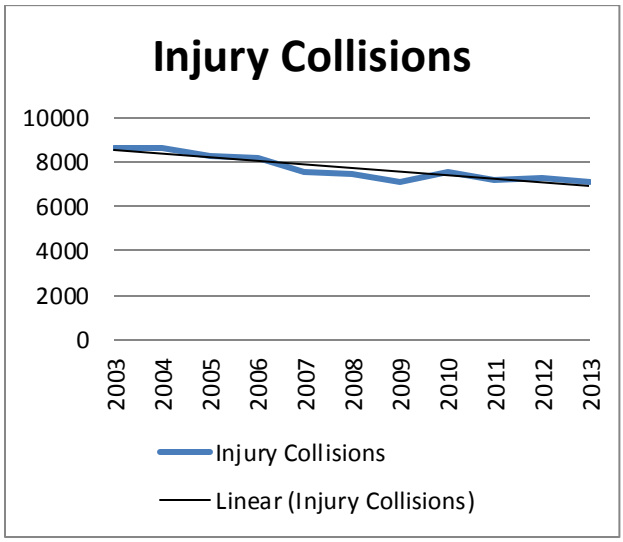
[248] U.S. Department of Transportation, National Highway Traffic Safety Administration. (2008). *National pedestrian crash report*. Retrieved from NHTSA website: http://www-nrd.nhtsa.dot.gov/Pubs/810968.PDF

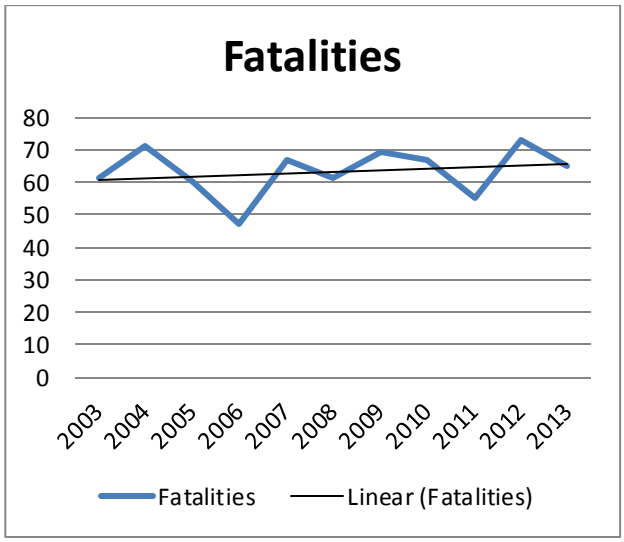
[249] Zeeger, C. V. Massachusetts Highway Department, Traffic Engineering Council Committee. (1998). *Design and safety of pedestrian facilities* (RP-026A). Retrieved from Institute of Transportation Engineers website: http://safety.fhwa.dot.gov/ped_bike/docs/designsafety.pdf

Existing Conditions

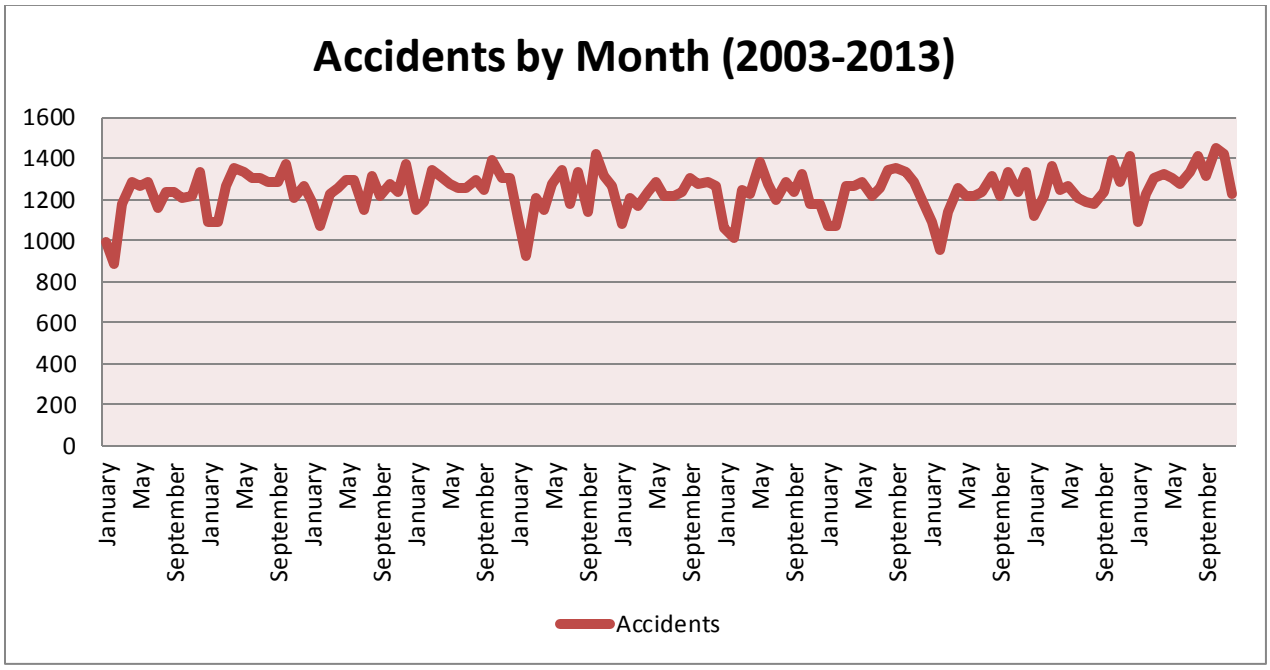
All Collisions:

Injury collisions involving motor vehicles are dangerous for all parties involved. Between the years of 2003 and 2013 there were 163,864 automobile accidents within the Oklahoma City limits, 1,401 of which involved a pedestrian, and 607 involving a bicyclist. The fatality rate of these accidents was 0.425%; the number of accidents involving human injury decreased over this time, but the rate of fatalities increased slightly.





The number of accidents on the road follows a surprisingly regular pattern from month to month, with January consistently being the month with the least accidents, and October as the month with the highest average number of collisions per month. There is little correlation with the number of fatalities as May is the deadliest month since 2003, and February is the least deadly.



The map below illustrates all of the motor-vehicle collisions in a heat map visualization, revealing that nearly every intersection and road in the city has had an accident in the past 11 years, with a particularly high frequency on the interstates and major highways.

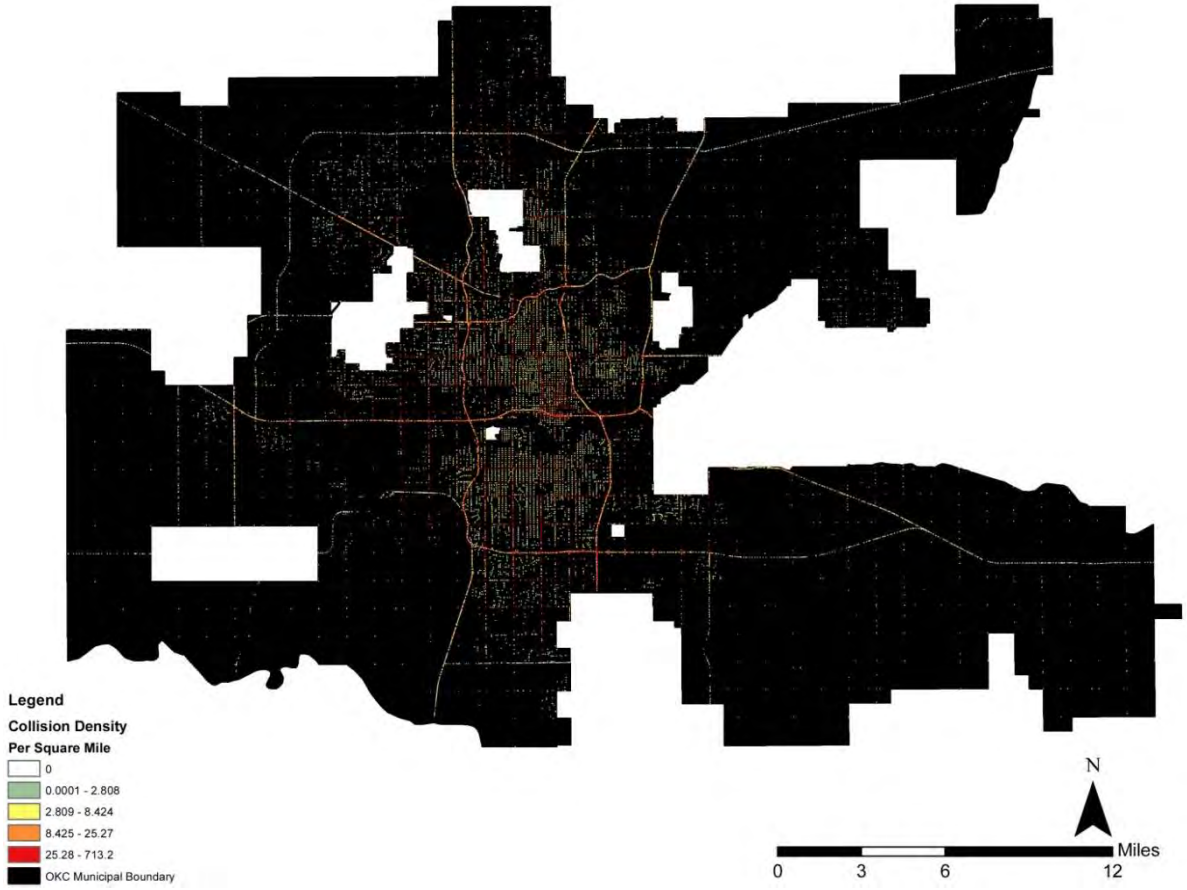


Figure 21: Automobile Collision Heat Map

Pedestrian Collisions:

Of the 1,401 collisions involving pedestrians from 2003 to 2013, an even 100 resulted in a pedestrian fatality. When comparing these collisions and fatalities to the sidewalk infrastructure of the city, we find that 953 collisions and 51 fatalities occurred in areas with sidewalk infrastructure, and 448 collisions and 49 fatalities occurred in areas without sidewalk infrastructure. This gives a fatality rate of 5.4% for areas with sufficient pedestrian infrastructure, and a fatality rate of 10.9% in areas without. In other words, pedestrians who attempt to walk in areas without sidewalks are twice as likely to be killed when involved with an automobile collision. Of the 100 fatalities, 94 of them were on streets with a speed limit of 30 mph or greater, namely along major arterial streets and highways.

The data used for this analysis from the Oklahoma Department of Transportation ranks each collision on a scale of severity from 1 to 5, where 1 implies no injuries, and 5 implies a fatality. The map below illustrates where pedestrian collisions occurred with fatality location, and the subsequent maps illustrate the areas of the city with the highest number of incidences, and then the areas of the city with the highest average severity of a collision. Notice the apparent inversion of the second and third maps, illustrating that though there are more pedestrian collisions in the downtown area, the average severity is much lower than for areas outside of the urban center, where pedestrian infrastructure is less robust and speed limits are higher.

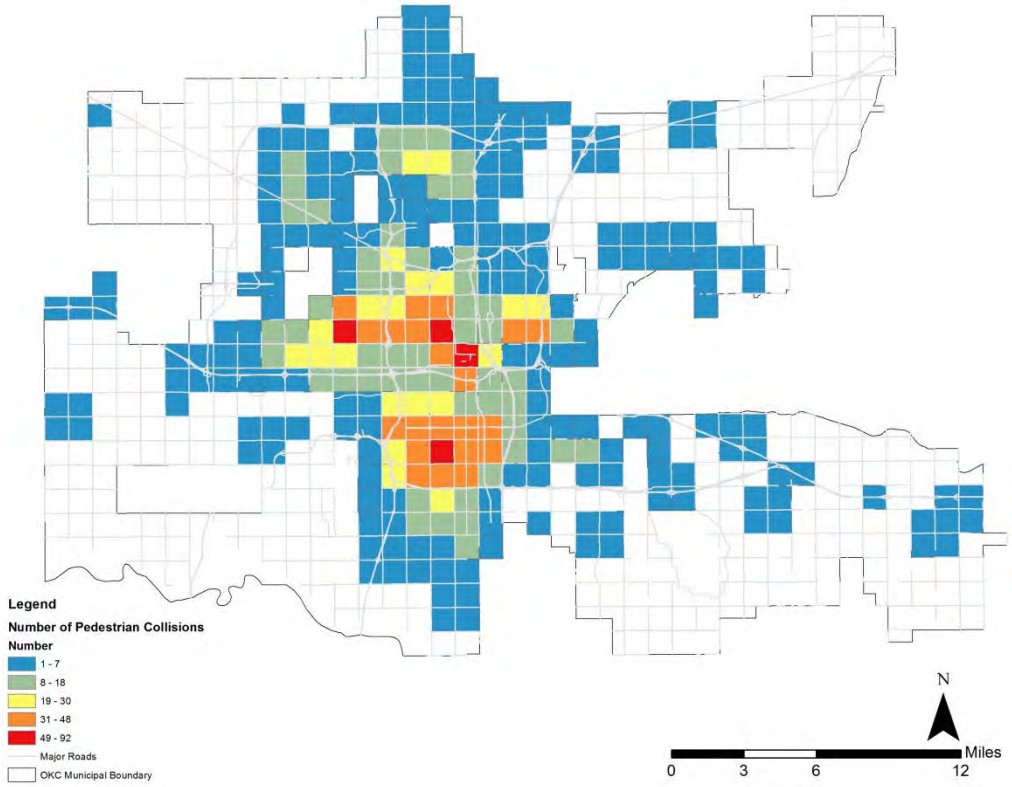


Figure 22: Number of Pedestrian Collisions

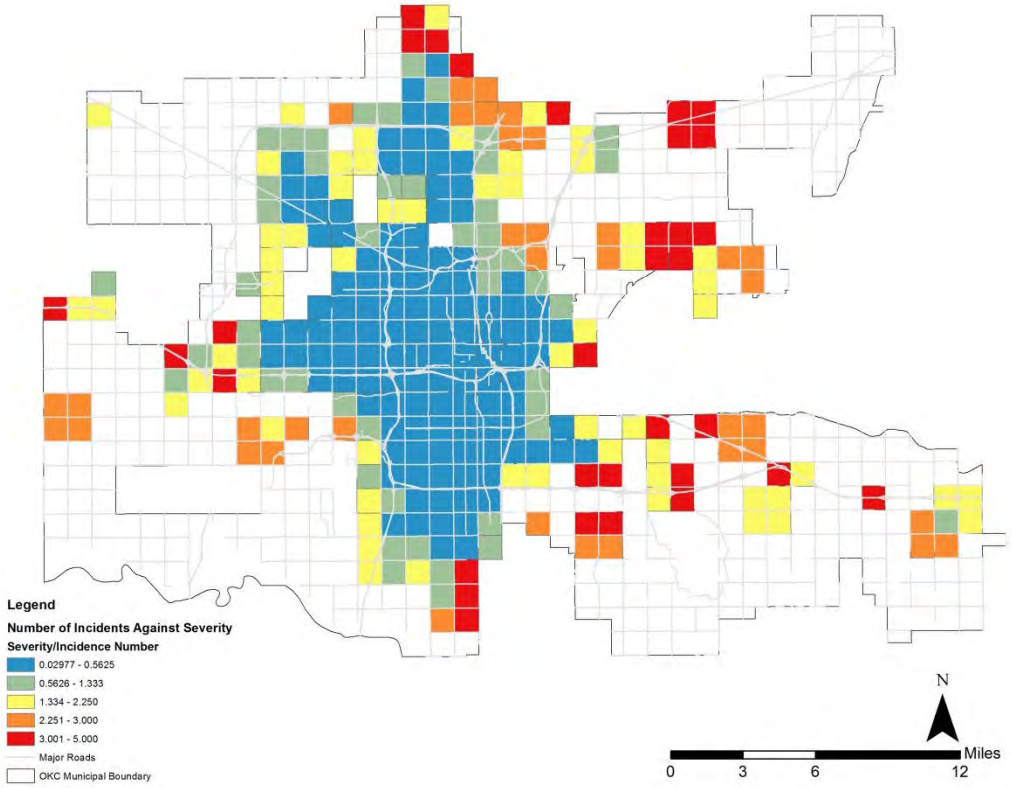


Figure 23: Average Severity of Pedestrian Collisions

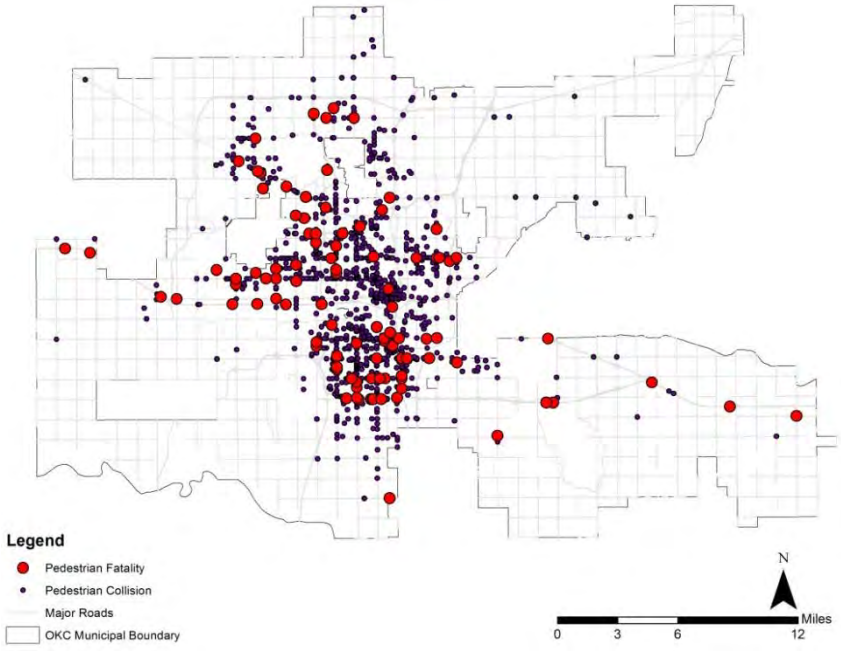


Figure 24: Pedestrian Collisions and Fatalities

Cyclist Collisions:

Of the 607 collisions involving a cyclist from 2003 to 2013, only 7 resulted in a cyclist fatality, all of which occurred on a major arterial street. Nearly two-thirds of the 607 collisions occurred on streets with speed limits of 30 mph or greater. Since bicycle lanes and infrastructure are in a relatively early stage of implementation in Oklahoma City, it would not make sense to compare the collision data to areas where there is presently bicycle infrastructure, as it likely did not exist when the collision occurred. As bicycling becomes more popular it will be important to monitor the number and severity of collisions.

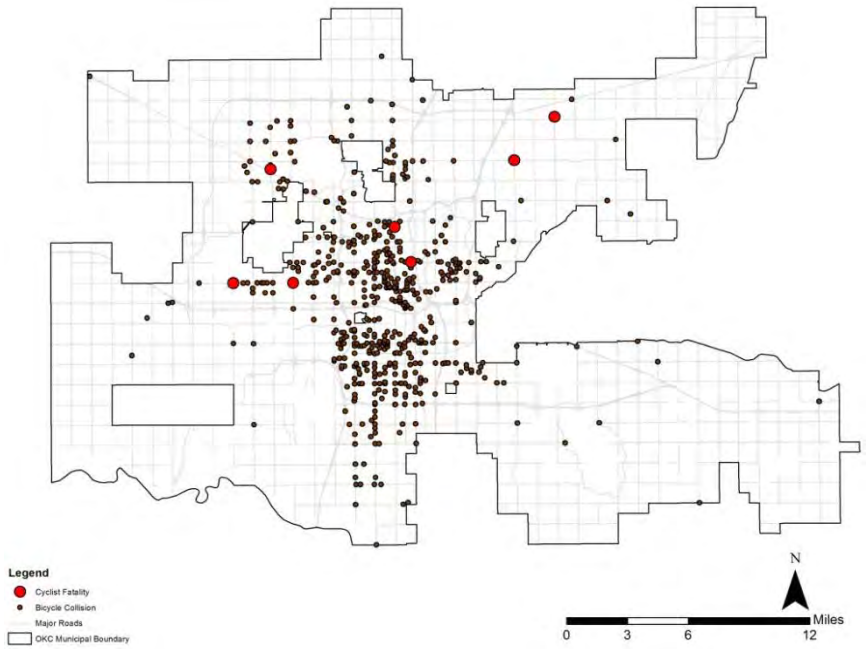


Figure 25: Bicycle Collisions and Fatalities

Scenario Analysis

With a greater number of people residing within the Oklahoma City limits, the total number of vehicle collisions will almost certainly increase. This includes injury and fatal collisions, but development pattern can have a significant impact upon the rate and severity of these. The Envision Tomorrow Travel Application uses a variety of factors to predict what the rate of injury, fatal, and total collisions will be for each of the three scenarios. These factors include VMT, density of employment, density of intersections, percentage of total intersections that are four-way intersections, and modal share. The table below illustrates the changes in the number and percentage of collisions in each scenario relative to existing conditions:

Vehicle Collisions							
	Existing	**Scenario A**		**Scenario B**		**Scenario C**	
Total Collisions	15,169	29,416	*93.9%*	27,418	*80.8%*	24,516	*61.6%*
Injury Collisions	4,927	7,671	*55.7%*	7,322	*48.6%*	6,921	*40.5%*
Fatal Collisions	61	87	*42.6%*	84	*37.7%*	82	*34.4%*

Unfortunately, the Envision Tomorrow tool does not itemize the categories of collisions by transportation mode (motor vehicle, bicycle, pedestrian). If the rates of pedestrian and cyclist collisions from existing conditions are transposed onto the three scenarios, then it would be likely that each year Scenario A would have 12 fatal pedestrian collisions and 1 fatal cycling collision, Scenario B would have 21 pedestrian fatalities and 2 cyclist fatalities, and Scenario C would have 29 fatal pedestrian collisions and 3 fatal cyclist collisions. However, the figures for Scenario C would seem to be inflated as the denser development pattern would lower average vehicular speeds, which is the most significant element of fatal collisions. Vehicles that are traveling more slowly are less likely to cause a fatality when a collision with a pedestrian or a cyclist occurs. Conversely, in Scenario A and Scenario B where a greater percentage of development will occur in existing rural areas, speeds will likely be higher on the roads, whereby a pedestrian or cyclist collision would be more severe.

Conclusions

A) Scenario A would see the largest increase in total automobile collisions, as well as the greatest increase in injury collisions and greatest increase in fatal collisions. Accidents with pedestrians and cyclists would likely happen at a lesser rate than Scenario B or Scenario C, but the collisions would likely be more severe, resulting in higher rates of fatal collisions.

B) Scenario B would see a lower increase in total automobile collisions, injury collisions, and fatal collisions than Scenario A, but a greater amount than Scenario C. There would likely be more pedestrian and cyclist collisions in Scenario B than Scenario A due to a higher number of trips by these modes, but collisions would likely be less severe. However, there would be less pedestrian and cyclist trips in Scenario B than Scenario C, and the collisions would likely be more severe.

C) Scenario C would see the lowest increase in total automobile collisions, injury collisions and fatal collisions. There would likely be more pedestrian and cyclists collisions in Scenario C than the other scenarios due to the greatest increase in trips made by walking and cycling; however, these incidents

would likely be the least severe of the three scenarios due to the lower speeds of the vehicles involved inherent to the nature of more urban streets.

Policy Review

Overview:

Safety and physical walkability of pedestrian walkways, sidewalks, connectors and trails can encourage and promote healthy exercise for Oklahoma City residents, whether it is in downtown, residential, or recreational areas. Oklahoma City can continue to encourage downtown healthy behaviors through pedestrian usage by establishing access standards that ensure safe and convenient access for all transportation modes and give priority to capital investments for pedestrian-oriented improvements in the public right of way. This may include pedestrian design standards such as pedestrian zone location and size, appropriate widths, crosswalk and signals or encouraging "kid-friendly" development nearby and discouraging uses that could be detrimental to the school's viability.

Relevant Policies:

Sustain.LandUsePatterns.**278**

Sustain.LandUsePatterns.**302**

Sustain.LandUsePatterns.**317**

Sustain.LandUsePatterns.**338**

Connect.TransportationSystems.**175**

Connect.TransportationSystems.**235**

Strengthen.Placemaking.**235**

Recommendations

- Utilize traffic-calming measures along urban streets that are the most useful for pedestrian and cyclist traffic.
    - Prioritize roads and corridors that provide the greatest ease of access via sidewalks and bike routes to the greatest amount of uses.
    - Separate high-traffic motor vehicle routes from pedestrian and cyclist facilities.
- Reduce speed limits and design street speed capacity to a maximum of 25 miles per hour along all street types that are deemed a priority for pedestrian and bicyclist routes.
- Improve signage of pedestrian and bike facilities to bring awareness to drivers, riders, and walkers.
- Update the ordinances related to pedestrian crossings to increase the amount of time given to cross intersections before full liability is leveraged upon the pedestrian.
    - Give pedestrians a head start so they are out of the intersection.
- Develop streetscape standards that emphasize pedestrian and bike safety (lighting, trees, and traffic calming measures).
- Develop building design standards and revise zoning codes to emphasize pedestrian/bike safety, especially on key pedestrian, bike and transit corridors.

V. connectokc Indicators

C.6 Percentage of Average Income Spent on Transportation

Health-based Rationale

The more money individuals are spending on transportation costs. This is money that could be used for healthy options for food, exercise, and healthcare. According to AAA, the average cost of car ownership in the United States for the year 2013 is $9,122[250]. The average car-owning family in the U.S. owns 2.28 vehicles, with 35% of households owning 3 cars, 34% owning 1 car, and 31% owning 2 cars[251]. The most recent median household income data from the U.S. Census Bureau is $51,017[252]. This yields a potential transportation cost of nearly 40%; however, the average family in the U.S. spends 19% of their income on transportation[253].

Taking public transportation, bicycling, walking, using a car sharing service and more lowers the amount of money a household will spend on transportation per year. In Oklahoma City a monthly transit pass costs $50, or $600 per year[254]. There isn't very much information about the cost of bicycle commuting, but the League of American Bicyclists claims a $308 per year price[255]. And walking is for all intents and purposes free.

Having less money is indicative of lower levels of health in families. 21% of families below 150% of the federal poverty level have a family member in with low health quality, which contrasts with the 16.7% of families that are above this income level[256]. Coupling housing and transportation costs can make healthcare less affordable and less of a priority for low-income individuals. If they are unable to get to a healthcare facility without a car, then there is little option but to own one, and then healthcare costs become unaffordable. This allows health conditions of all kinds to deteriorate without proper treatment.

Existing Conditions

The Center for Neighborhood Technology (CNT) is an award-winning innovations laboratory for urban sustainability that created the H+T Affordability Index which provides a comprehensive view of affordability, one that includes the cost of housing and transportation at the neighborhood level. Household Transportation Costs are calculated as the sum of auto ownership costs, auto use costs, and public transit

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[250] Pritchett, G. (2013). *Cost of owning and operating vehicle in U.S. increases nearly two percent according to AAA's 2013 'your driving costs' study.* Retrieved from http://newsroom.aaa.com/2013/04/cost-of-owning-and-operating-vehicle-in-u-s-increases-nearly-two-percent-according-to-aaas-2013-your-driving-costs-study/

[251] Fielder, C. (2008). *Experian automotive press release*. Retrieved from http://www.reuters.com/article/2008/02/12/idUS146089 12-Feb-2008 PRN20080212

[252] DeNavas-Walt, C., Proctor, B. D., & Smith, J. C. U.S. Department of Commerce, Economics and Statistics Administration. (2013). *Income, poverty, and health insurance coverage in the United States: 2012*. Retrieved from U.S. Census Bureau website: http://www.census.gov/prod/2013pubs/p60-245.pdf

[253] Southern California Assocation of Governments, (2008).*The affordability index toolbox: A new tool for measuring the true affordability of housing choices*. Retrieved from Compass Blueprint website: http://www.reconnectingamerica.org/assets/Uploads/htai_toolbox_plus_case_studies.pdf

[254] COTPA. (n.d.). *Metro transit: Passes and fares*. Retrieved from http://www.gometro.org/fare-overview

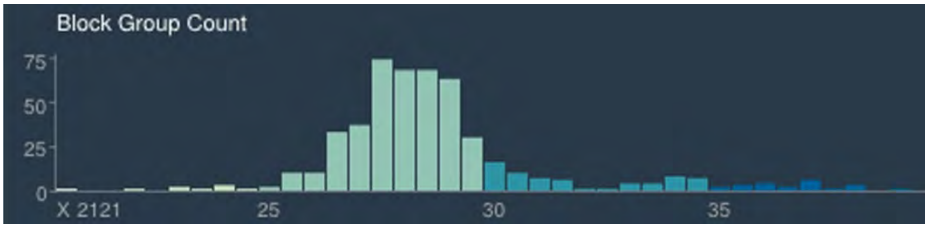
[255] Mohn, T. (2012, May 20). *Pedaling to prosperity: Biking saves U.S. riders billions a year*. Retrieved from http://www.forbes.com/sites/tanyamohn/2012/05/20/bicyclists-in-the-united-states-save-at-least-4-6-billion-a-year-by-riding-instead-of-driving-ased-on-friday-to-coincide-with-national-bike-to-work-day-part-of-national-bike-month-which-occurs-each/

[256] The Urban Institute, Office of Public Affairs. (2009). *Low-income working families: updated facts and figures*. Retrieved from The Urban Institute website: http://www.urban.org/UploadedPDF/411900_LIWF_fact_sheet.pdf

costs. Dividing these costs by the representative income illustrates the cost burden placed on a typical household by transportation costs.

Calculating for Oklahoma City region, this includes 442,473 households and goes further than the Oklahoma City boundaries, results in an average of 30.44% of income spent on transportation costs (Minimum 21.43% and Maximum 39.5%). By reducing the regional area down to Oklahoma City only, the percentages are a fraction lower but still similar. Computing data for Oklahoma City only, the number of households is 221,590. The average income spent on transportation costs is 29.41% (Minimum, 21.43% and Maximum: 39.72%).[257] Based upon the median income of Oklahoma City of $45,474, it is reasonable to expect that the average resident is spending around $13,500 each year on transportation costs. According to the H+T figures, nearly 1/3 of the population of Oklahoma City is spending greater than 30% of their income on transportation costs.

Percentage of Income Spent on Transportation in Oklahoma City		
Criteria	Population	% of Population
Insufficient Data	0	0%
< 15 %	0	0%
15 to 25 %	3,852	0.7%
25 to 30 %	391,528	71.1%
30 to 35 %	130,822	23.8%
35 + %	24,267	4.4%
Total	550,469	100%



Percentage of Income Spent on Transportation

Oklahoma City residents on average spend 22.56% of their income on housing, meaning that Oklahoma City residents spend $1.30 in transportation costs for every $1.00 spent on housing costs.

[257] Center for Neighborhood Technology (CNT). (2014). Retrieved 1 12, 2014, from H + T Affordability Index: http://www.htaindex.cnt.org/map/

The table below compares the average percentage of income spent on housing and transportation for Oklahoma City with several peer cities in the region. Affordable housing prices are a recognizable trend in the Midwest, but Oklahoma City lags behind in median income as well as total % of income spent on housing and transportation, leaving less money to be spent discretionally. The impact of this condition is compounded for the City due to the reliance upon sales tax revenues that come directly from discretionary spending.

Location	*Median Income*	*% Spent on Transportation*	*% Spent on Housing*	*% Combined Transportation and Housing*	*Remaining Income*
Oklahoma City	$45,474	29.41%	22.56%	51.97%	$21,841
Tulsa	$45,701	28.32%	22.03%	50.35%	$22,690
Kansas City	$55,409	26.17%	23.25%	49.42%	$28,025
Fort Worth	$55,459	25.66%	21.87%	47.53%	$29,099
Denver	$59,932	19.56%	22.76%	42.32%	$34,568

Scenario Analysis

The Envision Tomorrow Travel Application analysis generates transportation costs for each scenario relative to existing conditions, giving a clear understanding of the implications of each development pattern. The table below illustrates the percent change in income spent on transportation for each scenario, the resulting expected amount spent each year (not adjusted for inflation or rising fuel costs), and the savings or loss relative to existing conditions.

	Scenario A	Scenario B	Scenario C
% Change from Existing Conditions	3.7%	-1.6%	-7.3%
$ Amount per Year	$13,868.73	$13,159.92	$12,379.60
Savings/Loss per Year	- $494.83	$213.98	$976.29

Scenario A is the only one of the three that increases the expected percentage of income spent on transportation in Oklahoma City. With a 3.7% increase in transportation spending, the average resident of the city would be spending around 30.5% of their income on transportation costs alone. Scenario B changes a small amount, but does trend toward a lower overall percentage. If the development pattern of Scenario C became the future of Oklahoma City, a 7.3% decrease in percentage of income spent on transportation costs would bring the city's average transportation costs below Tulsa at a rate of 27.2% and increase the amount of money remaining after transportation and housing costs by $976.29, an increase of 4.5%. This increasing spending power could be spent on sales tax generating products and services, housing improvements, put into savings, spent on charitable ventures, or any number of other things. Regardless of what it is spent on, this increase in discretionary spending capacity would improve the local economy.

Conclusions

A) Under Scenario A average income spent on transportation increases, decreasing the amount of discretionary spending available for other things. Scenario A is the only scenario of the three with a net increase in transportation expenses.

B) Under Scenario B average income spent on transportation decreases slightly. Scenario B does not performs better than Scenario A, but not as well as Scenario C.

C) Under Scenario C average income spent on transportation decreases significantly, increasing the amount of discretionary spending available for other things. Scenario C performs better than both Scenario A and Scenario B.

Policy Review

Overview:

Families commuting long distances incur increased transportation costs. Transportation costs may include direct costs such as fuel, tolls, insurance and taxes or indirect costs such as time away from family or inhibitor of unhealthy eating or exercise habits. Oklahoma City can help alleviate the cost of transportation expenses through regulation of fuel, road conditions, and taxes. The city can affect the percentage of household income that is spent on transportation by creating programs, financial incentives, and regulations to lower the costs of housing and healthy food options, especially in underserved areas that may be forced to commute for job opportunities.

Relevant Policies:

Sustain.LandUsePatterns.**336**

Green.Agriculture and Food.**504**

Live.Housing.**455**

Live.Housing.**457**

Play.Accessibilty and Use.**369**

Recommendations

- Promote alternative transportation options with an acknowledgement of the cost savings afforded to those who drive less or choose to go car-less.
- Improve the perception of safety for transit, cycling, and pedestrian transportation.
    - Ensure that these improvements are legitimate; a safer system will be more attractive to all potential users.
- Control urban sprawl to lessen the percentage of the population that lives at a distance from land uses they utilize.
    - Incentivize inclusionary zoning to ensure an equitable housing mix.

serveokc indicators

Se.1 First Responder Time by ZIP Code: Fire and Police

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What is the first responder time by ZIP code: Fire and Police?	GIS mapping with data from Fire and Police	Response time; insurance rates based upon proximity ($); property and personal belonging damage/destruction	Death; disability; stress; depression

Se.2 Percentage of Residences with Storm Shelters

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What percentage of the population has access to a storm shelter?	Public Works data	Knowledge of natural disaster protocol; personal emergency knowledge (CPR, etc.)	Death; disability

Se.3 Rate of DUI

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What is the rate of DUI occurrence?	Census data; GIS data from Police and ODOT	Auto accidents; arrest; medical response time	Death; disability; injury; depression

Se.4 Public Utility Service Area

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What percentage of the population utilizes public water and sewer services?	Utilities GIS data, Census data	Public water quality; ground water quality; water body quality Access to fresh water; cost effective public utilities	Infectious disease; poisoning; death; death of marine life Water-borne disease; stress from financial costs

Se.5 Rate of Recycling and Proximity of Recycling Locations to Residential

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What is the rate of recycling? What percentage of the population lives in proximity to a recycling facility?	ODEQ statistical data	Amount of waste; larger landfills; impact on natural environment	Air-borne, water-borne, vector-borne disease; well-being of animal species

VI. serveokc Indicators

Se.1 First Responder Time by ZIP Code: Fire and Police

Health-based Rationale

First responder response times can affect a community in several ways. There are many personal associations involved including fear of death and disability during a crisis (e.g. home fire, burglary, domestic altercation, etc.). The speed in which responders react to each emergency can strengthen or weaken the community morale, trust in authority, and health outcomes such as stress and depression.

In order to be effective, police agencies, like other organizations, depend on support and resources from their environment[258][259]. This includes organizational support and funding from the public. It is important as a public agency to be objectively critical of how the communities perceive the agency and how their actions can affect the health outcomes of the entire community. Crime victims, as a group, may share needs and expectations that differ from those of the general public, and, because of their victimization, they are more likely to base evaluations on similar factors. Hence, such studies may provide data specifically relevant to improvements in police practices[260].

In recent years the community perception among minority groups seems to be of great concern. Since 1961 the United States Commission on Civil Rights has explored police-minority relations extensively in multiple investigations. The Commission's findings show various forms of discrimination against minorities, ranging from disproportionately low levels of minority employment in police departments to slower police response times in minority areas and inadequate police services in minority neighborhoods[261]. These perceptions of persecution or lack of protection for any community of people has the potential for increased stress.

Note that perceptions and health outcomes often begin at a young age. Although directed towards a presence of law enforcement rather than focused on response times, a study of adolescents' depressive symptomology reports that adolescents from lower social class backgrounds in urban areas may simultaneously experience heightened surveillance and a lack of protection from police in their communities, contributing to feelings of pessimism and/or hopelessness. [262]

On a more measurable health outcome indicator, emergency situations have the possibility of deaths and disability. Various factors influence EMS response times (defined as the time from unit notification to unit arrival on scene). Minimizing delays is crucial to maximizing patient outcomes[263].

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[258] Pfeffer, J., and Salancik, G. R. (1978). *The external control of organizations: A resource dependence perspective*. New York Harper and Row.
[259] Thompson, J. (1967). *Organizations in action*. New York: McGraw Hill.
[260] Brandl, S. a. (1991). CRIME-VICTIM EVALUATION OF POLICE. *Journal of Criminal Justice*, 109-121.
[261] U.S. Commission on Civil Rights(1981). *Who is guarding the guardians?.* Washington, D.C.: U.S. Government Printing Office.
[262] Tummala-Narra, P. a.-R. (2013). Perceived support from adults, interactions with police, and adolescents'. *Journal of Adolescents*, 209-219.
[263] Pons P, Haukoos J, Bludworth W, Cribley T, Pons K, & Markovchick V. (2005). Paramedic response time: Does it affect patient survival? *Acad Emerg Med*, 12(7), 594-600.

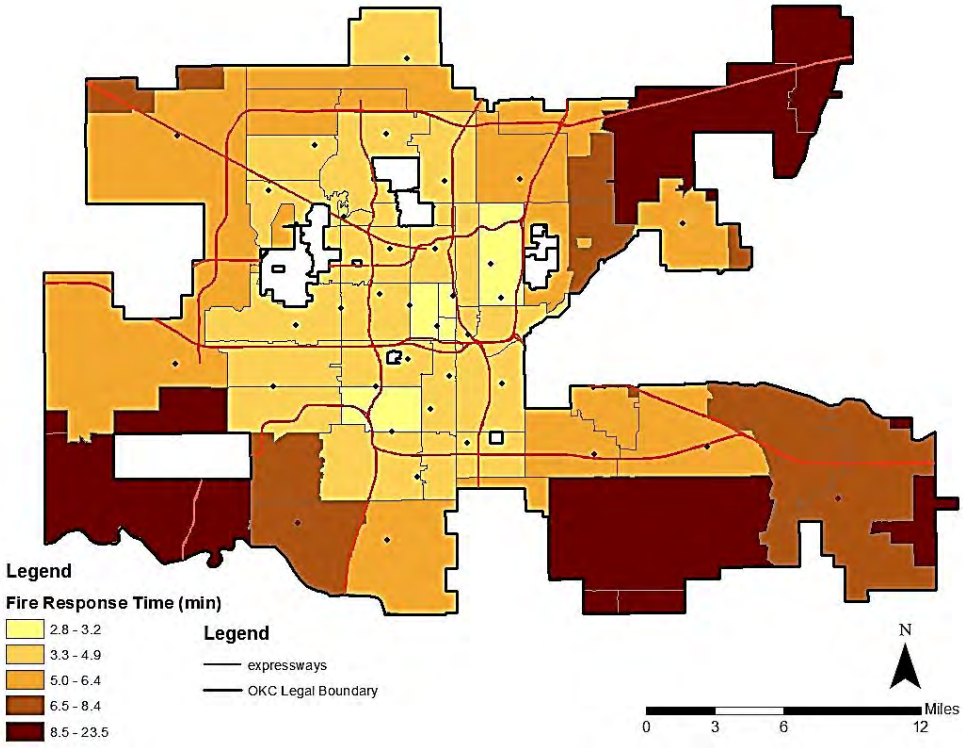
Existing Conditions

Fire Response Times:

The Oklahoma City Fire Department responds to tens of thousands of different incidences each year. Surprisingly, the vast majority of these responses are for medical aid, and not for fire-related happenings. Of the 445,475 responses between 6/10/08 and 7/10/2012, 387,372, or 86.96%, were for medical aid, while 13,536, or 3.04%, were responses to fire-related events. Another 8.9% of responses were to assist in auto accident instances.

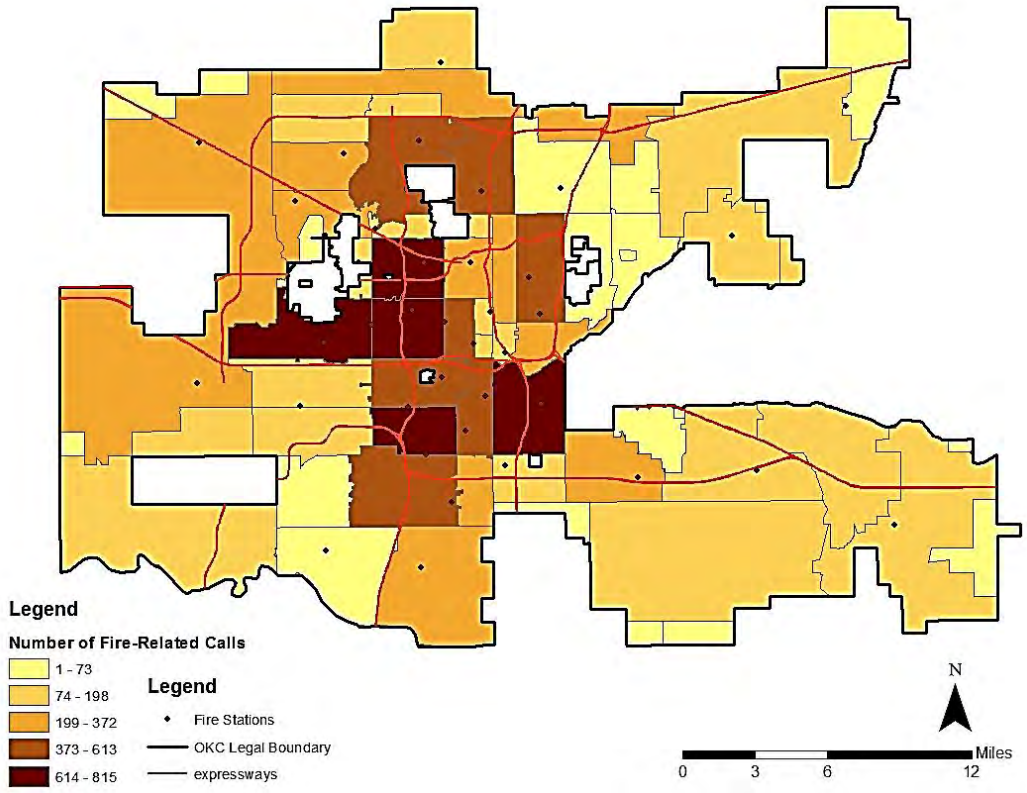
There are 36 fire stations and 806 firefighters in Oklahoma City[264], equating to 1.34 firefighters per 1,000 residents. The average response time for the city is 4 minutes and 5 seconds. The goal time for standard fire engine response is 3.2 minutes, and 4.9 minutes for a large ladder truck[265]. In the table below you can see the top and bottom five ZIP codes relative to response time, excluding ZIP codes with less than 100 responses in the four-year time period as they are substantially served by other jurisdictions and outliers.

Top 5		Bottom 5	
ZIP	Response Time	ZIP	Response Time
73102	2 min 51 sec	73064	8 min 26 sec
73103	2 min 52 sec	73165	8 min 40 sec
73106	2 min 56 sec	73049	8 min 52 sec
73119	3 min 8 sec	74851	9 min 10 sec
73111	3 min 9 sec	73054	10 min 27 sec



[264] Oklahoma City Fire Department. *Operations*. Retrieved from website: http://www.okc.gov/Fire/ops/index.html
[265] Fire Chiefs Online, (n.d.). *Response-time considerations*. Retrieved from website: https://firechief.iso.com/FCWWeb/mitigation/ppc/3000/ppc3015.jsp

Below is a map of ZIP codes based upon the frequency of fire-related instances to which the fire department responded. Following is a table with the five ZIP codes with the most fire-related incidents between 6/10/2008 and 7/10/2012.



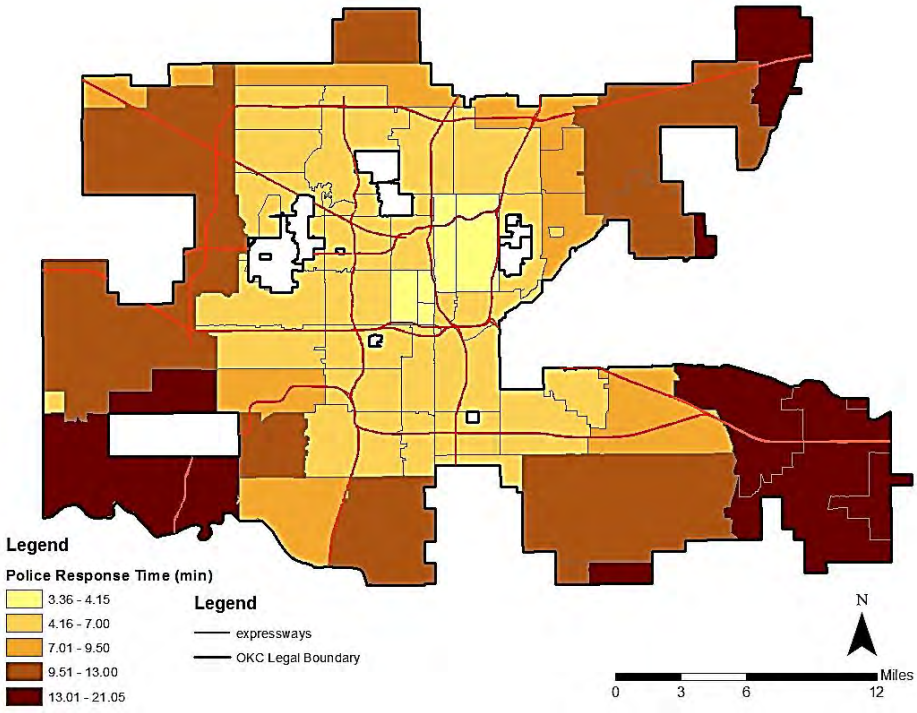
ZIP	Number of Incidents
73127	815
73119	806
73129	782
73112	742
73107	724

Police Response Times:

The Oklahoma Police Department also responds to tens of thousands of calls each year, and has a system by which calls are placed in a 9-class hierarchy based upon the urgency of the call. For this study only those which qualify as a legitimate emergency, Class 1, were considered. In the same time period as the fire response data, 6/10/2008 to 7/10/2012, the OKCPD recorded 36,746 Class 1 calls. According to the OKCPD website there are 1,023 uniformed officers, equating to 1.71 officers per 1,000 residents.

The average Oklahoma City Police Department response time for the city is 5 minutes and 37 seconds. In the table below you can see the top and bottom five ZIP codes relative to response time, excluding ZIP codes with less than 100 responses in the four-year time period as they are substantially served by other jurisdictions and outliers.

Top 5		Bottom 5	
ZIP	Response Time	ZIP	Response Time
73106	3 min 22 sec	73020	13 min 16 sec
73105	3 min 22 sec	73064	14 min 21 sec
73111	3 min 39 sec	74851	15 min 25 sec
73102	4 min 0 sec	74857	16 min 34 sec
73103	4 min 16 sec	73054	21 min 3 sec



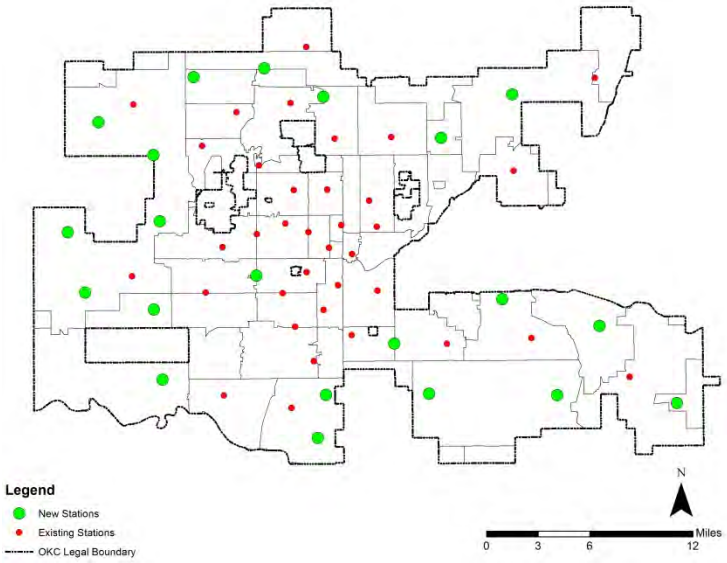
Scenario Analysis

Fire:

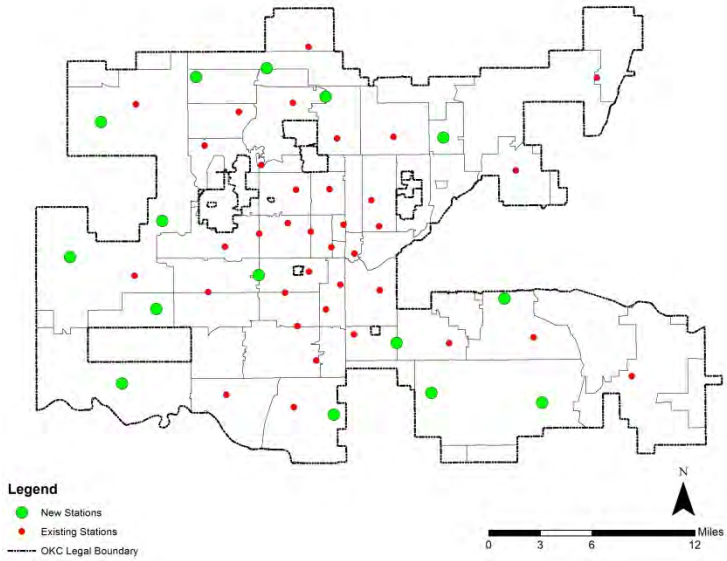
In each of the scenarios a new average response time for the fire department was calculated based upon the density of development in relation to existing fire stations. Calculations based on the expected length of a response time relative to the number of calls made from a certain location generated the following results:

Fire Response Times				
	Existing	Scenario A	Scenario B	Scenario C
Response Time (minutes)	4.06	4.06	4.02	3.95
Percent Change	N/A	0.0%	-1.0%	-2.7%

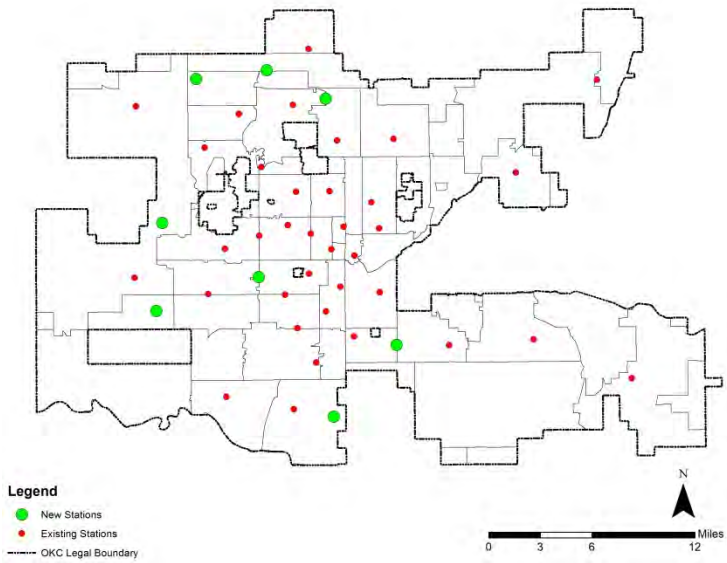
None of the Scenarios degrade the existing conditions; however, in order for the fire department to maintain current levels of service for the increased scenario population, new fire stations must be placed in the city. The maps below show the number of stations required by each of the three scenarios.



Scenario A requires 21 new fire stations to maintain current levels of service. This includes 3 urban locations, 11 suburban locations, and 7 rural locations. The cost for an urban station is $4.9M, a suburban station is $4.5M, and a rural station is $4.2M. This results in a total of $94.0M of investment in fire stations to maintain current levels of service.



Scenario B requires 15 new fire stations to maintain current levels of service. This includes 1 urban location, 9 suburban locations, and 5 rural locations. The cost for an urban station is $4.9M, a suburban station is $4.5M, and a rural station is $4.2M. This results in a total of $66.7M of investment in fire stations to maintain current levels of service.



Scenario C requires 8 new fire stations to maintain current levels of service. This includes 0 urban locations, 7 suburban locations, and 1 rural location. The cost for an urban station is $4.9M, a suburban station is $4.5M, and a rural station is $4.2M. This results in a total of $36.0M of investment in fire stations to maintain current levels of service.

Additionally, estimated operating costs for the scenarios show that Scenario A would require $156.8M per year, Scenario B would require $146.6M per year, and Scenario C would require $135.1M per year. This is due to the number of stations to manage and staff.

Police:

In each of the scenarios a new average response time for the police department was calculated based upon the expected length of a response time relative to the number of calls made from a certain location. The scenario analysis looked at all levels of police response, not simply Class 1 calls. This generated the data in the table below:

Police Response Times				
	Existing	**Scenario A**	**Scenario B**	**Scenario C**
Response Time (minutes)	6.37	6.37	6.33	6.30
Percent Change	N/A	0.0%	-0.6%	-1.1%

The difference in response time is subtle but could mean the difference between life and death in an emergency.

The table below breaks down the estimated operating costs for the police in each of the scenarios as determined through the scenario generation:

Police Operating Costs			
Lines of Business	**Scenario A**	**Scenario B**	**Scenario C**
1 Administration	$ 28,824,142	$ 27,700,183	$ 26,626,370
2 Investigations	$ 50,222,413	$ 50,454,589	$ 50,640,810
3 Operations	$ 139,380,506	$ 130,288,334	$ 121,660,361
4 Public Safety Support	$ 33,730,867	$ 33,882,259	$ 34,003,942
Total	$ 252,157,928	$ 242,325,365	$ 232,931,483

Scenario A is more than 8% greater than Scenario C; Scenario B is roughly 4% greater than Scenario C. The development pattern of Scenario C lends itself to a more efficient operational strategy for the police wherein long drives across the city are minimized. This saves money in the form of fuel, vehicle maintenance, and more.

Conclusions

A) Scenario A requires the greatest amount of additional funding for both fire and police services in order to maintain current levels of service. Of the three scenarios, Scenario A has the slowest response times, though these are equivalent to existing conditions (which are quite fast).

B) Scenario B is less expensive than Scenario A for both fire and police services, but is more expensive than Scenario C. Scenario B has faster response times for both fire and police than Scenario A and existing conditions, but not as fast as Scenario c.

C) Scenario C is the most cost-effective of the three scenarios, requiring the fewest number of new facilities. Scenario C also has the fastest response times of the three scenarios.

Policy Review

Overview:

The time it takes for emergency responders such as fire and police departments to respond to a call is a very intricate process of dispatchers, available responders, transportation and communication methods, weather conditions, and the need of the citizen. In an effort to decrease response times Oklahoma City can focus on adopting design standards to enable emergency management resources to be highly effective, such as resilient buildings, interconnected transportation networks, and other design considerations that help ensure community safety and recovery. This can be done by increasing the efficiency of public safety operations, allowing a greater number of residents to be reached by responders in a shorter amount of time.

Relevant Policies:

Sustain.Land Use Patterns.682

Serve.Fire and Emergency.548

Serve.Fire and Emergency.552

Serve.General.688

Connect.Roadways.188

Live.Neighborhood Safety.414

Recommendations

- Create new forms of first response for the fire department such that ladder trucks are not required for the 97% of calls that are not fire related. This could be some sort of car, motorcycle, or SUV.
- Create an alternative location for police officers to book those whom have been arrested other than the downtown location, to ensure that patrol is constant.
- Encourage dense development in order to avoid stretching resources further and requiring greater funding to build new stations, greater amounts of patrol mileage, and wear and tear on vehicles.
- Support clustered development in regions where water supply is adequate for fighting fires.
- Improve connectivity for ease of access for first responders in new and existing subdivisions.
- Maximize fire safety through actions such as:
    - Require subdivisions to have more than one point of access.
    - Minimize the threat of fire risk at the interface of the urban and rural areas.
    - Require exceptional, effective, and easy access to sites augmented by a thorough system of connections within and between developments.

VI. serveokc Indicators

Se.2 Percentage of Residences with Storm Shelters

Health-based Rationale

Emergency preparedness is crucial to a community during natural disasters. There have been many disasters worldwide that can account for national, and even global, response to aid the wounded, devastated, and dead. As a result of disasters such as floods, tornados, hurricanes, winter storms, thunderstorms, fires, ice storms, and earthquakes, between the years of 2004 and 2006, 2387 persons died and 7757 people were injured in the United States[266]. Many communities, families, and individuals state that they are prepared for a natural disaster, but often death, injury, and disability may not be avoided.

As a growing concern for many communities, it is imperative that vulnerable populations are identified and sheltered, According to a recent study on personal emergency preparedness of individuals with disabilities, people with disabilities who are women, minorities, non-white, as well as people with low income and low educational status are at higher risk and are further compromised by lack of emergency preparedness. In addition, during natural and man-made disasters, people with disabilities may be more vulnerable to injury and/or death[267]. Another vulnerable population to protect is children. Both natural disasters and armed conflicts heighten the risks to children at multiple levels of children's social ecologies – especially the family, community, and societal levels[268].

Immigrant communities are at a greater risk of life-threatening danger during a natural disaster when English is the only language meteorologists speak, particularly in the case of tornadoes where every second is valuable. There are an estimated 24 million Americans with limited-English proficiency (LEP) and a strong contingency of Spanish-speaking citizens in the State of Oklahoma[269].

Existing Conditions

Storm Shelters in Schools:

The results of a statewide survey released determined that 62 percent of Oklahoma's 1,804 public schools don't have storm shelters, and only 15 percent have shelters built to withstand the 250 mph winds of an EF5 tornado, like the ones that swept through central Oklahoma in May 2013[270]. This translates to around 25 Oklahoma City Schools, which includes Unified School Districts: Oklahoma City, Putnam City, Western Heights, Midwest City, Del City, and Moore which have storm shelters.

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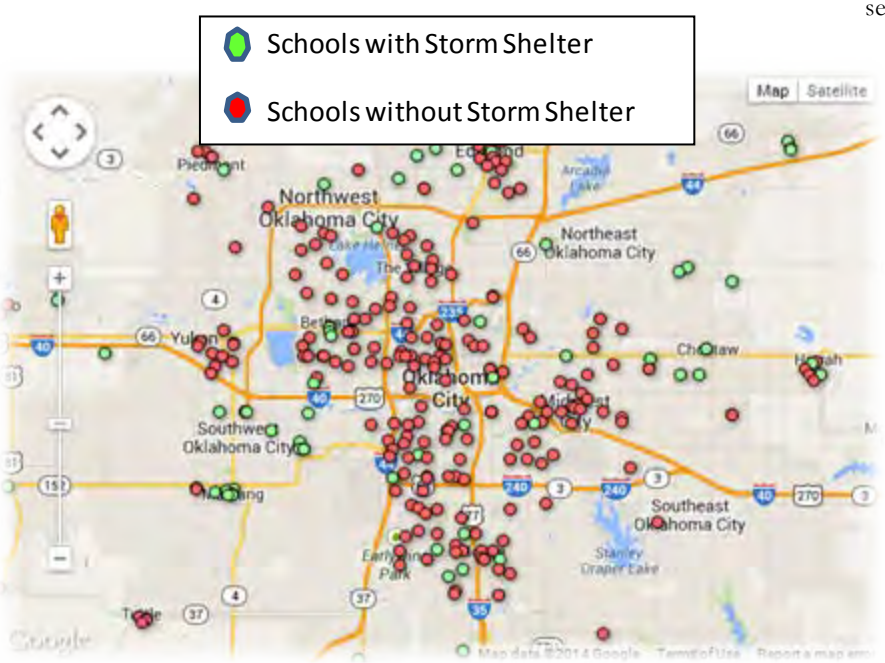
[266] National Weather Service. *Summary of Natural Hazard Statistics for 2004-2006 in the United States*. http://www.nws.noaa.gov/om/hazstats.shtml. Accessed September 12, 2008.

[267] Smith, D. a. (2009). Personal emergency preparedness for people with disabilities from the. *Disability and Health Journal*, 86-94.

[268] .Wessells, M. a. (2013). Child Friendly Spaces: Toward a Grounded Community Based Approach. *Child Abuse & Neglect*, 19-40.

[269] Penuel, K.B. and Statler, M. (Eds.). (2011). *Encyclopedia of Disaster Relief*. Sage Publication. Retrieved from http://www.texashealthinstitute.org/uploads/1/3/5/3/13535548/language_issues_and_barriers-purtle.pdf

[270] Wertz, J. (2013, 09 27). State Impact. Retrieved 01 13, 2014, from Mapped: *Which Oklahoma Schools Have Storm Shelters*: http://stateimpact.npr.org/oklahoma/2013/09/27/mapped-which-oklahoma-schools-have-storm-shelters/



Residential Properties with Storm Shelters:

In Oklahoma City there are a total of 19,025 shelters, of which 16,696 are located upon residential property, some of which serve more than one household, giving a total number of households with access to a storm shelter of 19,143. While this may sound like an impressive number, and undoubtedly greater than most cities, this represents only 7.7% of households within the city limits.

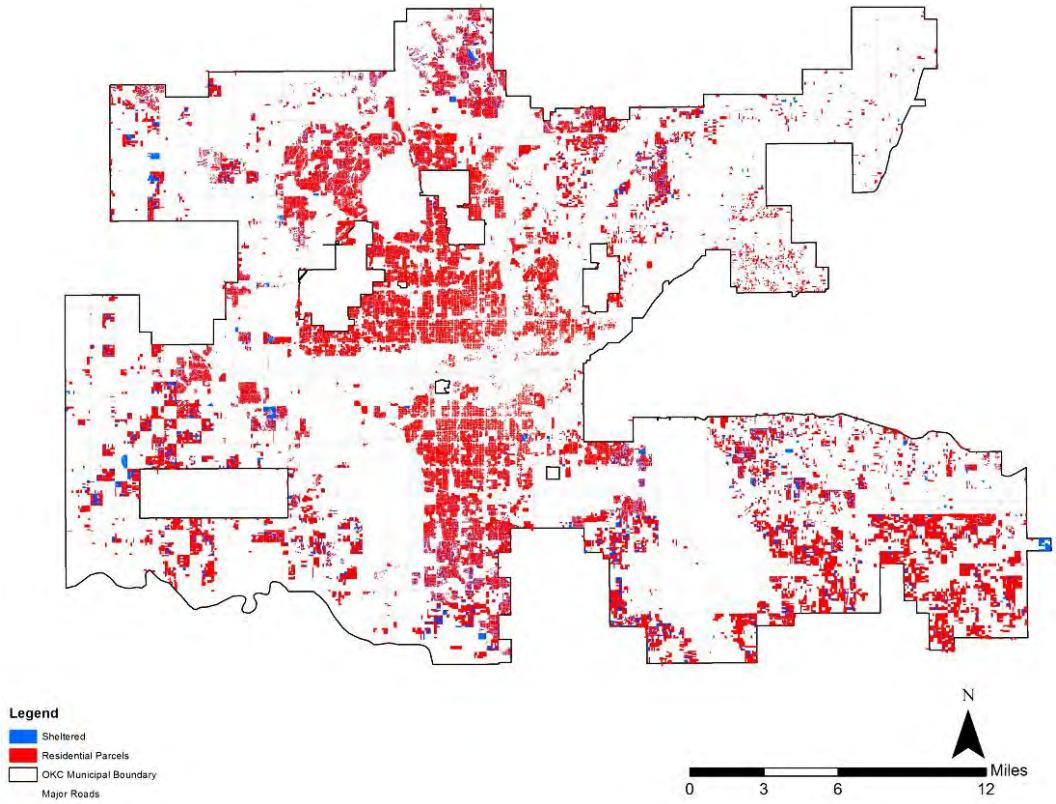


Figure 26: Parcels with Storm Shelters

Tornadoes:

The alarming fact exists that tornadoes of any size can be destructive, potentially deadly and highly unpredictable. In the US, 2011 brought 1691 tornadoes and resulted in 552 deaths, while most recent data shows 2013 incurred only 891 tornadoes resulting in 54 deaths[271]. The State of Oklahoma had the highest number of tornadoes on record in 1999 with 145 tornadoes and the lowest record year was 1988 with 17 tornadoes[272].

Oklahoma's Annual Tornadoes		
Highest Annual Total of Tornadoes		
Rank	**Year**	**Total**
1	1999	145
2	2011	119
3	1957	107
4	2010	103
5	1982	101
6	1960	98
7	1983	92
8	1998	83
9	1961	82
10	2013	79

Oklahoma's Annual Tornadoes		
Lowest Annual Total of Tornadoes		
Rank	**Year**	**Total**
1	1988	17
2	2002	18
3	1989	20
4	1978	21
5	1952	22
6 (tie)	1987	23
	1950	23
8	1980	25
9 (tie)	2006	27
	2005	27

Scenario Analysis

There is no correlation between the percentage of homes with storm shelters and the pattern of development that could be effectively measured; therefore, no comparative scenario analysis can be completed with confidence. Policy decisions will have a much greater impact to ensure that a greater proportion of the population is prepared for disaster.

Conclusions

The percentage of residences with storm shelters does not depend upon development pattern in such a way that a distinction could be made among the three scenarios. Policy decisions are much more relevant to the implementation of plans and projects to include storm shelters as part of development standards. With less than 10% of the population living in homes with storm shelters, it should be imperative in all of the scenarios to develop policy agendas that incentivize households to invest in protective measures from the inevitable dangerous weather that frequently hits Oklahoma City and the surrounding areas.

[271] The National Oceanic and Atmospheric Administration. (2013). Retrieved 1 13, 2014, from *TORNADO TOTALS AND RELATED DEATHS*: http://www.spc.noaa.gov/climo/torn/STAMTS.txt

[272] National Weather Service Weather Forecast Office. (2014). Retrieved 1 13, 2014, from *Monthly and Annual Tornado Statistics in Oklahoma*: http://www.srh.noaa.gov/oun/?n=tornadodata-ok-monthlyannual

Policy Review

Overview:

With Oklahoma City's unique geographic location, the city has been a target for tornadoes and storms for decades. Emergency evacuation plans and storm shelters provide protection during these life threatening weather conditions. During such emergencies, Oklahoma City keeps citizens up to date through weather forecasts and news radio programs, but the unexpected nature and tenure of these types of storms makes it difficult to have a city-wide plan or designated safety locations. Oklahoma City would be able to increase preparedness and gain a better understanding of emergency capabilities through a system-wide study of the emergency response system. The findings from these market studies should be incorporated into emergency planning and used to inform Capital Improvement Projects.

Relevant Policies:

Serve.General.**532**

Serve.EmergencyManagement.**552**

Live.Neighborhood Safety.**414**

Recommendations

- Work with area school districts to create a retrofit program for installation of storm shelters.
- Require all new schools to be fitted with sufficient storm sheltering.
- Incentivize the installation of storm shelters in homes.
- Encourage currently trained EMTs to gain paramedic training.
- Increase emergency preparedness, particularly in the reaction planning process.
    - Ensure the organization of volunteers by identifying volunteer collection sites.
- Expand funding for trainings and publicity about emergency preparedness.
- Set benchmarks on how many citizens are trained to respond to emergencies in each area. Designate a public agency responsible.
- Support the Oklahoma City Red Cross, and other outreach programs, in outreach efforts to bring people into their CERT training (Community Emergency Response Team).
- Adopt design standards to enable emergency management resources to be highly effective, such as resilient buildings and interconnected transportation networks. (
- Require storm shelters as a part of new single-family residential construction.
- Require multi-lingual reporting of emergencies concurrently with English-speaking reporting.

VI. serveokc Indicators

Se.3 Rate of DUI

Health-based Rationale

Driving under the influence of alcohol or other substances has been found detrimental to cognitive skills and reaction times while operating a motor vehicle. Not only can it cause harm to the driver, but also to innocent bystanders, other travelers, and community health. An accident resulting in death, disability, or injury caused by a DUI can have a lasting impression on the lives of family members and members of the community.

It is no secret that in the U.S. driving under the influence is prevalent. A recent study of young adults and drinking patterns indicates the likelihood of DUI was higher among whites, followed by Hispanics, Asians, and blacks in all models. Perception of easy home access to alcohol increased risk for future DUI for whites, Hispanics, and Asians but not for black youth[273]. Each year, nearly 11,000 motor vehicle deaths are attributable to alcohol[274].

While the government has taken great strides in reducing DUI and other alcohol-related death and injuries through seatbelt laws, minimum drinking age laws, zero-tolerance laws, and roadway improvements, a study on effectiveness of alcohol control policies finds uunemployment had a positive effect on alcohol-related traffic fatalities per total fatalities, implying that more motor-vehicle crashes are alcohol related when the unemployment rate is high. One possible explanation is that some unemployed people resort to alcohol to self-medicate when depressed. However, when looking at per-capita traffic fatalities, fewer alcohol-related fatalities occurred when the unemployment rate was high, probably because people were busy looking for jobs and/or had less time and money to spend procuring alcoholic beverages[275]. Results of multivariate modeling procedures showed number of DUI to be a significant correlate of the suicide rate, controlling for other potential indicators[276].

Out of the 55,681 drivers involved in fatal car accidents in 2007, 22% were found to be above the legal BAC limit. And out of these 12,068 drivers, 55% were in rural areas versus 43% in urban areas[277]. This correlation is prevalent throughout the country, that rural drivers die from alcohol-related collisions more frequently; this, however, may be contingent upon several factors, such as delayed time of medical response, higher speed limits, lack of sufficient medical facilities in proximity, less use of seatbelts, more substantial vehicles (trucks, trailers, etc.), and a general trend to consume greater quantities of alcohol[278].

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[273] Delcher C., J. R.-M. (2013). Driving After Drinking Among Young Adults of Different Race/Ethnicities. *Journal of Adolecent Health*, 584-591.

[274] National Highway Traffic Safety Administration. *Traffic safety facts 2009: Alcohol impaired driving*. 2010. Available at: http://www-nrd.nhtsa.gov/Pubs/811385.PDF

[275] Chang, K. W. (2012). The effectiveness of alcohol control policies on alcohol-related traffic fatalities in. *Accident Analysis and Prevention*, 405-415

[276] Hourani, L. D.-S. (2006). Suicide prevention and community-level indictors. *Evaluation and Program planning*, 377-385.

[277] National Highway Traffic Safety Administration, National Center for Statistics and Analysis. (2007). *Traffic safety facts 2007: Rural/urban comparison*. Retrieved from website: http://www.nrd.nhtsa.dot.gov/Pubs/810996.pdf

[278] Donaldson AE, Cook LJ, Hutchings CB, Dean JM. (2006). Crossing county lines: The impact of crash location and driver's residence on motor vehicle crash fatality. *Accident Analysis and Prevention* 38:723-7.

Existing Conditions

The Federal Bureau of Investigation reports in 2012 in the State of Oklahoma, 13,801 individuals were arrested for DUI related offenses and 134 of those offenders were under the age of 18. The US DUI arrests total 1,282,957 for that same year, leaving Oklahoma as only 1.07% of the total offenses nationwide. This data represents the number of persons arrested; however, some persons may be arrested more than once during a year[279]. Although data is not available for 2012 in specific relation to Oklahoma City, the Oklahoma State Bureau of Investigation reports the Oklahoma County crime statistics for 2011 which includes alcohol related arrests numbering 6,340. Of those offenses 175 were juvenile offenders. Note that OSBI reports Alcohol related offenses, not necessarily DUI statistics[280].

Although excess alcohol intake can negatively affect your own health, getting behind the wheel of a motor vehicle after consuming alcohol can lead to a plethora of side effects that may cause unsafe or dangerous driving conditions that may endanger others on the roadway, pedestrians, and bystanders. Some of those side effects include; lowered inhibitions, loss of coordination, impaired balances, speech, vision, reaction time and hearing, and loss of judgment. In Oklahoma, law enforcement officials typically test alcohol content levels by measuring Blood Alcohol Content (BAC) and/or field sobriety tests. At a 0.06% BAC level, Oklahomans can experience criminal penalties[281].

OKLAHOMA ALCOHOL IMPAIRMENT CHART FOR MEN

**women's chart may differ slightly*

APPROXIMATE BLOOD ALCOHOL PERCENTAGE									
DRINKS*	BODY WEIGHT IN POUNDS								EFFECT ON PERSON
	100	120	140	160	180	200	220	240	
0	0	0	0	0	0	0	0	0	ONLY SAFE DRIVING LIMIT
1	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	IMPAIRMENT BEGINS.
2	0.08	0.06	0.05	0.05	0.04	0.04	0.03	0.03	
3	0.11	0.09	0.08	0.07	0.06	0.06	0.05	0.05	DRIVING SKILLS SIGNIFICANTLY AFFECTED.
4	0.15	0.12	0.11	0.09	0.08	0.08	0.07	0.06	
5	0.19	0.16	0.13	0.12	0.11	0.09	0.09	0.08	** CRIMINAL PENALTIES IN OKLAHOMA AT .06%
6	0.23	0.19	0.16	0.14	0.13	0.11	0.1	0.09	
7	0.26	0.22	0.19	0.16	0.15	0.13	0.12	0.11	LEGALLY INTOXICATED.
8	0.3	0.25	0.21	0.19	0.17	0.15	0.14	0.13	
9	0.34	0.28	0.24	0.21	0.19	0.17	0.15	0.14	CRIMINAL PENALTIES INALL STATES
10	0.38	0.31	0.27	0.23	0.21	0.19	0.17	0.16	

Subtract .01% for each 40 minutes of drinking.

*** One drink is equal to 1¼ oz. of 80-proof liquor, 12 oz. of beer, or 4 oz. of table wine.**

****ALL states** have a .08 BAC per se law*

[279] Investigation, T. F. (2012). *Uniform Crime Reports*. The Federal Bureau of Investigation.

[280] Oklahoma State Bureau of Investigation. (2011). Retrieved 1 17, 2014, from Oklahoma SAC: http://www.ok.gov/osbi/Statistical_Analysis_Center/Data_and_Statistics/Oklahoma_County.html

[281] Firm, H. D. (2013). Oklahoma DUI Defense Firm. Retrieved 1 16, 2014, from http://www.okdui.com/

In Oklahoma City during 2012, out of a total 7,274 motor vehicle crashes, 73 fatal crashes resulted in 79 fatalities. Of these crashes, 48% involved a driver under the influence of alcohol. As seen in the map below, these 77 crashes were dispersed around the city.

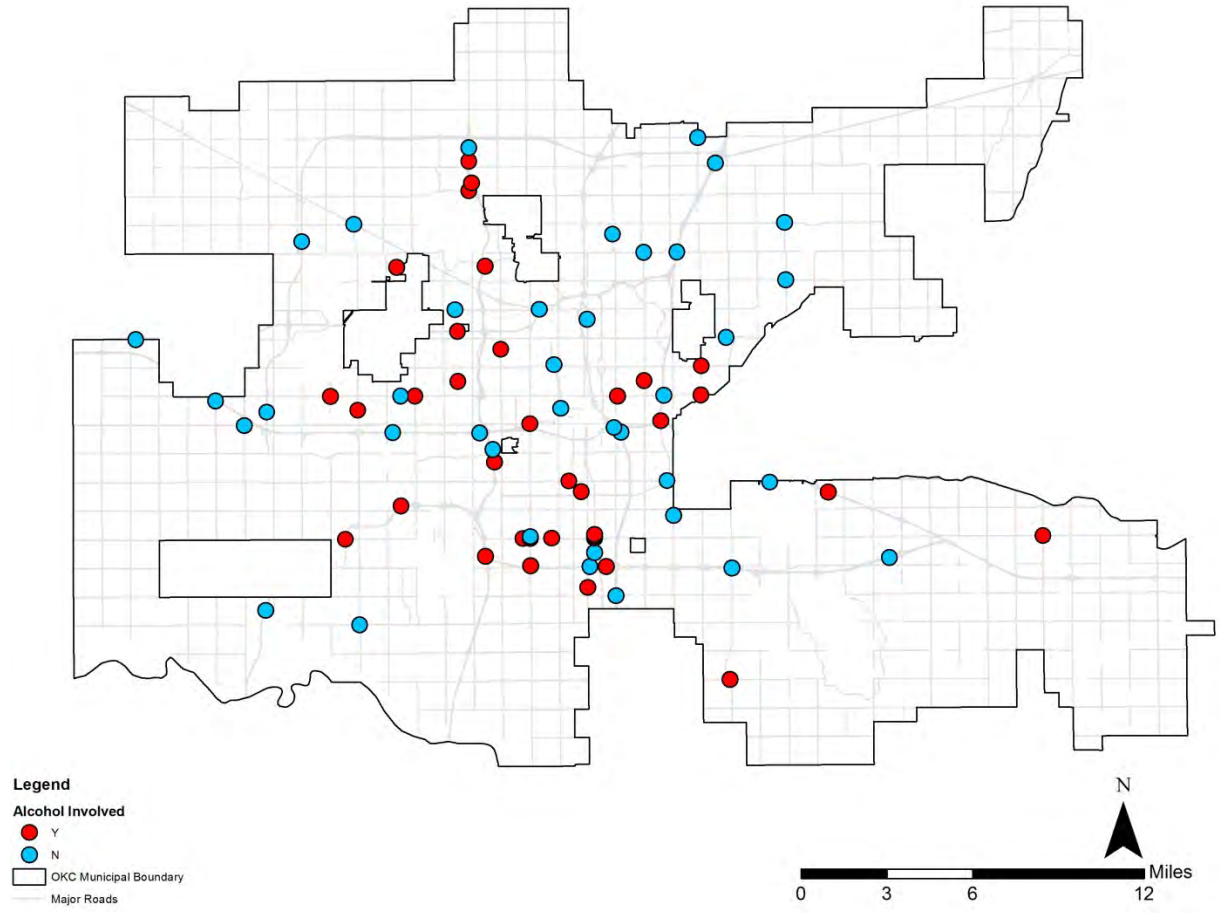


Figure 27: Fatal Collisions 2012 - Alcohol Involvement

When compared to the State of Oklahoma as a whole (1502 fatalities), only 5.3% of fatal vehicle car crashes were represented in Oklahoma City. The total vehicle crashes with fatalities in the US for 2012 is 75,882, in which the State of Oklahoma represents 2%[282].

Scenario Analysis

It is not likely that a prediction regarding the rate of DUI charges for each of the scenarios would be accurate; however, using collision data, reasonable predictions can be made as to the likelihood that DUI accidents end fatally. The different development patterns of the three scenarios encourage drivers to take different roads to get to their homes and jobs. Scenario A and B place 75.9% and 66.8% of the new population in areas of the city that are outside of the present urbanized area, respectively. Scenario C, on the other hand, places only 39.6% of the new population outside of existing urbanized areas. With a longer distance to drive motorists are more likely to take highways and high-speed streets. In addition, the Envision

[282] National Highway Traffic Safety Adminstration. (2014). Retrieved 1 16, 2014, from NCSA Data Resource: http://www-fars.nhtsa.dot.gov/QueryTool/QuerySection/Report.aspx

Tomorrow tool produced figures for the average amount of time spent driving per week, resulting in 9 hours and 52 minutes for Scenario A, 9 hours and 12 minutes for Scenario B, and 8 hours and 24 minutes for Scenario C. The more time every driver is spending in their car, the more likely they will be on the road when negative events occur.

DUI conviction data was not available, but motor-vehicle collisions that involved alcohol or drugs data was available to use; collisions with pedestrians and cyclists were removed as the data does not specify which party was under the influence of mind-altering substances. There have been 9,361 vehicle collisions involving drugs or alcohol since 2003, and of those, 7,633 (81.5%) have been on streets with a speed limit of 30 mph or greater. Of these 9,361 collisions 217 ended in a fatality, 180 (82.9%) of which occurred on streets with a speed limit of 30 mph or greater. Clearly there is a strong correlation between DUI accidents, both fatal and non-fatal, and speed.

Conclusions

A) Scenario A would likely have the highest amount of the negative impacts of DUI activities due to the likelihood for people to drive on roads with higher speed limits.

B) Scenario B would have a slightly lower likelihood of negative DUI impacts than Scenario A as a smaller percentage of the population would be living in distant regions of the city. However, Scenario B is significantly more likely to have these problems than Scenario C.

C) Scenario C would likely have the lowest rate of DUI crashes and fatalities of the three scenarios due to the compact development pattern that would not require high-speed driving to get to daily activities.

Policy Review

Overview:

Driving under the influence of drugs or alcohol can be devastating to the individual, families, and communities involved in the aftermath. While not all occurrences end in fatalities, Oklahoma City can promote safe driving habits and encourage community education programs to reduce the number of DUI related incidences. Community involvement programs such as Light Up The Night, Neighbors Night Out, and other similar activities and programs designed to strengthen neighborhoods can adopt safe driving programs and educate community members on the dangers of drinking and driving. By committing to exploring enhancements of the police operations such as a certain number of officers per capita and/or per square mile of urbanized area and Increasing patrols (automobile, bicycle, or on foot) in targeted areas Oklahoma City can effectively reduce the number of fatalities from drinking and driving.

Relevant Policies:

Live.Neighborhood Safety.**416**

Strengthen.Public Safety.**248**

Serve.Police.**540**

Recommendations

- Implement evidence-based interventions and policies against alcohol-impaired driving:
  - Implement 0.08% blood alcohol concentration (BAC) laws. These are state laws that lower the illegal BAC for drivers from 0.10% to 0.08%.
  - Increase the use of sobriety checkpoints.
- Support education efforts:
  - Fund mass media campaigns to educate the population about the dangers of drunk driving.
  - Increase school-based education programs to educate students about the dangers of drunk driving and of riding with a drinking driver.
  - Promote safe driving habits and encourage community education programs to reduce the number of DUI related incidences.
- Increase patrolling police presence in areas that have high rates of DUI based upon results from sobriety checkpoints.
- Create harsher punishments for DUI incidents where the driver was traveling above 30mph, or a speed that would likely prove fatal if a pedestrian or cyclist were hit.

VI. serveokc Indicators

Se.4 Public Utility Service Area

Health-based Rationale

The U.S. population grows with a net gain of one person every 16 seconds, according to the U.S. Department of Commerce, United States Census Bureau. This increasing population, specifically in suburban settings, places traumatic strain on utilities including electric, gas, sewer and water supplies. The unique physical nature of these utilities, create additional hazards for consumers. Utility management can largely affect the health of a community by providing clean water sources and cost-effective utilities. Over usage, underutilization, and inefficient planning of utility management can both mentally and physically harm the community.

The Federal Energy Policy Act (1992) formally defined the term "Integrated Resource Planning" for the U.S. Federal Government and required utilities that purchased electricity from federal power authorities (e.g., Western Area Power Administration) to create an IRP. The Energy Policy Act provides some basic guidelines, but rules and requirements governing long-term electric utility planning activities are mandated by state or local governments and agencies. State-level planning requirements are carried out through legislation, codes, agency requirements, or PUCs who adopt IRP regulations. Today, there are 28 states with formal IRP filing requirements, and 11 other states that have adopted the Long-Term Procurement Plan[283]. As operational costs of doing business increase, costs are transferred to the consumer. These transferred costs can be detrimental to already poverty-stricken communities bringing additional financial burdens, and degrading individual health status.

Cold-related deaths occur mostly through changes in blood pressure and blood chemistry during cold weather, which in turn increase the risk of catastrophic cardio- or cerebra-vascular events such as strokes, myocardial infarctions or pulmonary embolisms[284]. The immune system is also suppressed, increasing the risk of infections[285]. More recently, studies have begun to examine the enduring and potentially cumulative health effects that might be associated with living in cold conditions. These include increased risk of influenza, pneumonia, asthma, arthritis, and accidents at home[286]. Strategic efforts have been made worldwide to combat these health outcomes through programs for low-income housing restorations, energy grants, and public service assistance.

Just as electric utilities incur operational costs, so do water treatment facilities and both private and public water utility companies are causing great concern for equitable access and sanitation of water supplies. The presence of biological, chemical, thermal, and potentially radiological pollution of global water resources effectively reduces the utility of the available water volume and, in the developed nations at least, attention has focused on management of water 'quality' to maximize the 'quantity' of the available resource[287]. A major

[283] Wilkerson, J., et al. (2013) *Survey of Western U.S. electric utility resource plans*. Energy Policy. Retrieved from: http://dx.doi.org/10.1016/j.enpol.2013.11.029i

[284] Crawford, V.L.S., McCann, M., Stout, R.W. (2003). Changes in seasonal deaths from myocardial infarction. *Quarterly Journal of Medicine* 96, 45–52.

[285] Howieson, S.G., Hogan, M. (2005). *Multiple deprivation and excess winter deaths in Scotland. Perspectives in Public Health.* 125, 18–22.

[286] WHO, (2007). *Housing, Energy and Thermal Comfort*. World Health Organization, Copenhagen.

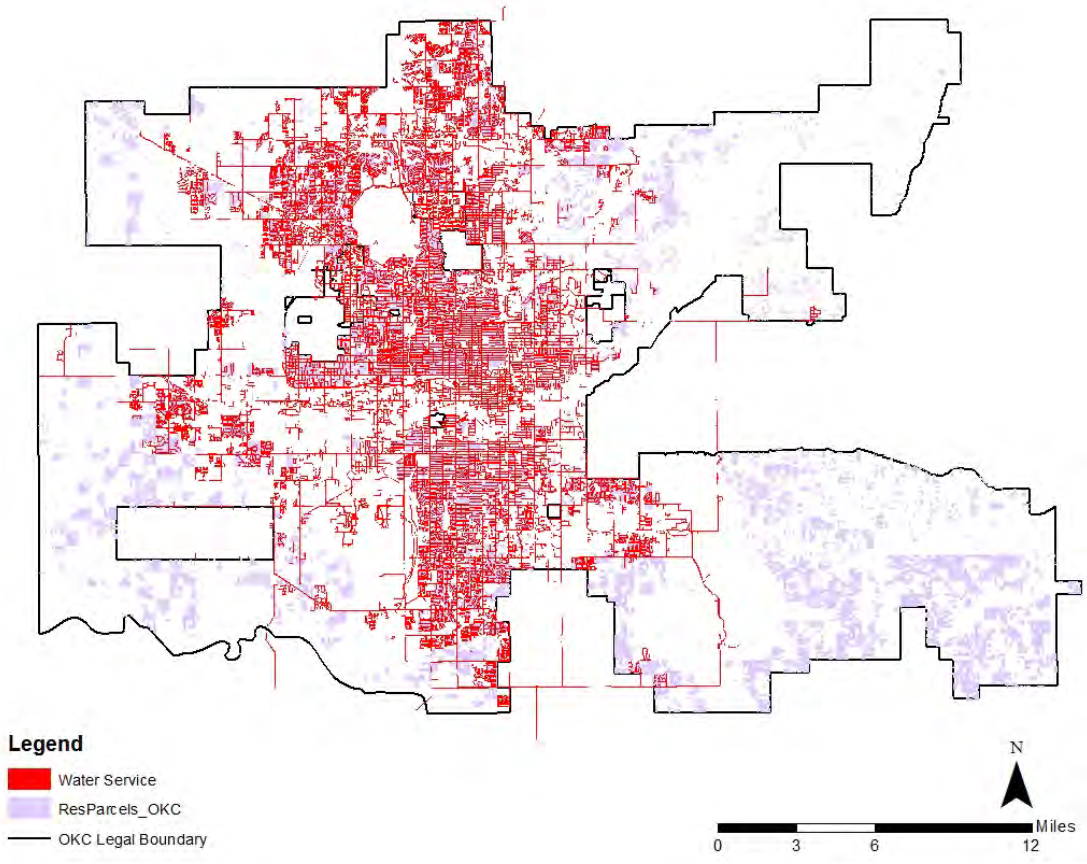
[287] Kay, D. (2009). *Water Management*. International Encyclopedia of Human Geography, 207-214.

health issue could arise, as people confronted with increases in the water price might turn to less expensive but less safe alternatives, such as private groundwater wells of questionable water quality. Affordability concerns are not just linked to tariff levels; they are actually driven by five sets of variables in a given country or area, including:

- Income level and distribution
- Cost of provision in a given country or area
- Subsidy policies
- Tariff policies
- Individual behavior of users in terms of water consumption[288].

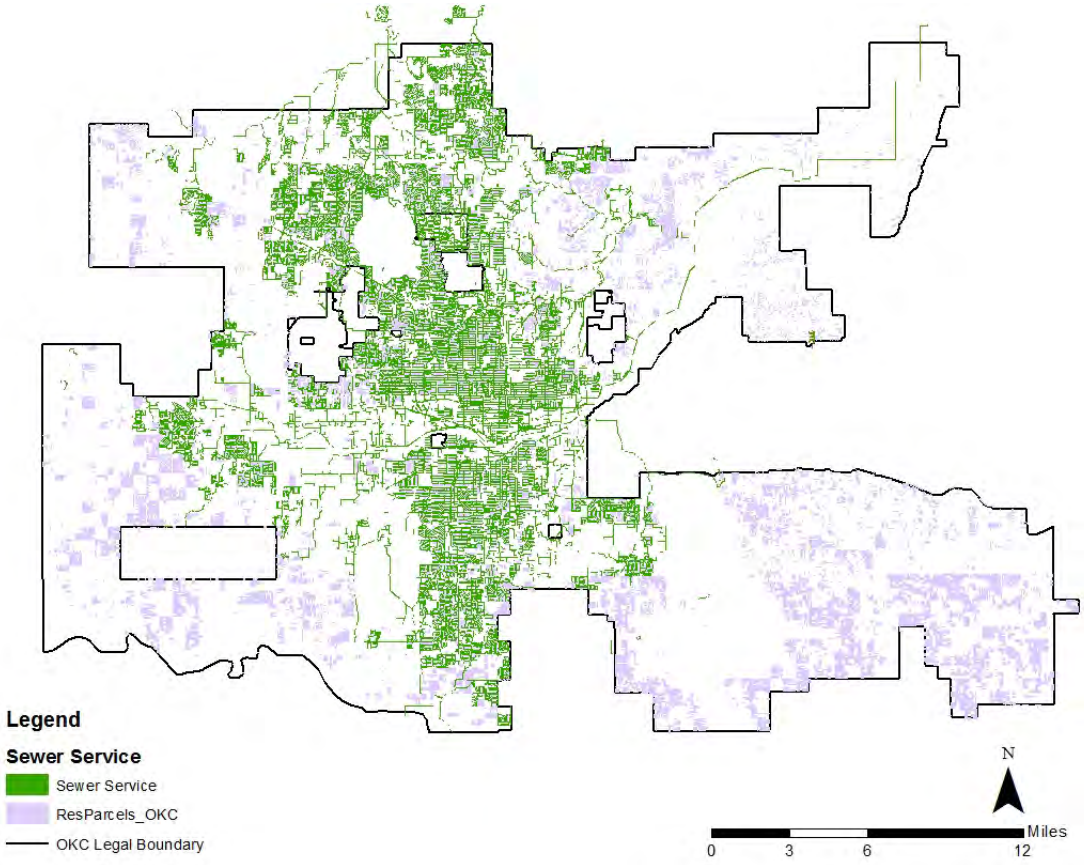
Existing Conditions

The City of Oklahoma City maintains an entirely public water and sewer system. In the water system, there are 7.5 miles of active gravity water main, 2,890.5 miles of active pressurized water main, and 557.8 miles of active secondary water service lines. Additionally, 22,780 water hydrants cover the city. With an increasing population, installation of water service lines will increase, and the installation of mains depends upon the pattern of development. People who live outside of the water utility service area rely on well water to meet their daily needs. Roughly 94% of Oklahoma City households are within the water utility service area.



[288]Europe, U. N. (2013). *The Equitable Access Score-Card.* World Health Organization, Europe.

The sewer system has 2,814.3 miles of active gravity main, 62.7 miles of active pressurized main, and 355.5 miles of lateral sewer lines. Much like the water utility service area, an increase in population will create a need to augment existing sewage systems, and the more compact that population is, the less this augmentation will require. People who live outside of the water utility service area rely on septic tanks and disposal services. Roughly 92% of Oklahoma City households are within the sewer utility service area.



Scenario Analysis

For the scenarios it was necessary to differentiate between future development that would necessitate water and sewer service and that which would not require being connected to the City water and sewer networks. Based upon the City's subdivision regulations[289] [290] [291] [292], projections to the future were then correlated to development patterns run through the Envision Tomorrow tool. This provides a systematic

[289] Where the subdivision is within one-quarter (1/4) mile of the existing or funded City water supply, the applicant shall connect with said water supply system and make it available to each lot within the subdivision. § 5.10.4.B

[290] Where an approved public water supply is not available, the rural subdivision may be served by a private water system or individual water wells. Both private water systems and individual water wells must meet Federal and State Drinking Water Standards. § 5.10.4.D

[291] Where the subdivision is within one-quarter (1/4) mile of an existing or funded City sewer system or an extension of the City sewer system, and within the natural drainage basin of said system, the applicant shall connect with said sewer system and make it available to each lot within the subdivision. § 5.10.5.B

[292] Where an approved public sewer system is not available, individual sewage disposal systems may be used, provided such systems meet all City, County and State Health Standards. Such systems are subject to approval by the State Department of Environmental Quality, and said approval must be submitted prior to a final plat being
submitted to City Council for action. In addition, any special requirements and/or conditions placed on such approval shall be so itemized on the face of the plat. § 5.10.5.D

methodology by which to calculate how much additional mileage would be required in order to meet the needs of all qualified properties.

The table below shows the amount of additional piping that would be required by each scenario, divided by the gauge of piping. This division serves to explain what amount would likely need to be laid by private development entities, and that which would be likely need to be laid by the City.

	2010	2050		2010 - 2050	
	Total	Net Change	Total	Growth Rate	Total % Change
Scenario A					
Water Pipes (=< 12") (Miles)	2,521	839	3,360	0.72%	33.28%
Total Water Pipes (Miles)	2,898	1,163	4,061	0.85%	40.13%
Sewer Pipes (=< 8") (Miles)	2,067	688	2,755	0.72%	33.29%
Total Sewer Pipes (Miles)	2,877	801	3,678	0.62%	27.84%
Scenario B					
Water Pipes (=< 12") (Miles)	2,521	766	3,287	0.67%	30.39%
Total Water Pipes (Miles)	2,898	1,021	3,919	0.76%	35.23%
Sewer Pipes (=< 8") (Miles)	2,067	628	2,695	0.67%	30.38%
Total Sewer Pipes (Miles)	2,877	885	3,762	0.67%	30.76%
Scenario C					
Water Pipes (=< 12") (Miles)	2,521	611	3,132	0.54%	24.24%
Total Water Pipes (Miles)	2,898	677	3,575	0.53%	23.36%
Sewer Pipes (=< 8") (Miles)	2,067	501	2,568	0.54%	24.24%
Total Sewer Pipes (Miles)	2,877	534	3,411	0.43%	18.56%

Conclusions

A) Scenario A requires the greatest length of water lines to be added in order to maintain the level of service of existing conditions. Scenario A requires a greater addition of sewer lines than Scenario C, but less than is required by Scenario B. This is due to the number of properties that do not meet the requirements for connection to existing sewer systems based upon the subdivision regulations, but would still connect to water.

B) Scenario B requires less length of water lines than Scenario A, but a greater length than Scenario C. Scenario B requires the greatest length of additional sewer pipes, particularly large-gauge pipes, which are the responsibility of the City.

C) Scenario C requires the least amount of additional water lines and sewer pipes of all of the three scenarios.

Policy Review

Overview:

As the population of a city grows, so does the demand for public utilities such as water, electric, gas, and even cable services. Considering many necessities such as water and electricity are limited resources, the need for management of public utilities is of the utmost importance. As demand grows, unfortunately, so does the cost of providing these resources to consumers. In lower income households, this often becomes a dilemma;

to provide food for the family or pay the electric bill. As Oklahoma City grows, it is important to address the growing concern for limited resources by maximizing utility system efficiency, minimizing the detrimental appearances of accessory utility equipment and providing public services in the most cost-effective manner through efficient growth.

Relevant Policies:

Enrich.UrbanDesignandForm.634

Strengthen.Place-Making.238

Strengthen.Fiscal Stability.250

Serve.Water and Sewer.536

Serve.Water and Sewer.690

Serve.Water and Sewer.717

Recommendations

- Coordinate with DEQ to find failures of compliance and to enforce strict regulation of septic tanks.
- Locate any new utility pipes under the street or sidewalk to ensure that street trees and other vegetative elements can be planted in the right-of-way.
- Require all new utility lines to be buried and bury existing utility lines when possible.

VI. serveokc Indicators

Se.5 Rate of Recycling and Proximity of Recycling Locations to Residential

Health-based Rationale

The concept of recycling is to reduce, reuse, and re-cycle domestic goods in order to create *more* goods with little reoccurring waste. For many countries, recycling serves as an environmentally efficient substitute for increasingly costly dumps, landfills, and incinerators. Unfortunately, the aftermath of breaking down physical components of a product and changing their physical composition into a new or different product, may be very cumbersome on not only the environment, but also plants, animals, and people. As one would expect, there is an increased risk of health disparity related to occupational health hazards, but risks are involved for residential and commercial communities as well.

Several reports have indicated that waste sorting and recycling is associated with occupational health problems such as pulmonary diseases, gastrointestinal symptoms, mucous membrane, skin problems, and musculoskeletal disorders[293][294][295][296][297]. A study of occupational health problems related to sorting and recycling of domestic waste finds disorders and gastrointestinal problems. High concentrations of total airborne dust, bacteria, fecal coliform bacteria and fungal spores have been reported. The concentrations are considered to be sufficiently high to cause adverse health effects. In addition, a high incidence of lower back injuries, probably due to heavy lifting during work, has been reported among workers at landfills and incineration plants[298]. A more recent study reports that workers involved in scrap metal recycling have the potential for exposure to ergonomic hazards, noise, dusts and fumes, and powerful machinery[299]. These hazards are then passed on to consumers and residential areas by wind, rain, water supplies, and other natural elements. While the study of metal and industrial recycling has found health implications, other recycling techniques may be less harmful. There are no indications that recycled paper creates any harm to human beings resulting from contamination by pathogens, chemicals (e.g. formaldehyde dioxins and furans) or heavy metals (e.g. lead)[300]; leaving only a lessened carbon footprint from paper manufacturers.

As the US has progressed towards recycling, it becomes more important to identify what municipal recycling rate is socially acceptable. Recycling targets in the United States are set at the state level and vary across states[301]. By taking into consideration municipal collection and disposal costs, household recycling

[293] Boutin, P., Moline, J. (1986). *Health and safety aspects of compost preparations and use*. In Proc. of Compost: Production, Quality and Use, Italy, pp. 198-209.
[294] Malmros, P., K. et al. (1990). *Problems with the Working Environment in Solid Waste Treatment*. At-Rapport Nr. 10/1990, Arbejdstilsynet, Kobenhavn, pp. l-27.
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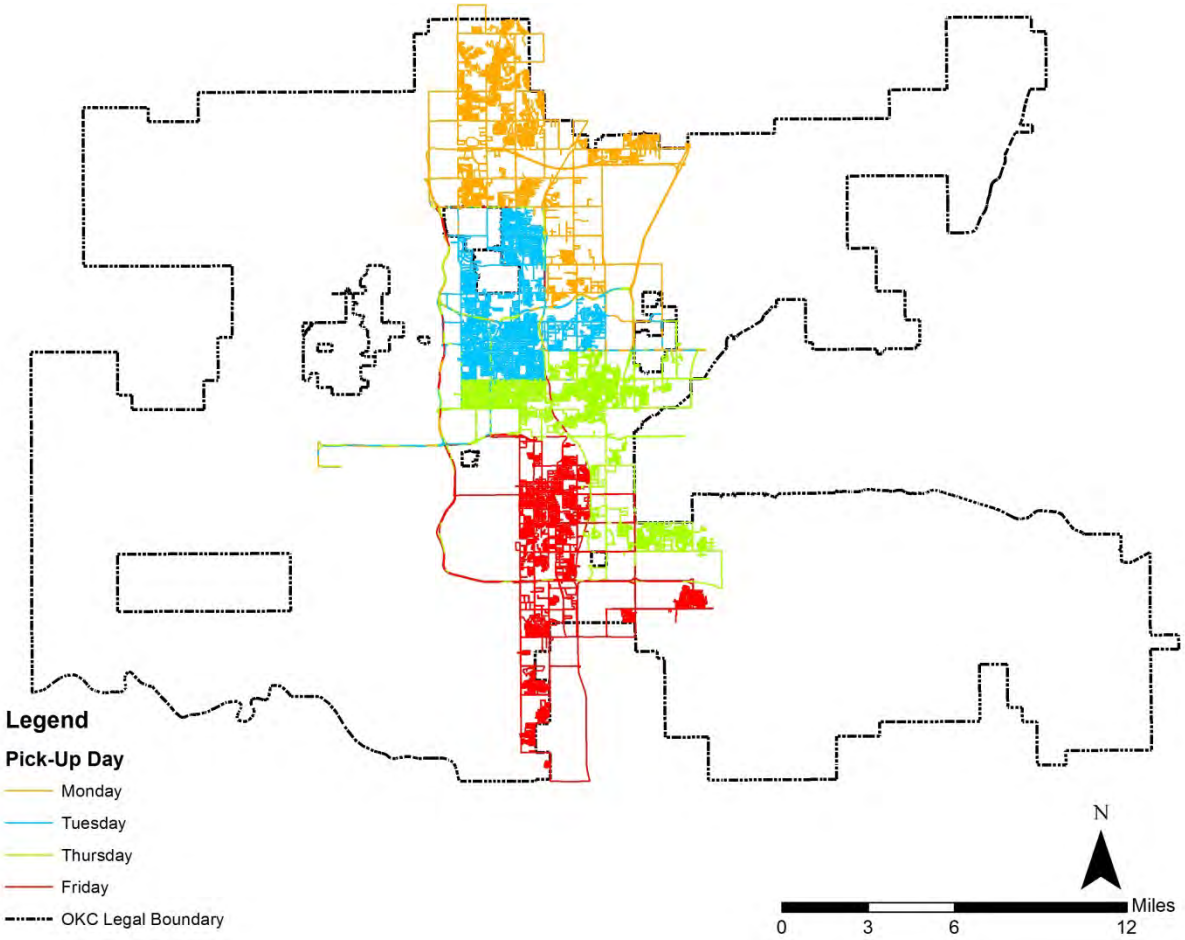
[298] Poulsen, O.M., et al. (1995). Collection of domestic waste. Review of occupational health problems and their possible causes. *Sci. Total Environ*., (in press).
[299] Neitzel, R. C. (2013). A mixed-methods evaluation of health and safety hazards at a scrap metal. *Safety Science*, 432-440.
[300] Bajpai, P. (2014). *Recycling and Deinking of Recovered Paper.* Patiala, India: Pulp and Paper, Consultant
[301] Kinnaman, T. (2013). *Determining the socially optimal recycling rate*. Resources, Conservation and Recycling

costs, external costs and external benefits, a recent study conducted by Kinnaman, et al. (2012), determined an optimal recycling rate of 36%[302].

Existing Conditions

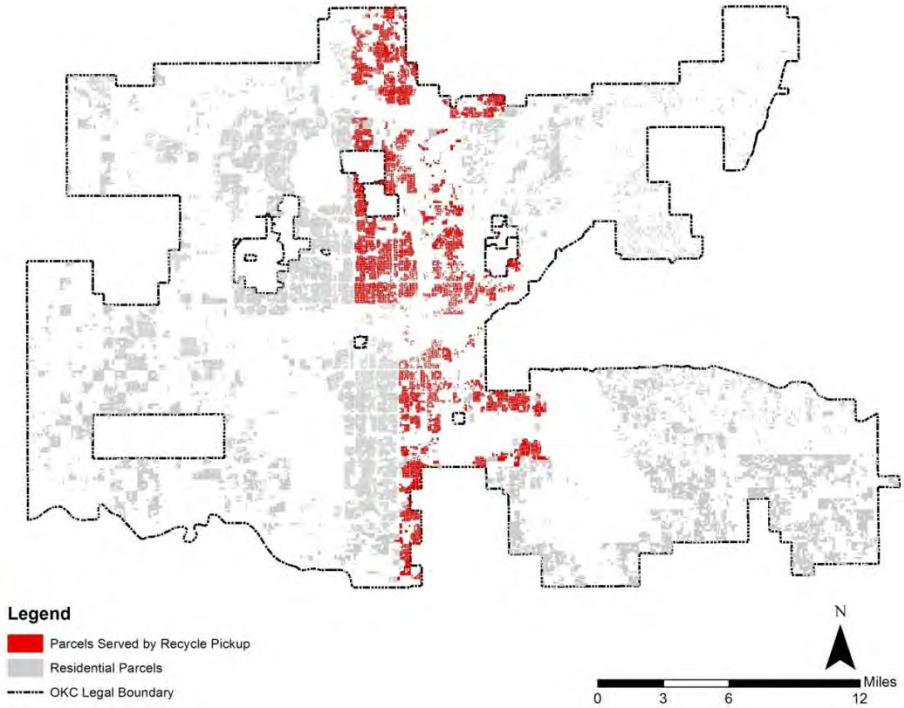
The Solid Waste Department for the City of Oklahoma City contracts the collection of recycling to Recycle America (a subsidiary of Waste Management) for non-commercial properties, excluding multi-family residential above duplex/triplex-style homes. This service area is comprised of 92 routes that are traversed on Monday, Tuesday, Thursday or Friday every week. Last fiscal year 8,672 tons of recycling was collected, equating to a 3.1% diversion rate (waste diverted from landfills).



This route structure provides a service area for around 72,500 households in Oklahoma City, or 29.1% of the total population. This figure is derived by removing any multi-family residential parcels from the data to include just single-family, duplex and triplex homes, as these are the only style homes serviced. Presently, the set-out rate is around 25%, meaning that on any given day roughly 25% of eligible households will have their bins at the curb for pick-up, roughly 7.3% of all households in Oklahoma City. If the Solid Waste Department did not discriminate by housing type, the number of potential households served by this route structure would rise to 102,717 households, or 41% of the total population. This figure represents the ideal scenario where all households that can utilize the recycling service do utilize it; unfortunately data regarding the actual rate of usage is not available.

[302] Kinnaman TC, Shinkuma T, Yamamoto M. (2012). *The socially optimal recycling rate: evidence from Japan.* Working Paper; Bucknell University.

Below you can see the large swaths of residential areas that presently are not serviced by the recycling program. In particular, if the service area in the south of the city were extended west to Will Rogers airport, a much greater percentage of residents would have the option to have recycling picked up from their homes.



In addition to publicly-offered services, there are private recycling facilities located around the city. The DEQ website provides a list of dozens of locations to recycle metal, paper, auto parts and more within Oklahoma County, 34 of which fall within the Oklahoma City municipal boundary[303]. These 34 locations provide recycling services for a variety of materials, but many are specific to single types; in particular Pep Boys and Valvoline's locations only recycle motor oil, which does provide a service that is beneficial to the environment and personal health, but is very one dimensional in its impact.

Recycling Locations in Oklahoma City		
Recycling Station Location	**Address**	**Materials**
C & J Metals	1905 S Eastern Ave.	ABC, AL, BR, CP, SC, SS, Lead BAT, Auto Radio
Central Oklahoma Oil & Lube	8324 Candlewood Dr.	UO
Corrugated Services	7216 S Bryant Ave.	OCC, ABC, TC, Mixed Paper
Derichebourg Recycling	100 N Bath Ave.	AP, ABC, AL, Br, CP, CS, MT
Habitat Renovation Station	1800 N. Broadway Ave.	Construction materials, carpet, furniture, appliances, cars
Haskell Lemon Construction	6401 SW 15th St.	Shingles
Haskell Lemon Construction	1400 NE 2nd St.	Shingles
Hite Plastics	7637 NW 3rd St.	PL
Homeland Store #122	6473 N. MacArthur Blvd.	ABC

[303] Department of Environmental Quality - Oklahoma. (n.d.).*Oklahoma county recyclers*. Retrieved from https://www.deq.state.ok.us/lpdnew/recyclers/recyclers_oklahoma.html

Homeland Store #206	11120 N. Rockwell Ave.	ABC
Hunter's Battery Warehouse	514 SW 25th St.	BAT
IFCO	2211 S May Ave.	Pallets
Integrity Metals	1101 E Reno Ave.	BAT, MT, TC, AL, OCT
Oklahoma Goodwill Industries	316 S Blackwelder Ave.	ABC, OCC, OFP, GL, PL, AL, BAT, and TC, clothes, books, MT, TB
Pep Boys	7600 S Walker Ave.	UO
Pep Boys	2317 W Memorial Rd.	UO
Pep Boys	7401 NW Expressway	UO
Quik Service Steel Co.	1948 SE 44th St.	ABC
Recyclers of Oklahoma/Nova Star Recycling	1931 S Penn Ave.	AL, ABC, SS, BR, BC, CR, PB, BAT-Car only, electronics
Recyclers of Oklahoma/Nova Star Recycling	3550 Newcastle Rd.	AL, ABC, SS, BR, BC, CR, PB, BAT-Car only, electronics
Red Earth Recycling	923 SW 4th St.	ABC, BAT, Books, BKB, Carpet, Electronics, Cooking oil, OCC, CPO, MT, WOFP, TB, PL, TO
Republic Services - AWS of Central/Western OK	7540 SW 59th St.	OCC, WOFP, PL, TC, ABC
Select Recycling	7005 W Wilshire Blvd	ABC, AL, BR, CP, CS, Appliances, Electronics, BAT
Standard Iron & Metal Co. Inc.	1501 E Reno Ave.	MT, AL, ABC, SR, CR, AR, BAT
Swick Alternators & Starters	1300 NE 23rd St.	AP
Taylor Foam/P.S. Foam	370 N Rockwell Ave.	FP
Valvoline Instant Oil Change	3924 N Meridian Ave.	UO
Valvoline Instant Oil Change	2801 N MacArthur Blvd.	UO
Valvoline Instant Oil Change	6704 S Western Ave.	UO
Valvoline Instant Oil Change	2651 W Britton Rd.	UO
Valvoline Instant Oil Change	1308 Cornell Parkway	UO
Valvoline Instant Oil Change	2909 NW 63rd St.	UO
Vantage Point Asset Solutions LLC.	4020 Will Rogers Pkwy.	Electronics
Waste Management Recycle America	5519 NW 4th St.	WOFP, PB, OCC, PL, ABC, SC, GL, electronics

Legend

ABC – Aluminum Beverage Container
AF – Anti-Freeze
Al– Aluminum
AP – Auto Parts
AR– Auto Radiators
ATF-Automatic Transmission Fluid
BAT – Battery
BKB – Brown Kraft Paper Bags
BR – Brass
FP – Foam Pad
CPO – Computer Printout Paper
CR – Copper
CTS – Clothes and Shoes
FL – Fishing Line
GL – Glass
HBB – Hard Back Books
Hg - Mercury
MT – Metal
F- Ferrous Metal
NFM - Non-Ferrous Metal
OCC – Corrugated Cardboard
OCT - Old Car Tags
OFP – Office Paper
OMG – Magazines
ONP – News Paper
Pb– Lead
PL – Plastic
SC – Clean Steel
SS – Stainless Steel
TB – Telephone Books
TC – Tin Cans
TO – Toner Cartridges
UO – Motor Oil
WCD – Wood Chips
WD – Wood
WG – White Goods-Metal appliances regardless of color
WOFP – White Office Paper
YW – Yard Waste

Around 49,500 households live within one mile of a recycling location, or roughly 7% of the households in Oklahoma City. The impact of this proximity to residential properties has positive and negative attributes: on the one hand, these residents have a more convenient location to recycle in proximity to their homes, but on the other hand, there are environmental risks by living close to an industrial use. Some of these locations accept recycling materials not allowed by the Waste Management pick-up service where cardboard, Styrofoam, batteries, e-cycling, household hazardous wastes and tires are not accepted.

Scenario Analysis

In order to compare the three scenarios total population numbers from polygrids that fall within the existing service area of recycle pick-up were compared. There are formulae with regard to the number of housing units per street that would cause the service area to change, but this level of detail is not achievable with the polygrid scale of Envision Tomorrow; thusly, it is sufficiently accurate to compare the population from the same number of polygrids from each of the three scenarios. The table below shows the number of households that would be serviceable by the existing pick-up routes, as well as the percentage of total households as compared to existing conditions. Using the housing ratios for each scenario allowed for a more accurate look the households that would be suitable for current service standards; i.e. non-multi-family residential units.

Households Serviceable by Recycle Pick-Up (No Multi-Family)				
	Existing	**Scenario A**	**Scenario B**	**Scenario C**
Number of Households Served	72,500	102,790	107,649	123,890
Percentage of Total Households	29.1%	28.8%	30.2%	34.7%
Percent Change from Existing	N/A	- 0.3%	+ 1.1%	+ 5.6%

Due to the denser pattern of development in Scenario C, we see a significant improvement in the number and percentage of households that would have access to recycle pick-up services, despite a higher multi-family rate than Scenario A. All three of the scenarios have lower rates of multi-family residential than existing conditions; therefore, the development patterns play less of an important role than if the percentages were held constant from existing to the new scenarios. The table below shows the figures if multi-family were included in the analysis. Scenario A becomes less efficient, as does Scenario B, but Scenario C actually improves further upon existing conditions when all residential housing types are included.

Households Serviceable by Recycle Pick-Up (All Residential)				
	Existing	**Scenario A**	**Scenario B**	**Scenario C**
Number of Households Served	102,717	131,782	145,472	167,432
Percentage of Total Households	41%	36.9%	40.8%	46.9%
Percent Change from Existing	N/A	- 4.1%	- 0.2%	+ 5.9%

In order to maintain the current level of service (potential level of service if multi-family homes were serviced) for Scenario A, recycle trucks would have to drive greater distances, or new trucks and routes would need to be added to the service. This would cause health impacts in the form of air quality, noise pollution, plus the side-effects of the additional monetary costs required to finance the growth of the operation.

Caveat:

Higher numbers of people within the service area only shows the potential number of households who may recycle. Promotion of services is more likely to be an effective measure at increasing rates.

Conclusions

A) Scenario A would lower the percentage of the total population with access to existing recycling services due to the sprawling pattern of development. Any adaptation of the recycle pick-up service to accommodate this pattern would be more expensive than that which would be required in Scenario B or C.

B) Scenario B barely changes the percentage of the total population with access to existing recycling services. Scenario B performs better than Scenario A and worse than Scenario C.

C) Scenario C would significantly increase the percentage of the population with access to existing recycling services. Any increase in the service area of the recycle pick-up would have the greatest positive impact in Scenario C as the denser development pattern locates the majority of residents in close proximity to the existing service area.

Policy Review

Overview:

Recycling and composting allows Oklahoma City residents to participate in a greener environment. The proximity of a recycling location to a housing development or business may encourage or hinder consistent use. In order to encourage recycling Oklahoma City can actively participate in, and support the development and completion of, the long-range solid waste flow and disposal plan, incorporate applicable recommendations and policies, and coordinate with the county extension offices and neighboring jurisdictions to improve the public outreach campaign about the benefits of backyard composting.

Relevant Policies:

Serve.Solid Waste and Recycle.**538**

Serve.Solid Waste and Recycle.**539**

Sustain.Land Use Patterns.**252**

Recommendations

- Increase recycling service to include multi-family housing within serviced areas.
- Increase recycling service to include businesses within serviced areas.
- Expand the service area in the city to include areas not currently served.

- Actively participate in, and support recommendations that are consistent with the comprehensive plan for the long-range solid waste flow and disposal plan. Ensure robust vetting with other departments and citizen oversight.
- Promote recycling habits and encourage community education programs to increase the usage of recycling programs within the city.
    - Merge public outreach efforts of all relevant City departments. (Office of Sustainability, Solid Waste, etc.)
- Design performance-based incentives tailored to specific land uses for the regulation of waste and waste products.
- Create a new design for recycling bins such that they are more usable by seniors and the disabled; i.e. with wheels, a lid, etc.
- Create interactive "Beyond the Bin" online material that explains where residents can take specific types of recyclables for processing.

liveokc indicators

L.1 Proportion of Population within a 10-Minute Walk of Public Schools

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What proportion of the population lives within a 10-minute walk of school?	GIS school proximity mapping data	Physical activity; cohesive community; safety; vehicle collisions	Obesity; depression; disability; death

L.2 Proportion of Population with Access to Healthy Groceries

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What proportion of the population has access to healthy groceries?	GIS proximity data; NEMS	Healthy choices; Number of options	Diet-related disease; obesity; local business success/failure

L.3 Residential Density

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What is the residential density of Oklahoma City?	Census data	Sprawl; physical activity; air quality; global warming; isolation	Obesity; chronic disease; respiratory disease; birth defects; infectious disease; depression; mental health

L.4 Isolation Index of Vulnerable Populations

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What is the isolation index of select vulnerable populations?	Social statistics; survey results	Social isolation vs. connectedness; teenage birth; drug use	Anxiety; hostility; stress; pessimism; weakened immune system; loneliness; life expectancy; stress; suicide

L.5 Rate and Concentration of Gang Activity

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
Where is gang activity occurring, and to what degree?	CDC data; Police GIS data; Oklahoma Gang Investigators Association	Violence; illegal enterprise (drugs, prostitution, etc.); unsafe neighborhoods	Mortality; addiction symptoms; suicide; depression; stress; anxiety

L.6 Percentage of Population within 1 Mile of a Healthcare Facility

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What percentage of the population lives in proximity to a healthcare facility?	GIS land use and population data	Access to healthcare; untreated medical conditions	Disease; disability; premature death

VII. liveokc Indicators

L.1 Proportion of Population Within a 10-Minute Walk of Public Schools

Health-based Rational

Physical activity is needed for healthy growth and development and can track into adulthood thus preventing chronic diseases[304] [305]. Overweight and obesity during childhood increase the risk for a number of adverse health conditions including type 2 diabetes[306], high cholesterol levels, cardiovascular complications[307] [308], cancer[309], and unfavorable musculoskeletal conditions[310]. Walkability studies for elementary school children generally focus on walking to school, which has consistently been negatively associated with distance[311] [312] [313], and positively associated with population density[314] [315] [316] [317] [318] [319].

In the context of increasing prevalence of obesity and overweight in children and youth[320], the consideration of active school transport (AST) as an important and utilitarian source of physical activity is of interest. Children who walk to school are more physically active than children who are driven[321]. However, there has been a consistent decline in the use of active modes (i.e., walking, biking) to and from school

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observed in western nations[322]. Active transportation to school, including walking, incorporates physical activity into daily routines, reduces risk of childhood obesity[323], and alleviates automobile congestion and traffic-related air and noise pollution[324]. Walking and biking provide a reliable and affordable form of transport for most segments of the population[325]. It has also been estimated that the benefits (e.g., improved health, reduced noise and air pollution) of investments in infrastructure for walking and biking are 4–5 times larger than the associated costs and concluded that such investments are more beneficial to society than automobile-related transport investments[326]. Regarding density, compact neighborhoods may encourage non-motorized travel and reduce single occupant vehicle (SOV) travel by bringing origins and destinations closer together. Moreover, compact neighborhoods could increase non-motorized travel in other ways such as having greater land use mix, less parking, and improved transit level of service[327]

Associations with land use, pedestrian infrastructure and connectivity have been inconsistent and often contradictory to findings in adult studies[328] [329]. Additionally, although the phenomenon of children from low-SES backgrounds walking to/from school more often appears beneficial from a cardiovascular health perspective, they are also more likely to be exposed to danger and more likely to be harmed while walking to school[330] [331] [332] [333] [334]. This social inequality can be regarded as a form of environmental injustice, which is defined as the disproportionate exposure to and burden harmful environmental conditions experienced by low-income populations[335].

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Existing Conditions

Living within a 10-minute walk of a school gives children an opportunity to make a manageable walk to school. Additionally, access to schools can serve as access to recreational facilities after school hours if the school allows access.

Oklahoma City has over 175 elementary, middle, high and vocational schools within its boundaries. 76% of these schools are public, 18% are private, and 6% are charter schools. This percentage is fairly standard compared to the rest of the country, where 25% of schools are private, and 5% of schools are charter schools[336] [337]. Several of the schools (particularly the private schools) are not strictly elementary, middle, or high schools, but are a combination of two or all three school types.

Schools of Oklahoma City			
Public	**Number**	**Urban**	**Rural**
Elementary Schools	96	86	10
Middle Schools	26	24	2
High Schools	20	18	2
Vocational Schools	9	9	0
Non-Public	**Number**	**Urban**	**Rural**
Elementary Schools	35	28	7
Middle Schools	30	24	6
High Schools	23	17	6

These schools are distributed reasonably evenly around the city in terms of geography, but looking at their location relative to number of households per Census tract [see Fig. 1] reveals a discrepancy between household number and school location. Particularly in the outer regions of the city there is a lack of schools while there are several thousand households. This implies that a great deal of driving in necessary to get all of the students to school, whether that means greater distances for school busses to travel or that parents have to drive their children to school. In fact, of the 142 public schools documented in this study, only 12 are outside of the urban boundary in rural areas, and of those 12 schools, only 505 households are within half of a mile, serving a measly 1,263 individuals. Compare that to the 130 public schools within the urban boundary that service 50,636 households and 126,590 individuals. This would be reasonable, except that roughly 8% of the Oklahoma City population lives outside the urban boundary, and less than 3% of those households are within a half-mile of a school.

Percentage of Households within ½-mile of public schools			
Area	**Number of Schools**	**Total Households/Served**	**% of Households Served**
Urban	130	230,149/50,636	22%
Rural	12	19,080/550	2.9%
Citywide	142	249,226/51,186	20.5%

[336] Council for American Private Education. (n.d.). *Facts and studies*. Retrieved from http://www.capenet.org/facts.html
[337] Institution for Education Sciences. (n.d.). *Fast facts*. Retrieved from http://nces.ed.gov/fastfacts/display.asp?id=30

If you add in the private and charter schools for the city the numbers for the urban, rural and citywide areas increase, but the rural figure remains at a very small amount. Families in rural areas must make decisions about whether to homeschool or drive long distances so that their children can attend school.

Percentage of Households within ½-mile of public, private or charter schools			
Area	**Number of Schools**	**Total Households/Served**	**% of Households Served**
Urban	168	230,149/60,408	26.2%
Rural	18	19,080/1,036	5.4%
Citywide	186	249,226/61,444	24.7%

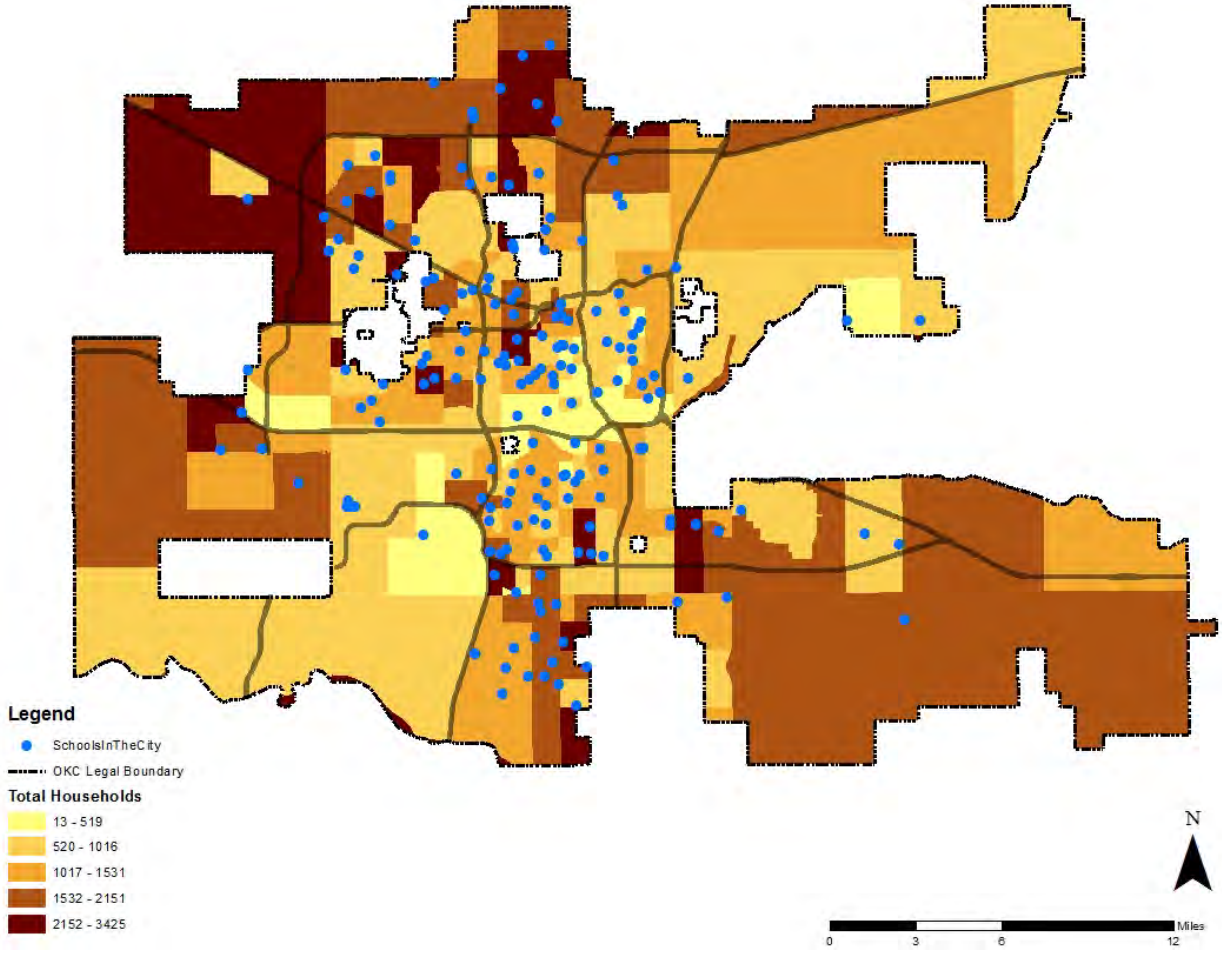

Figure 28: Schools and Household by Census Tract

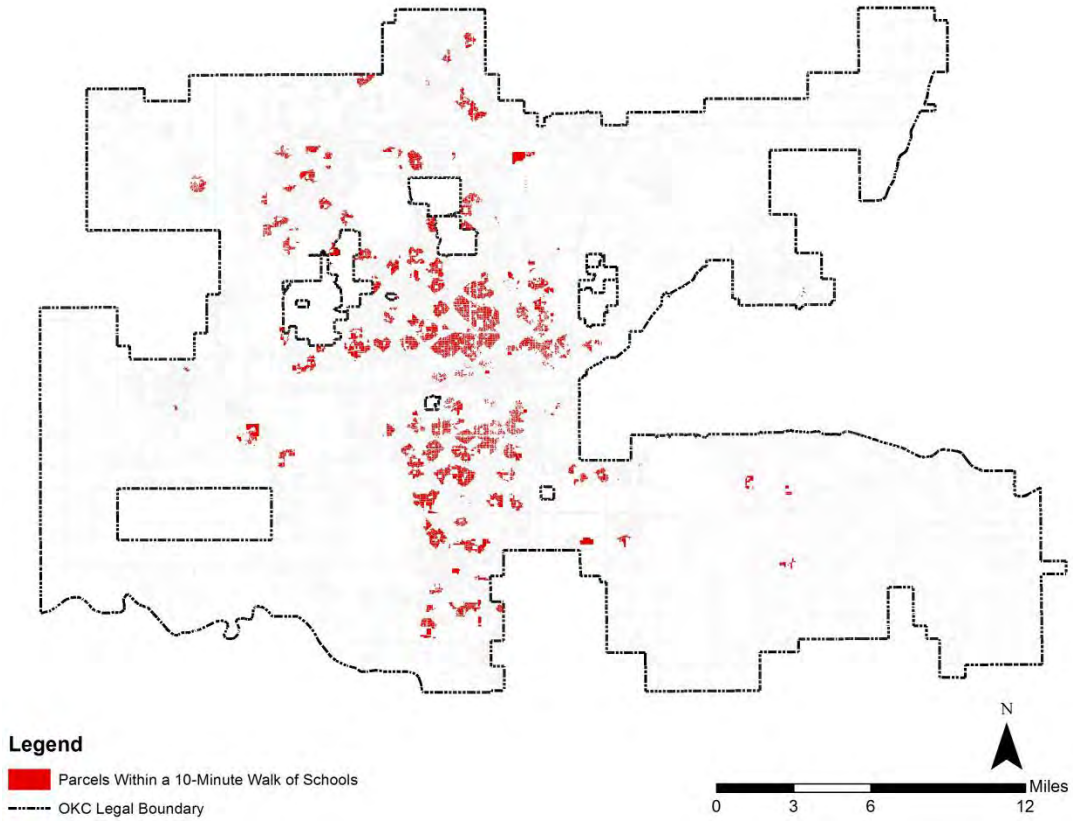

Figure 29: Residential Parcels within a 10-Minute Walk of Schools

Scenario Analysis

As there is no current plan in place for where to place future schools, the scenarios were each compared to the existing schools to determine what impact would be felt based upon each of the three development patterns. Therefore, service areas that were determined for each school in the existing conditions analysis were transposed over the poly grids for each of the three scenarios to reveal future population within a 10-minute walk of public schools as well as all schools (private, public, charter, etc.). The table below shows the resultant comparison of the three scenarios:

Number and Percent of Households Within a 10-Minute Walk | Scenario Analysis				
	Existing	**Scenario A**	**Scenario B**	**Scenario C**
Public Schools 10-Minute Walk	51,186	42,340	47,836	53,588
Percent of Total Population	*20.5%*	*11.9%*	*13.4%*	*15.1%*
All Schools 10-Minute Walk	61,444	49,768	56,084	63,224
Percent of Total Population	*24.7%*	*14%*	*15.7%*	*17.7%*

These figures are troubling due to the fact that all three scenarios decrease the overall percentage of the population within a 10-minute walk of a public school, though Scenario C does increase the total number of households within a 10-minute walk. With the addition of new schools to meet population increase, this discrepancy made dissolve.

Caveat: Parcels that have high numbers of residential units such as apartment complexes can skew the relationship between the scenarios and existing conditions as the scenarios evenly spread population over poly grids, which are geometric areas that are significantly larger than the average parcel.

Conclusions

A) Under Scenario A there is a steep decline in the number and percentage of households that would live within a 10-minute walk of a school as compared to existing conditions. Scenario A has the lowest figures and percentages when compared with Scenario B and C.

B) Under Scenario B both the number and percentage of households that would live within a 10-minute walk of a school decline, but not as much as in Scenario A. Scenario B performs better than Scenario A in all categories, but not as well as Scenario C.

C) Under Scenario C the total number of households that live within a 10-minute walk of a school increases when compared to existing conditions; however, the percentage of total population within a 10-minute walk decreases based upon the scenario population numbers. Scenario C performs better than Scenario A and B in all categories.

Policy Review

Overview:

Families and individual can benefit from residential locations near public schools. When homes are located near public schools potential exists for increased recreational activities for children such as walking or biking to school which can positively affect health disparities, encourage school attendance, and reduce the economic footprint from additional car admissions. Individuals without children can also benefit from living near a public school from a community perspective. Many schools open facilities to the public, such as outdoor gym equipment and running paths for after-school use. Oklahoma City can help residents make healthy decisions by increasing the number of joint-use agreements that allow community access to school recreational facilities outside of school hours and establishing pedestrian linkages connecting residential areas to nearby parks, schools, churches, and retail opportunities. In addition, Oklahoma City can focus on creating opportunities for more income diversity and mixed-income neighborhoods near public schools or proposed school sites.

Relevant Policies:

Live.Neighborhood Safety.423

Live..Schools.425

Enrich.Urban Design and Form. 627

Play.Accessibility and Use.371

Play. Accesibility and Use.373

Strengthen.Employment and Opportunity.173

Connect.Transportation Systems.172

Connect.Sidewalks.207

Live.Housing.457

Recommendations

- Ensure all new large communities that are developed have a public elementary school by having developers pay a fee for the construction of a local school.
- Address perception of Oklahoma City School District to encourage families to live nearer to city center rather than moving to the edge of the city or surrounding municipalities.
- Continue and increase focus on improving sidewalk and bicycle infrastructure to and from schools, particularly those with recreation facilities.
- Establish a working relationship with all schools with recreation facilities to uphold the meaning of the joint-use agreements allowing community members to utilize said facilities.
- Disallow the building of any new schools within a hazardous distance of a high-traffic road to mitigate the risks of childhood asthma as a result of high concentrations of airborne particulate matter.
    - Retrofit schools within a hazardous distance of a high-traffic road with robust HVAC systems that will sufficiently filter the incoming air.
        - Make use of vegetation around outdoor recreation facilities to mitigate the risks of airborne particulate matter.

VII. liveokc Indicators

L.2 Proportion of Population with Access to Healthy Groceries

Health-based Rationale

A household's food intake depends on a many factors including access, availability of options, quality of goods, availability of transportation, cost, to name a few. Often, detrimental factors to obtaining healthy food choices are not limited to only urban communities; further research has determined detrimental factors also affect the disabled population, single-parent households, and targeted ethnic groups. It has been well established that food intake directly affects individual health, either positively or negatively.

People living in low-income neighborhoods have been found to have limited access to fresh produce[338] and tend to rely on convenience stores to purchase foods[339]. In a study designed to address environmental barriers for disabled individuals, findings suggest persons with mobility impairments face many levels of environmental barriers for maintaining a healthy lifestyle, more so than the able-bodied population. Physical accessibility of grocery stores is the first level of barriers. Secondly, poverty being prevalent in the disabled population[340] places them in low-income neighborhoods, and grocery stores and convenience stores in these areas have limited availability of healthy food choices for all residents. All these barriers further exacerbate the prevention of obesity in the disabled population[341].

The diversity and proximity of retail food outlets—and products, promotions, placement, and prices within those stores[342] —may influence health-relevant food shopping behaviors and dietary patterns[343]. Ample research points to socioeconomic differences in local food retail environments[344] [345] [346] [347] [348]. Poorer neighborhoods and those with a higher proportion of African-American residents often have fewer supermarkets[349] and more fast food outlets[350] [351], a more restricted selection of healthful options[352] [353], and

[338] Zenk SN, Schulz AJ, Hollis-Neely T, et al. (2005). Fruit and vegetable intake in African Americans income and store characteristics. *Am. J. Prev. Med.* 29, 1-9.
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higher prices[354]. In addition, single parents are heavier consumers of time-saving choices such as ready-to-eat food and fast-food restaurants[355]. Clearly, healthful foods remain unequally distributed in this urban setting as they are elsewhere[356] [357].

Recent studies have identified socially distressed neighborhoods with poor access to healthy food as 'food deserts'[358] [359]. When healthy foods like fruits and vegetables are not locally available, many people shop at 'convenience' stores where food is typically more expensive and less healthy (processed, higher in fats and sugars)[360]. Food deserts have emerged as a critical public health issue, as a healthy diet is linked to reduced risk of many chronic diseases, including heart disease, stroke, hypertension, type 2 diabetes, and certain cancers[361] [362] [363].

Regionally, food prices co-vary with obesity rates[364]. Obesity is associated with diabetes, high blood pressure, high cholesterol, arthritis, and poor health status[365]. Lower fruit and vegetable prices are associated with lower body weight among low-income populations[366] [367] and larger food budgets are associated with higher nutrient intake[368] [369]. Regions with lower prices for dark green vegetables and milk tend to have

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[351] Beydoun MA, Powell LM, Wang YF. (2008). The association of fast food, fruit and vegetable prices with dietary intakes among U.S. adults: is there modification by family income? *Soc. Sci. Med.* 66(11), 2218–2229.
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[366] Powell, L.M., Chaloupka, F.J. (2009). Food prices and obesity: evidence and policy implications for taxes and subsidies. *Milbank Quarterly* 87 (1), 229–257.
[367] Powell, L.M., Chirqui, J.F., Kahn, T., Wada, R., Chaloupka, F.J. (2013). Assessing the potential effectiveness of food and beverage taxes and subsidies for improving public health: a systematic review of prices, demand and body weight outcomes. *Obesity Review* 14 (2), 110–128.
[368] Monsivais, P., Aggarwal, A., Drewnowski, A. (2011). Following federal guidelines to increase nutrient consumption may lead to higher food costs for consumers. *Health Affairs (Millwood)* 30 (8), 1471–1477.
[369] Aggarwal, A., Monsivais, P., Drewnowski, A. (2012). Nutrient intakes linked to better health outcomes are associated with higher diet costs in the US. *Public Library of Science* 7 (5), 237533.

relatively low child body-mass index (BMI); low-income households exhibit the highest price sensitivity for these items[370]. Adolescents in the highest quintile for BMI tend to come from lower-income households who, again, exhibit the highest sensitivity to food prices[371].

Existing Conditions

Defining "healthy foods" is a challenge. For this study, where it is important to determine who has access to healthy foods, only grocery stores were included, as these are most indicative of locations where people purchase meat and produce. However, simply having access to a grocery store does not mean that a person has access to healthy options. A store may only carry low-quality food stuffs, or may charge a much higher amount for organic or healthier options. In order to account for this discrepancy, the NEMS-S[372] [373] (Nutritional Environment Measures Survey – Supermarkets) evaluation tool provided a solid metric by which to compare the quality of all of the major grocery stores in Oklahoma City. This, combined with a service area of 1 mile gives a better understanding of those in the city who have access to healthy foods, access to food that is not necessarily healthy, and those that have very little access to food whatsoever.

The NEMS-S rating system scores on a scale of 0 to 50, with 50 being the highest possible score. In Oklahoma City the range of NEMS-S scores is from 15 to 43, with a mean of 33.4 points. 19 stores scored 33 or below, and 26 scored 34 or above. Below is a comparative scoring of different areas within and around the Oklahoma City city limits.

Location	Number of Stores	Avg. Score
Oklahoma City	45	33.4
South of the Oklahoma River	12	33.6
East of I-235	2	24
Bethany/Warr Acres	4	40.8
Midwest City	7	33.8
Edmond	8	38

The area of Oklahoma City east of I-235 is often referred to as a food desert. This is supported by the figure above; there are fewer grocery stores in this area, and those that are do not score well when it comes to affordable healthy foods.

[370] Wendt, M., Todd, J.E. (2011). *The Effect of Food and Beverage Prices on Children's Weights. Economic Information Bulletin* No. (EIB-118) 29, Economic Research Service, U.S. Department of Agriculture. Last accessed August 2012 from ⟨http://ers.usda.gov/publications/err-economic-research-report/err118.aspx⟩.

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[372] Culver, K. (2013). NEMS-S Survey Data of Oklahoma County Supermarkets. Oklahoma City: Oklahoma City-County Health Department.

[373] Glanz K., Sallis J.F., Saelens B.E., Frank L.D. Nutrition Environment Measures Survey in Stores (NEMS-S): Development and evaluation. American Journal of Preventive Medicine, 32(4): 273-281, 2007.

38% of the Oklahoma City population lives within one mile of at least one grocery store. Only 8.1% of residents live within a mile of two grocery stores, and 3% live near three grocery stores. This paints a picture of a weak system that could inconvenience large groups of people if or when a grocery store closes.

The table below details the number of people who live within one mile of a grocery store based upon different tiers of NEMS-S scores:

NEMS-S Range	Households Within One Mile
15-33	41,942
34-43	52,604
Not within 1 Mile	154,680

Clearly, most people drive to the grocery store, as 62% of residents live more than a mile from the grocery store. While there are people who chose to live in rural areas, it is surprising to see that of the 154,680 households that live more than a mile from a grocery store, 87.3% live in what is considered to be the urban area of the city.

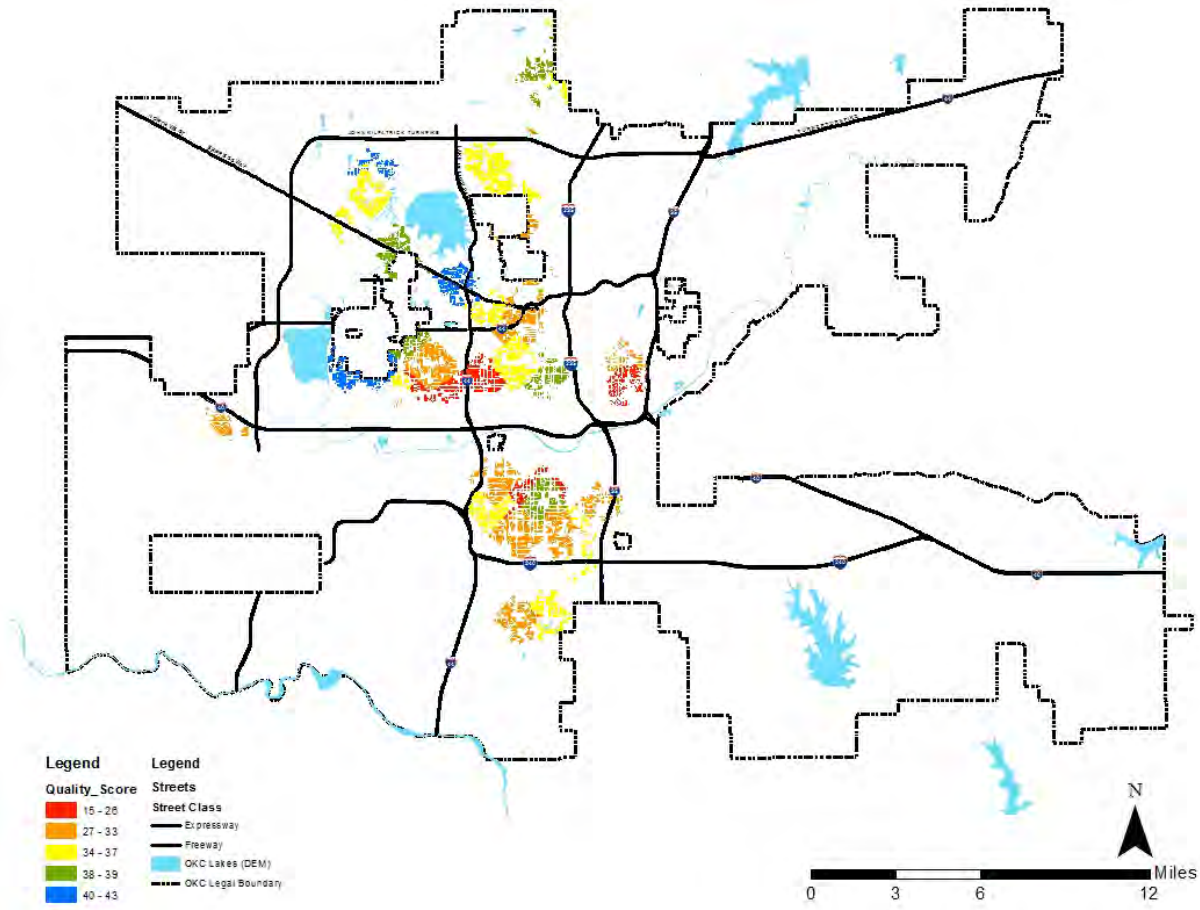

Figure 30: Grocery Stores – 1-Mile Service Area with NEMS-S Score

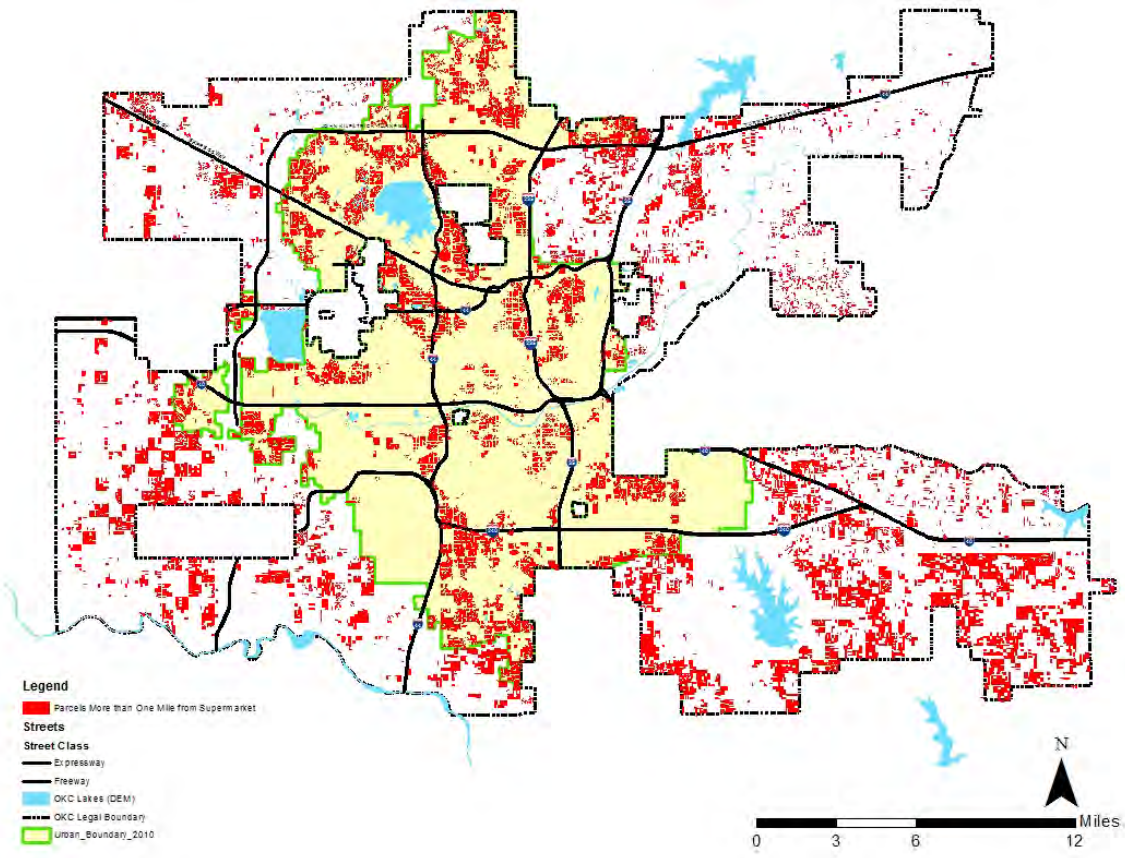

Figure 31: Parcels More than 1-Mile from Grocery Store

Scenario Analysis

As there is no practical way in which to project where new supermarkets will be located, and further, what the NEMS-S score of these locations will be, each of the scenarios were compared to existing supermarkets to determine what percentage of the future total population will live within one mile. The table below illustrates the relationship of each of the three scenarios with existing conditions:

	Existing	Scenario A	Scenario B	Scenario C
Number of Households within 1 mile	94,750	133,257	136,257	160,337
Percent of Total Population	38.0%	37.5%	38.2%	44.9%
Percent Near High NEMS-S Store (34+)	21.1%	19.0%	19.3%	22.7%

While all three scenarios increase the number of households living within 1 mile of a supermarket, only Scenario C increases the overall percentage of the population within this distance. Additionally, only Scenario C increases the percentage of the total population with access to stores that score well on the NEMS-S score,

indicating that Scenario A and Scenario B would likely lead to poorer quality meals for a greater percentage of the population, or at least longer drives to nicer grocery stores, which would then bring with it all of the negative health impacts associated with higher rates of vehicle miles traveled (VMT).

For the sake of comparison, if we make the assumption that no households are shopping at grocery stores outside of the city limits, how many additional grocery stores would it take to make it so that all households are served equally? Taking the number of households serviced by the 45 supermarkets in the city limits presently, and dividing them by 45 reveals an average number of potential shoppers at the grocery stores that live within a 1-mile service area. For Scenario A, this value is 2,973. For Scenario B, this value is 3,028. And for Scenario C, this value is 3,563. Now, if the number of households within the 1-mile service area is subtracted from the total number of households in the scenarios, we get a figure that can then be divided by the average number of potential shoppers for each scenario, giving the number of new grocery stores needed to provide equitable service to all households in the city. For Scenario A, an additional 75 supermarkets will be needed to meet the average number of shoppers for the entire population. For Scenario B, 73 supermarkets would be needed. And for Scenario C, 55 new supermarkets would be needed. While this concept is highly theoretical, it illustrates the fact that Scenario C is much more efficient in locating the future population in proximity to existing grocery stores, while still allowing room for plenty of growth in the supermarket industry.

Conclusions

A) Scenario A would decrease the percentage of the total population with proximal access to grocery stores in general as well as those that score well on the NEMS-S scale. Scenario A would require the greatest number of new grocery stores to satisfy the needs of the new population.

B) Scenario B would keep roughly the same percentage of the population living within proximal distance of grocery stores in general, but would decrease the percentage living close to stores that score well on the NEMS-S scale. Scenario B would require only slightly fewer new stores to meet population needs than Scenario A, but much more than required in Scenario C.

C) Scenario C would significantly increase the percentage of the total population with proximal access to grocery stores in general, and slightly increase the percentage of the population with access to stores that score well on the NEMS-S scale. Scenario C would require the fewest number of new supermarkets to meet the needs of the new population.

Policy Review

Overview:

Having access to affordable, healthy groceries is directly related to preparing healthy meals. Consumers who do not have access to healthy food choices will prepare unhealthy options such as higher fat and calorie foods or purchase unhealthy choices such as fast food or convenience meals. Oklahoma City can contribute to community health by considering creating incentives and/or easing regulations for small, locally-owned businesses such as farmers' markets, mobile food vendors, and natural food vendors, etc. which could offer healthier choices. Oklahoma City can also create an additional demand for healthier foods by conducting a market study to quantify existing and future potential, raise the level of public awareness and understanding of healthier food options through a healthy food campaign, and developing an incentive program that will assist convenience stores with providing fresh fruits, vegetables, and other healthy food items.

Relevant Policies:

Strengthen.Employment and Opportunity.172

Strengthen.Fiscal Stability.249

Sustain.LandUSePatterns.335

Green.Agriculture and Food.310

Green.Agriculture and Food.313.

Green.Agriculture and Food.504

Green.Agriculture and Food.509

Recommendations

- Provide incentives for grocery stores selling produce. Prioritize areas that have low access, regardless of resident income levels.
- Compile results from all food access studies to use in a healthy food financing program.
- Support existing Healthy Food Awareness campaign that includes:
    - Strategies for selection and preparation of healthy food that is cost- and time-competitive with manufactured food.
    - A uniform curriculum associated with selecting and preparing nutritious food for use in schools, recreation centers, senior centers, technical/trade schools, farmers markets, and anywhere people might go to learn.
    - Strategies to link training for unemployed people and welfare-to-work work programs with opportunities for living wage jobs in urban food-related businesses.
    - "Edible Schoolyards", a school-based program which integrates nutrition and gardening to raise awareness about the connection between healthy food choices and locally grown fresh produce.
    - Expansion of farm-to-school programs.
    - Farm-to-institution programs that offer healthy food choices to hospitals, universities, prisons, and businesses.
- Raise the level of public awareness and understanding of agriculture's ecological, economic, open space, and cultural value, and its importance to local food security by the following actions:
    - Support and create training activities in a variety of settings (schools, colleges, health care facilities, continuing education programs) that general agricultural topics.
    - Help raise awareness of start-up capital, credit, crop insurance, horticultural and financial advice, soil testing, markets, subsidies, tools, and inputs such as seeds and soil alterations.
    - Promote farms and gardens as a destination stop for tourists and visitor (farm tours, community garden crawl, etc.).
- Create a community garden program utilizing public property that can be contracted to local organizations.
- Provide support for the OCCHD mobile market.

VII. liveokc Indicators

L.3 Residential Density

Health-based Rationale

3.4 billion people—about half the world's population—live in urban areas, and this number might rise to 6.3 billion by 2050[374]. The proportion of the global population living in cities will be 60% by 2030[375],a 72% increase in 30 years. Considering the potential influx of bodies into limited urban spaces, individual health can be directly impacted. Two areas of consideration are urban sprawl and crowding.

Crowding may negatively affect individuals' health by increasing the likelihood of contracting airborne communicable diseases[376] [377] [378] [379], or reducing an individual's ability to regulate stimuli, which may result in increased stress and diminished ability to learn. It has also been found that living in crowded conditions during childhood is associated with earlier mortality[380]. An additional study found, using instrumental variables models, that adolescents in large families have worse academic performance than their counterparts in small families and suggested that the effect operates through crowding[381].

A spatial analysis conducted in Hong Kong describes its research as focusing on TB prevalence in relation to its compact urban development comprising of high-rise and high-density residential dwellings caused by rapid population growth and limited land resources[382]. Although not as prevalent in the US, tuberculosis as a public health threat may still be a concern. In 2010, a total of 11,181 tuberculosis (TB) cases were reported in the United States, for a rate of 3.6 cases per 100,000 population, which was a decline of 3.9% from 2009 and the lowest rate recorded since national reporting began in 1953[383].

In the last fifty years, activity levels have dropped for a variety of reasons including new technologies and automation that make our lives easier, television and computer use, and changes in the built environment

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that have led to sedentary life styles. Automobile use has substituted for active travel, and urban sprawl, the dominant development pattern in the United States, all but guarantees automobile dependence[384].

Research has established statistically significant links between elements of the built environment and the risk of obesity[385] [386] [387] , suggesting that some built environments may be more "obesogenic" than others[388]. Urban sprawl has been implicated in the prevalence of high blood pressure and diabetes[389]. In addition, urban sprawl has been implicated in rising obesity[390] [391] [392] [393] [394] [395] [396].

Existing Conditions

Oklahoma City is known for being a sprawling metropolitan area with low residential density. The average density for the whole city regardless of land use type, with a total of 263,731 residential units over 397,440 acres of land, is just 0.66 units per acre. For land use that is strictly residential, the land area is reduced to 79,567 acres, resulting in an average residential density of 3.31 units per acre. Residential areas make up 20% of the total land area of Oklahoma City. The table below illustrates that though some ZIP codes have very impressive density numbers, residential area is a small fraction of the surrounding area; some, however are above the city average of 20% residential area to total ZIP code land area.

Top 5			Bottom 5		
ZIP	Density (units/acre)	% of Total Area	ZIP	Density	% of Total Area
73102	60.2	5%	73165	0.3	23%
73104	12.29	8%	73049	0.29	4%
73103	11.09	34%	73064	0.27	16%
73106	9.03	29%	73054	0.27	1%
73145	8.77	1%	74851	0.26	37%

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[390] KellySchwartz, A. C., Stockard, J., Doyle, S., & Schlossberg, M. (2004). Is Sprawl Unhealthy? A Multilevel Analysis of the Relationship of Metropolitan Sprawl to the Health of Individuals. *Journal of Planning Education and Research*, 24, 184-196
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[392] Lopez, R. (2004). Urban Sprawl and Risk for Being Overweight or Obese. *American Journal of Public Health*. 94(9), 1574-9.
[393] Doyle, S., KellySchwartz, A., Schlossberg, M., Stockard, J. (2006). Active community environments and health: the relationship of walkable and safe communities to individual health. *Journal of the American Planning Association*, 72(1), 19-31.
[394] Ewing, R., Brownson, R. C., Berrigan, D. (2006). Relationship between urban sprawl and weight of United States youth. *American Journal of Preventive Medicine*, 31(6), 464-474
[395] Plantinga, A. J., Bernell, S. (2007). The Association between Urban Sprawl and Obesity: Is It a Two Way Street?. *Journal of Regional Science*, 47(5), 857-879.
[396] Joshua, C.E., Boehmer, T.K., Brownson, R.C., Ewing, R. (2008). Personal, neighbourhood and urban factors associated with obesity in the United States. *Journal of Epidemiology and Community Health* 62, 202-208.

Concentric rings are clearly visible in the map below (excluding Tinker Air Force Base, which is typically an exception) illustrating that as you move from the core of the city out to the rural areas, density decreases fairly uniformly.

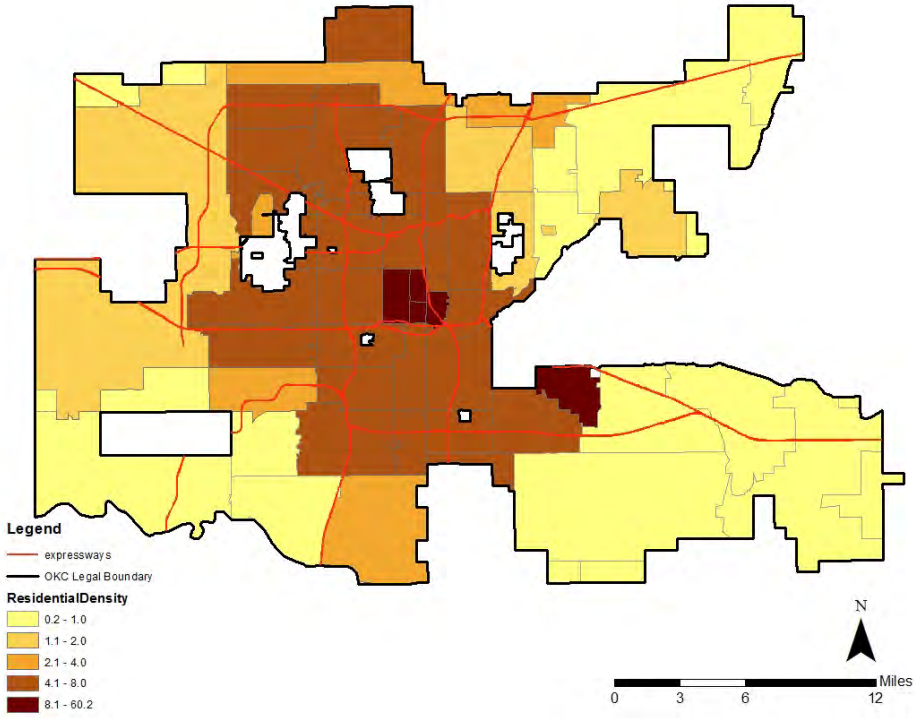

Figure 32: Residential Density by ZIP Code

Oklahoma City has a wide variety of densities within the city limits, ranging from high-rise apartment buildings, to tightly-packed suburban houses, out to very large rural residential properties. Below are some examples of densities in Oklahoma City that correspond to their respective ZIP codes and are close to the average density for these ZIP codes.

73102 | 60+ U/acre

73104 | 12+ U/acre

73020 | 7+ U/acre

73012 | 4 U/acre

73012 | 1 U/acre

731433 | 0.5 U/acre

73054 | 0.25 U/acre

Scenario Analysis

For the three scenarios the amount of new housing units was divided by the additional residential development area brought about by each scenario. All three scenarios include a total number of households of roughly 356,800 households; the amount of new developed residential area and the distribution of the population over all residential areas in the city are what differ among the three scenarios. The Envision Tomorrow tool allows for a visualization of residential density at the polygrid level, which are roughly 160 acre areas gridded over the entire city area. This gives a greater level of detail by which to observe the future trends of residential density around the city than what the large ZIP codes allow. The table below illustrates the residential density for the city as a whole, and the maps on the following page show the distribution of residential density by polygrid.

	Existing	Scenario A		Scenario B		Scenario C	
Residential Area (acres)	79,567	164,581	+107%	134,558	+69%	95,232	+20%
Average Density	3.31 u/acre	2.17 u/acre		2.65 u/acre		3.75 u/acre	

Scenario A:

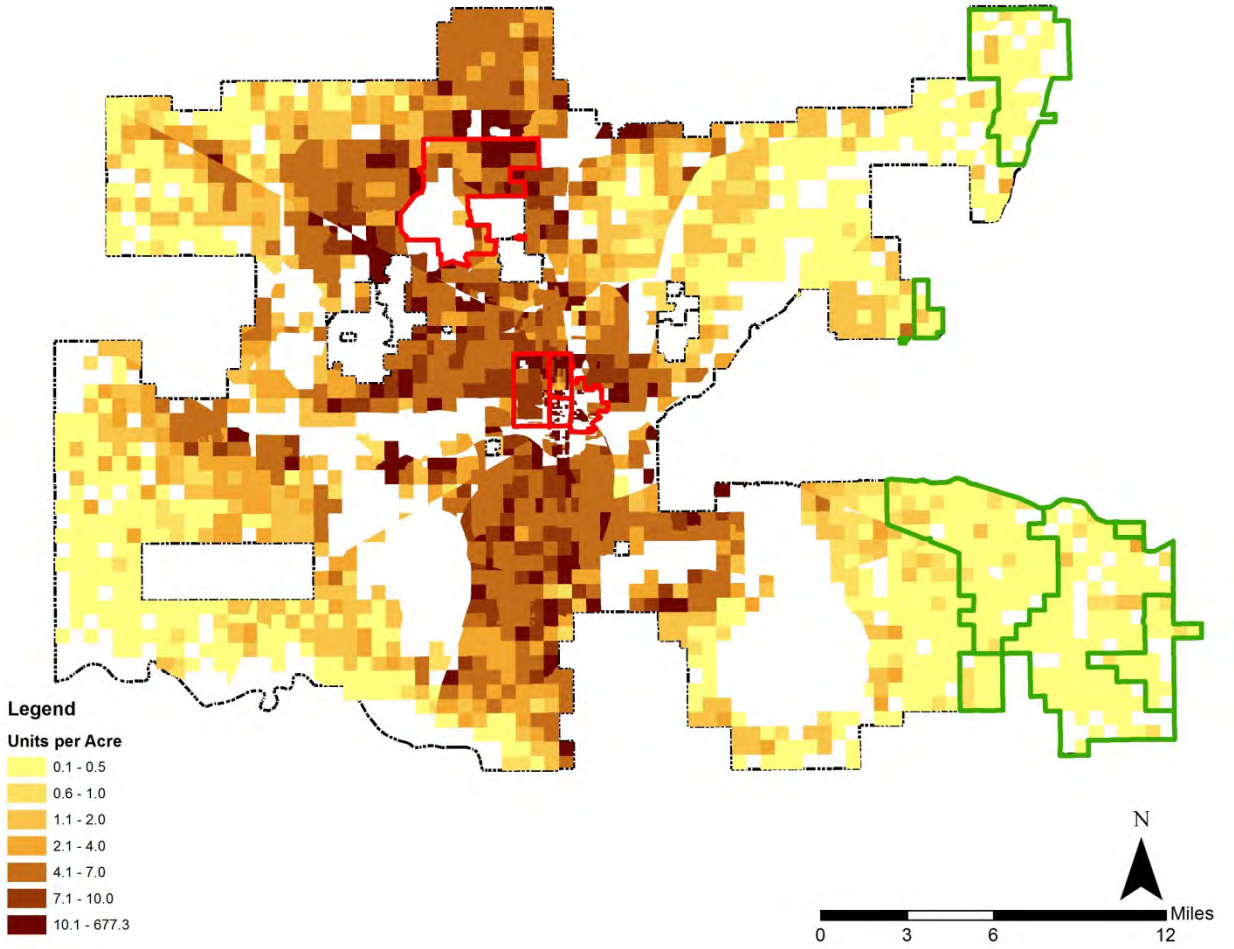

Figure 34: Scenario A Residential Density

Top 5			Bottom 5		
ZIP	Density (units/acre)	% of Total Area	ZIP	Density	% of Total Area
73102	126.76	13.3%	73020	0.58	61.7%
73104	28.03	17.3%	73045	0.47	69.1%
73103	23.77	53.8%	74857	0.43	44.3%
73120	12.26	33.5%	74851	0.31	41.1%
73106	10.92	30.9%	73054	0.28	44.1%

Scenario A spreads the population over the largest amount of area within the city limits, with roughly 41.4% of the city's land being residential. The mean density is 2.16 units per acre, and the median density is 1.81 units per acre. Scenario A has a lower top density and a higher bottom density, which is symptomatic of the sprawling homogenous development pattern pushing the suburbs into rural areas while not significantly densifying the inner core. 57% of the residential land will be for units with ½-acre or larger lots or 23.7% of the total city area.

Scenario B:

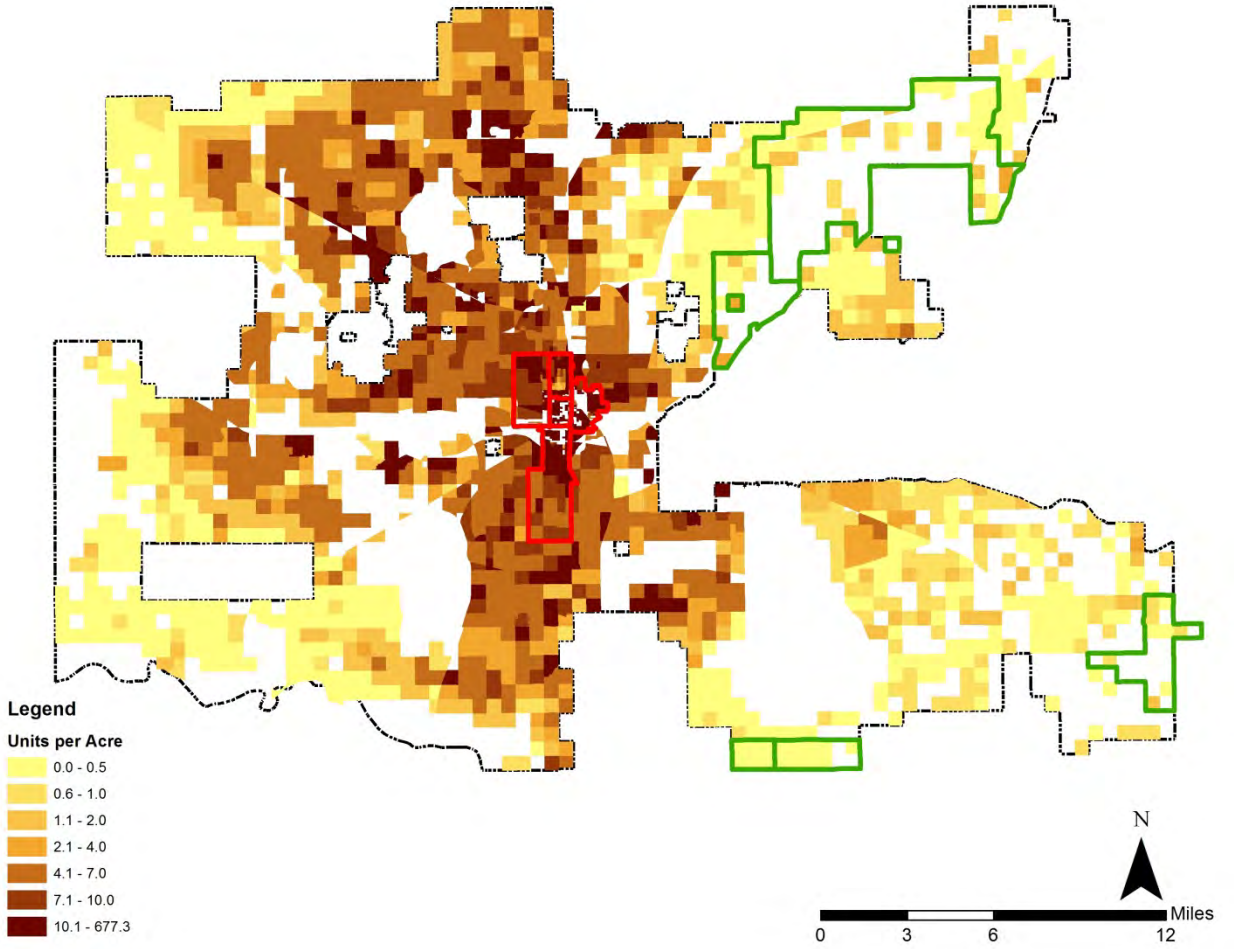

Figure 35: Scenario B Residential Density

Top 5			Bottom 5		
ZIP	Density (units/acre)	% of Total Area	ZIP	Density	% of Total Area
73102	130.43	18.2%	74851	0.43	16.5%
73104	27.39	23.9%	73141	0.30	18.1%
73103	23.91	48.2%	73049	0.24	16.7%
73109	15.36	41.0%	73071	0.14	71.6%
73106	13.26	36.2%	73026	0.13	62.1%

Scenario B increases the amount of residential area in the city by 69 percent, covering 33.9% of the total area of the city. The mean density is 2.65 units per acre, and the median density is 3.79 units per acre. Scenario B has a slightly higher top density than Scenario A, and a significantly lower bottom density, which corresponds to the development pattern that locates development primarily along major highways and not totally haphazardly across existing rural areas. 51% of the residential land will be for units with ½-acre or larger lots, but this only accounts for 17.4% of the total city area.

Scenario C:

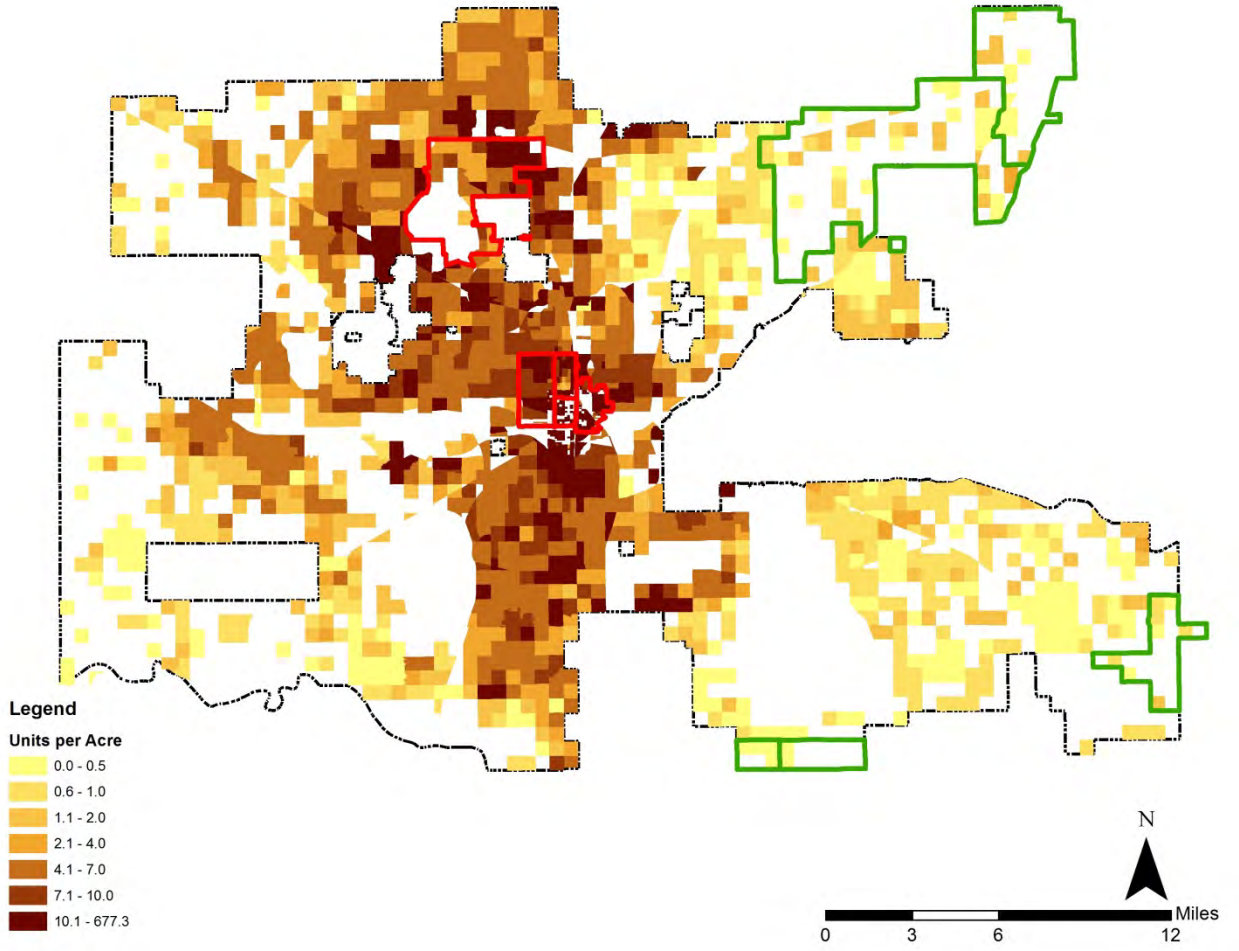

Figure 36: Scenario C Residential Density (u/acre)

Top 5			Bottom 5		
ZIP	Density (units/acre)	% of Total Area	ZIP	Density	% of Total Area
73102	160.68	20.0%	74851	0.55	10.2%
73120	59.55	31.7%	73049	0.36	8.1%
73104	44.40	20.4%	73054	0.18	9.7%
73103	36.62	43.6%	73026	0.15	6.3%
73106	18.33	35.2%	73071	0.14	48.9%

Scenario C concentrates the population of Oklahoma City most efficiently and densely, focusing on in-fill development rather than greenfield. Only 24% of the city's total land area will be used for residential purposes. The mean residential density is 3.75 units per acre, and the median residential density is 4.07 units per acre. Scenario C has the highest top density of the three Scenarios with higher percentages of total ZIP code area at high density development. Only 35% of the residential land will be used for residences with ½-acre or larger lots, accounting for just 8.4% of the total city area. This leaves the rural areas in their current condition rather than converting them to suburbs.

Conclusions

A) Scenario A has the lowest residential density of the three scenarios. The development pattern of Scenario A impacts significantly more land area than the other two scenarios.

B) Scenario B has a higher residential density than Scenario A, but a lower residential density than Scenario C. Some growth will impact the rural areas of the city, but other areas that are impacted by Scenario A will not be in Scenario B.

C) Scenario has the highest residential density of the three scenarios, focusing the majority of development on areas that are already somewhat developed. The rural areas of the city suffer the least negative impacts of development in Scenario C as a clear distinction between developed and undeveloped areas is created.

Policy Review

Overview:

Residential density of a city can both negatively and positively impact the health, economy, and environment. When considering housing, residential density is often encouraged to maximize land use and encourage alternate transit options such as walking, biking, and commuting. Oklahoma City can encourage the development of affordable housing in downtown and adjacent areas through incentives such as establishing a density bonus program and evaluating existing regulations for effectiveness in promoting density and mixed use development. In addition, Oklahoma City can focus transit improvements in high density areas with high ridership potential and along express routes that move people to activity nodes and downtown and create design standards and codes for high density urban residential development. Standards should ensure that these areas provide for privacy and livability in a high density, mixed-use environment.

Relevant Policies:

Sustain.LandUsePatterns.258

Sustain.LandUsePatterns.274

Sustain.LandUsePatterns.336

Sustain.LandUsePatterns.703

Connect.Transit.214

Live.Housing.459

Live.Housing.472

Recommendations

- Create a development terminology "cheat sheet" from the glossary of the comprehensive plan for use at Commission and Council meetings.

- Encourage density levels based upon land-use typology designations in the comprehensive plan such that neighborhoods closer to the city center have higher density levels and rural residential densities are the lowest, ensuring that intensity and compatibility are well organized.
- Evaluate the cost and benefit of a Transfer of Development Rights (TDR) system, particularly as it affects undeveloped areas.
- Infill vacant lots to increase the efficiency of City services, access to transportation, schools, businesses, etc.

VII. liveokc Indicators

L.4 Isolation Index of Vulnerable Populations

Health-based Rationale

An isolation index is used to determine separation in neighborhoods and measures the tendency of members of one group to live in neighborhoods where their particular background is above average in numbers. Racial separation has been linked to several negative health outcomes, both directly and indirectly; and although most studies have been thorough for the African American population, newer data has revealed additional ethnic groups whom are affected. Residential ethnic segregation, characteristic of so many US cities, reinforces economic inequalities and raises concerns about effects on public health[397].

Negative social interactions between deprived and affluent groups have been shown to increase instances of discrimination and racism, which lead to increased stress. This psychosocial stress has been shown to influence suicide[398], depression[399] [400], dementia and cognitive decline over the age of 65[401] and chronic disease[402]. Thus, to compound the direct mental health impacts of living in deprived or risky neighborhoods, there may also be psychosocial impacts[403] as groups feel deprived relative to other reference groups in society[404]. Psychosocial stress is believed to lead to physiological changes—including increased cortisol, altered blood-pressure response and immune system compromise—that increase the risk of premature birth and fetal growth impairment[405] [406] [407] [408].

Racial residential segregation has important implications for early breast cancer detection. Early detection of precancerous cells can reduce treatment complications, thus increasing the survival rates of breast cancer[409] [410]. Studies show blacks are more likely to receive late diagnosis than whites[411] [412] [413] and experience greater mortality[414] [415].

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[409] Abraido-Lanza, A.F., Chao, M.T., Gammon, M.D. (2004). Breast and cervical cancer screening among Latinas and non-Latina whites. *American Journal of Public Health* 94, 1393–1398

Existing Conditions

In the Oklahoma City area (those ZIP codes within and immediately surrounding the city limits) there are more than 1,117,000 people. Of these people there are five major racial and ethnic groups, in order of percent of population: White: 65.7%; Hispanic: 12.1%; Black: 10.8%; American Indian: 3.15%; and Asian; 3.08%. The remaining 5.17% are comprised of people who are of more than one racial or ethnic background or very small groups. 14.5% of people in the area are 62 years of age or above, in what is commonly considered retirement age. 12.6% of people in the Oklahoma City area are disabled. The median income for this region is $54,039. By utilizing all of these figures we can determine what areas of the city are prone to certain trends in terms of race, age, disability, and income, revealing concentrations of vulnerable populations.

Using common isolation index equations we are able to identify trends among the different groups in terms of location and evenness of distribution.

$$\textbf{Isolation Index} = \text{SUM}(g_Z/G) * (g_Z/T)$$

where:

$\mathbf{g_z}$ = group population in a ZIP code
G = total group population
T = total population

This gives a result between 0 and 1, where 1 means there is no isolation for a group, and conversely an asymptotic trend toward 0 relates to increased isolation. The relationship between the result of the summation and percentages of different groups illustrates whether these groups are distributed evenly around the area or if they cluster. In other words, for an isolation score to be significantly higher than a percentage of total population for any given group, this implies that they are generally located closely together, whereas, if the isolation index score is lower than the percentage of total population, this implies that this group does not typically cluster together. In regard to racial and ethnic isolation, the following figures were derived:

Group	White	Hispanic	Black	Asian	American Indian
Isolation Index	0.71	0.28	0.29	0.05	0.03

We can see that of the five groups, only American Indians do not have a greater isolation index score than their percentage of total income. Also, Whites and Asians have lesser deviations than Blacks and Hispanics, which implies that Black and Hispanic residents tend to cluster, whereas Whites, Asians, and American

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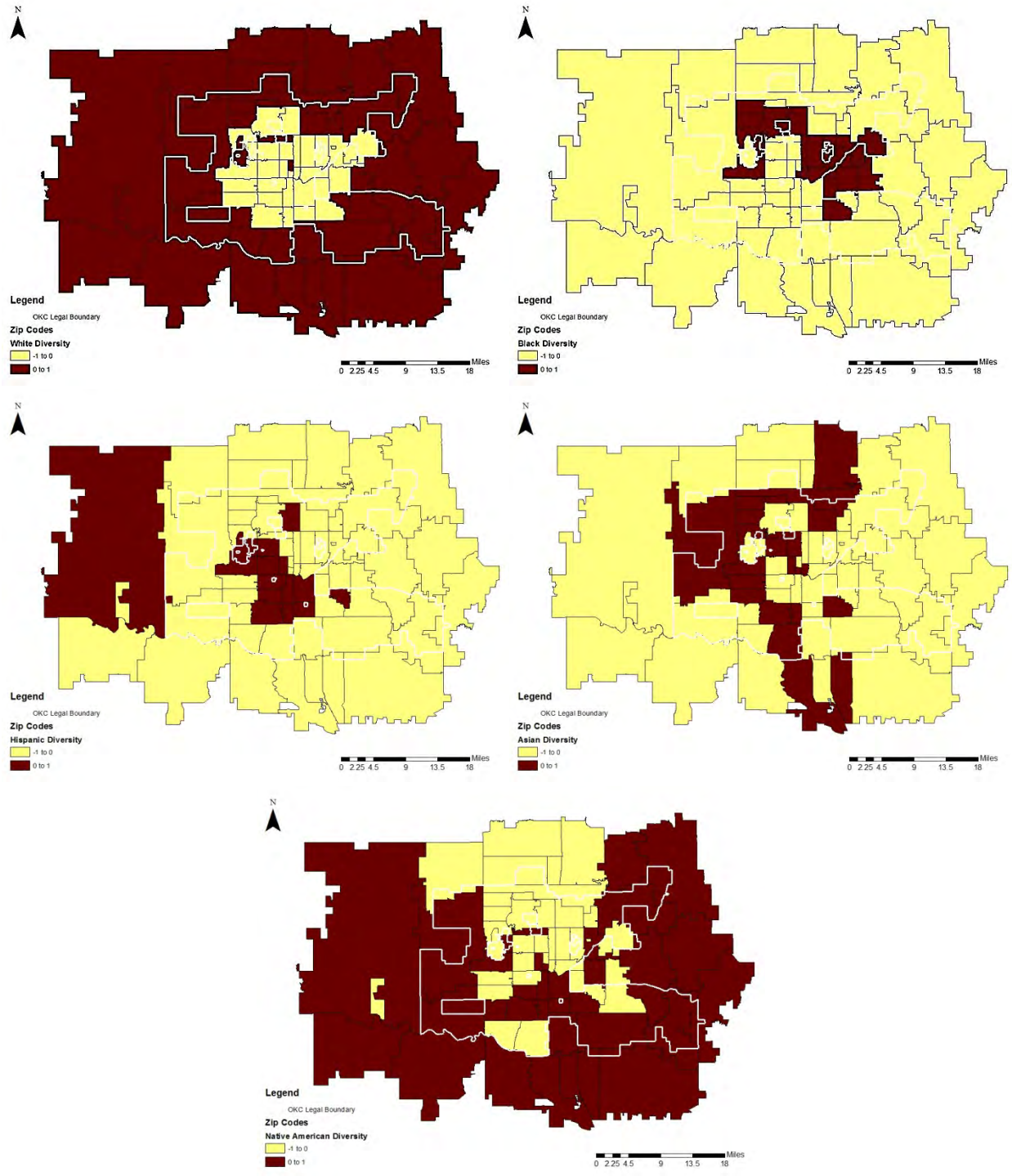
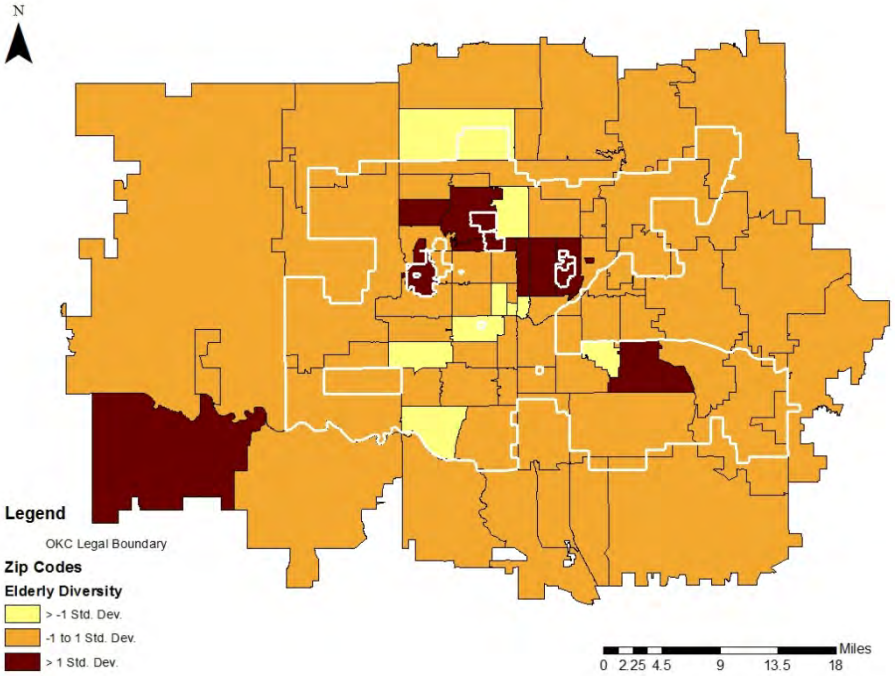
Indians are more likely to be found in non-clustered formations. Below are maps that illustrate ZIP codes that have higher than average populations for each of the five racial/ethnic groups:

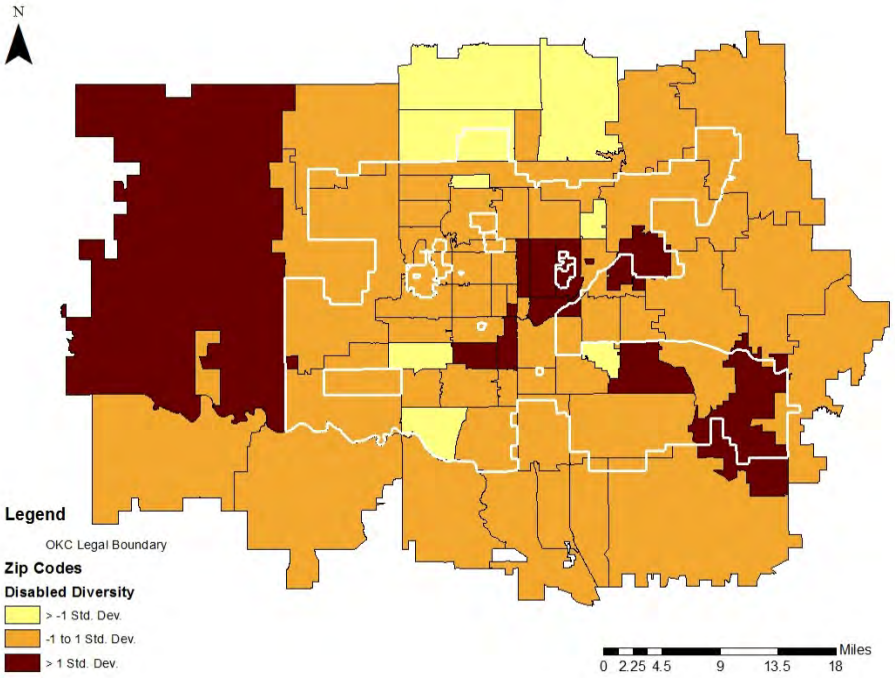


As predicted by the isolation index, the Black and Hispanic populations are above average in particular areas, which is indicative of grouping. Asian and White populations have clear patterns, but are less grouped, and the Native American population has less of a clear pattern, but tends to be smaller in the north of the city and into Edmond.

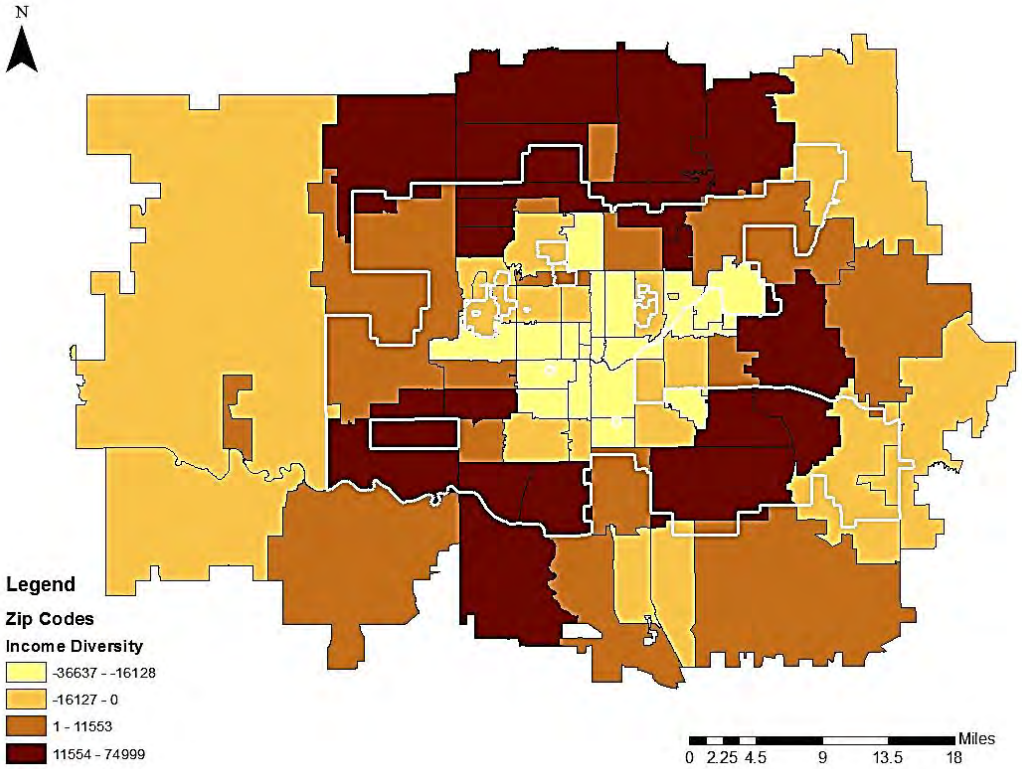
The same study was done for the percentage of people above the age of 62, but rather than just above or below average population percentage, the map is classified relative to standard deviation around the average percentage:



The standard deviation classification was also done to study the location of disabled individuals:



Finally, the median income figures were mapped to split the ZIP codes into four categories from those that earn less than the median, to those that earn more:



There are many different determinations that can be made from these images. In particular ZIP code 73111, in the MLK food desert region, has one of the lowest incomes, highest rates of disability and the elderly, and is predominantly minority.

Scenario Analysis

Demographic variation was not differentiated among the three scenarios; thusly, only inconclusive correlation would be possible for a comparison. Such speculation with such sensitive issues as race, disability and age would not serve a valid purpose. However, the pattern of development of each scenario would have a significant impact upon people of different income levels.

Scenario A, with its more homogenous single-family style development and tendency to sprawl to the outskirts, would most likely lead to a further separation of those with high incomes and those with low incomes, as property values in the more central areas of the city would lower in value. This would increase isolation indices in the city as funding for empowering services such as public transit and pedestrian or bicycle infrastructure would be spent providing for increased automobile and utility demands. Scenario C, having a more compact development pattern, would have the opposite impact, whereby those who presently are isolated due to lack of sufficient alternative transportation and housing prices would be better able to get around the city and to live in a closer proximity to a diversity of household types.

Conclusions

A) Scenario A would likely increase isolation for vulnerable populations in the city.

B) Scenario B would likely increase isolation for vulnerable populations in the city, but not to the extent of Scenario A.

C) Scenario C would likely decrease the isolation for vulnerable populations in the city.

Policy Review

Overview:

Isolation of vulnerable populations can increase stress, as well as cause other detrimental health outcomes of residents and decrease community moral. Oklahoma City can reduce the isolation index by increasing economic diversity through supporting development of industry clusters, creating specialized districts for large cultural or ethnic groups to enhance the diversity and perceptions of the city, and increasing the supply of housing for special needs groups to meet the diverse needs of households of different sizes, generational needs, incomes, and preferences.

Relevant Policies:

Live.Housing.**446**

Live.Housing.**457**

Strengthen.Place-making.**242**

Strengthen.Employment and Opportunity.**171**

Strengthen.Education System.**244**

Sustain.Land Use Patterns.**270**

Recommendations

- Incentivize employers to encourage volunteering and voting.
- Increase the number of community centers (such as recreation centers, cultural centers, etc.), particularly in areas that are presently underserved.
    - Consider an impact fee or some similar funding mechanism.
- When certain types of new development locate into existing urban areas (new schools, subdivisions, moderate to large businesses, etc.), require a "community benefits package" to be realized in the form of events (festivals, block parties, concerts, etc.).
- Support programming for mentoring programs with a focus on reaching out to different areas of the city.
- Support the organization of public events in all urban areas of the city.
- Create specialized districts for large cultural or ethnic groups to enhance the diversity and perceptions of the city.
- Study the supply of housing for special needs groups, such as the aging population and persons with disabilities, in locations convenient to transit, community facilities, daily needs, and appropriate support services.

VII. liveokc Indicators

L.5 Rate and Concentration of Gang Activity

Health-based Rationale

Consequences of gang membership are fairly well known and largely undebated. In the media, gangs have been determined to be responsible for the recent increase in youth crime, drug sales, and violence[416]. Spiraling effects of youth gang involvement propose direct ongoing impact into adulthood.

Some researchers have uncovered strong associations between gang activity and negative health and behavioral outcomes such as delinquency, criminal offending, gun use, substance abuse, and teen pregnancy[417] [418]. At the individual level, gang members and their partners are at a significantly increased risk for both violent victimization and dating violence behaviors[419]. This potentially opens the door for serious health concerns such as STI's, mental illness and substance abuse[420].

Several longitudinal studies show that adolescent girls with conduct disorder predictably suffered in multiple adult outcomes after adolescence. Their dysfunction unfolded over time and included poor physical health[421], increased mortality rates, increased criminality rates, high rates of psychiatric comorbidity, and participation in violent relationships[422].

Although gang involvement leads to many negative outcomes such as incarceration, drug and alcohol use, injury, and death, gangs may also serve a protective influence to those who join them. "Protective" factors promote resilience. Therefore, gangs provide members with affection, loyalty, understanding, recognition, and emotional and physical protection that they do not get from their biological family[423].

Existing Conditions

Gang activity in Oklahoma City is well known, and has gained national recognition for the amount and intensity of gang offences. The Oklahoma City Police Department documents arrests and incidences that are gang-related, including information regarding gang-on-gang violence, the type of offences that occur, as well as when and where these offences occur and by which gang. Determining what crimes are committed by gangs can be difficult, and terminology for offences changes over time, making it more difficult to characterize the trends in gang activity. Below is a graph and table that illustrate the number of documented

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offences for the top five crime categories by incidence for the years of 2008 through 2013. You can see that drive-by shootings rose sharply in 2011 and 2012, but have receded back to 2010 levels, while possession of controlled dangerous substances (CDS) has increased dramatically in recent years. Numbers have been decreasing for assault with a deadly weapon (ADW) offences as more firearms are being found and confiscated.

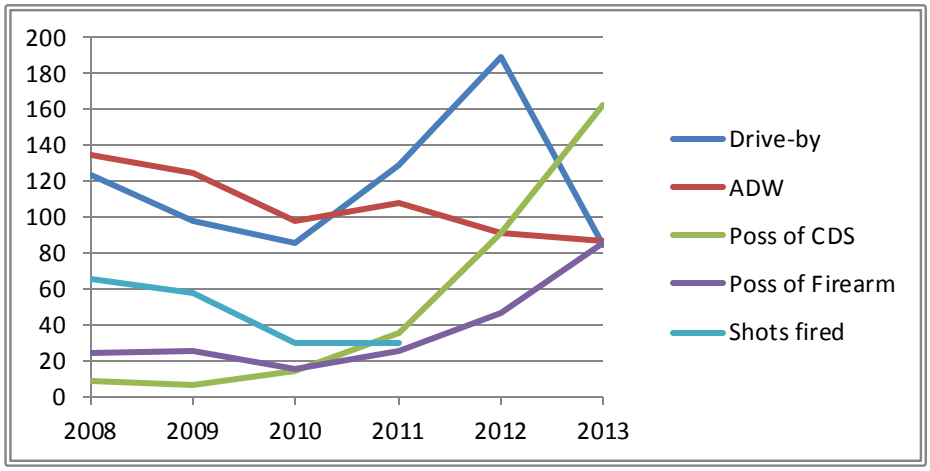

Figure 37: Number of Offenses by Type (2008-2013)

Year	Drive-By	ADW	Poss. Of CDS	Poss. Of Firearm	Shots Fired
2008	123	135	9	24	65
2009	98	125	7	25	58
2010	86	98	14	15	30
2011	129	108	36	25	30
2012	189	91	91	47	X
2013	85	87	162	86	X
Total	**710**	**644**	**319**	**222**	**183**

Table 1: Number of Offenses by Type (2008-2013)

Crime is a complex concept, and it would be a dubious venture to attempt to correlate any social trends with the numbers above; however, it is interesting to see the reliance upon drive-by shootings in a city that is known to be very car dependent.

Mapping the points illustrates key areas of the city that are prone to gang activity and violence. 39 of the 63 ZIP codes within the Oklahoma City municipal boundary have at least one recorded incident of gang violence. The table below shows the five ZIP codes with the highest number of gang-related incidences since 2008, as well as the five ZIP codes with the highest number of gang-related incidences per capita (population of respective ZIP codes).

ZIP	*73111*	*73119*	*73129*	*73114*	*73108*
Total Incidences	308	284	238	231	210
ZIP	*73111*	*73105*	*73108*	*73117*	*73114*
Per-capita Incidences	26.14	19.00	13.68	13.48	13.26

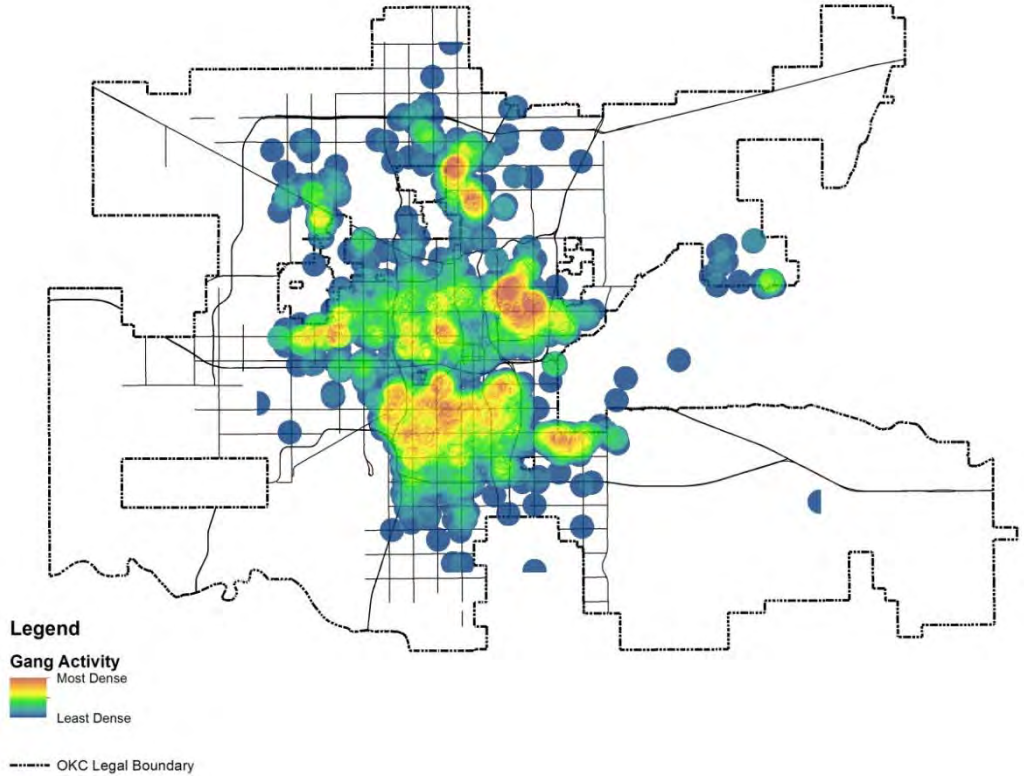

Figure 38: Density of Gang Activity by Incidence

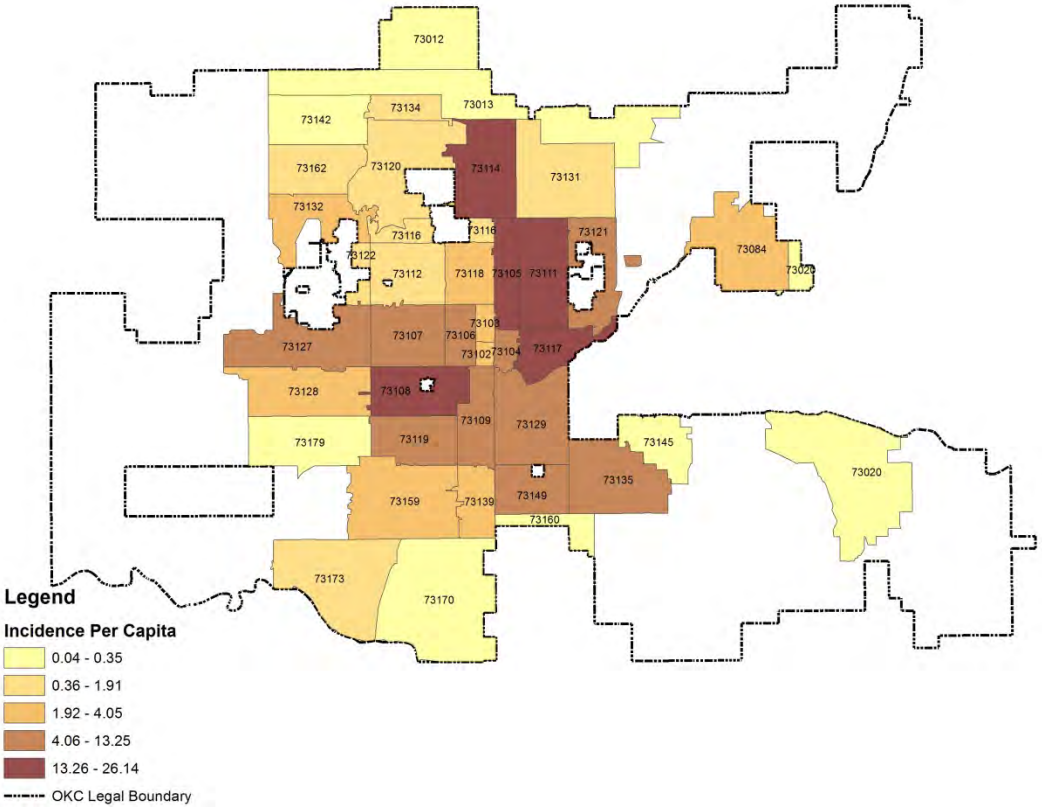

Figure 39: Incidences per Capita (ZIP)

Scenario Analysis

Gang activity being caused primarily by social interactions as well as prevalence of poverty does not correlate well to development patterns. Cities with economic successes and failures such as Chicago, which has excellent transportation options, often have gang violence. Policies that attempt to intervene in the lives of at-risk teenagers are much more important to quashing the prevalence of gang activity and the violence it spawns than development pattern choices.

Conclusions

Aspects of all of the scenarios could contribute to an increase in gang activity. Whether it's higher isolation indices in Scenario A or Scenario B, or the denser population of Scenario C, the scenarios are not a sufficient metric by which to measure future rates of gang activity.

Policy Review

Overview:

Many cities have battled increasing gang violence for decades, with mixed results. Inevitably, gang activity reduces safety and morale of a community, distracts police and emergency crews, and negatively impacts the environment. Reduced crime and improved feeling of safety can be accomplished through regulations and developing community-based activities and programs designed for at risk youth. Exploring police operations such as increasing effectiveness, number, and quality of patrols and establishing a Crime-Free Multifamily Housing Program designed to keep multifamily housing developments safe from crime can help Oklahoma City reduce gang activity. Additionally, focusing on environmental concerns such increasing emphasis on the enforcement of littering laws and expedient removal of graffiti can positively affect gang activity.

Relevant Policies:

Strengthen.Place-Making.**235**

Strengthen.Public Saftey.**248**

Enrich.Community Appeal.**122**

Play.Safety and Design.**378**

Live.Neighborhood Safety.**415**

Live.Neighborhood Safety.**416**

Live.Neighborhood Safety.**418**

Live.Housing.**452**

Serve.Police.**541**

Serve.Police.**544**

Recommendations

- Explore police operations such as establishing a Crime-Free Multi-family Housing Program.
- Address neighborhood appearance standards by intensifying code enforcement in areas with chronic violations:
    - Implement stricter enforcement of property maintenance regulations and consider more significant penalties for violations.
    - Increase emphasis on the enforcement of littering laws. Impose fines against littering in a uniform and consistent manner to reinforce a public perception that littering does carry a definite risk.
    - Focus on environmental concerns such increasing emphasis on the enforcement of littering laws and expedient removal of graffiti.
    - Immediately report and ensure expedient removal of graffiti that is visible from interstate highways and other important/designated viewshed corridors.
- Strengthen and create new partnerships with organizations that programmatically intervene with at-risk youths to prevent gang association.
- Enhance the City's ability to improve the appearance of existing parks through the following recommendations of the Parks Master Plan:
    - Targeted cleanup and beautification program;
    - Seek sponsors to donate funds to improve park signage and lighting;
    - Litter and graffiti abatement program.
- Standardize data recording terminology for gang-related crimes so that trends can be accurately measured and monitored.
- Find methods to cut down on recidivism, as well as to discourage gang activity within prisons. Ideally this would be accomplished with positive reinforcement that does not put individuals at risk of violence from the larger gang community.

VII. liveokc Indicators

L.6 Percentage of Population within 1 Mile of a Healthcare Facility

Health-based Rationale

Location of the nearest medical facility plays an important role in health care utilization; being ever more important to fragile populations such as the elderly, or those in need of emergency care for things like cardiovascular complications. Researchers have studied access and utilization of health care facilities and have been able to attribute the following characteristics.

Increased distance between residents and health care providers is commonly thought to decrease the utilization of health care[424] [425] [426] [427]. This barrier effect of distance is assumed to be greater for those with reduced access to transportation (for example, the elderly), and for those living in sparsely populated areas where distances between residences and facilities are large (for example, rural residents)[428]. Greater distance to hospitals adds more cost, time and effort to the decisions and actions an individual makes in seeking health care[429] . Considering the time that is taken to recognize symptoms and to call paramedics, and the time for ambulance response and transfer of patients to hospitals, distance is logically an important factor in speed of treatment and, ultimately, outcome of the event[430].

Evidence abounds that places characterized by geographic segregation of the poor and racial and ethnic minorities, especially African Americans, are handicapped by a variety of social problems such as higher than average infant mortality, poor prenatal care, crime, social and physical disorder, poor school achievement and violence[431] [432]. Residential segregation of the poor and racial and ethnic minorities is a robust phenomenon that has a powerful impact on health and healthcare[433] [434]. Social and physical isolation affects health by impacting the causes that increase mortality and morbidity[435] [436] [437]. These include the corrosive effects

[424] Bosanac, E.M., Parkinson, R.C., et al. (1976). Geographic access to hospital care: a 30-minute travel time standard. *Medical Care* 14, 616±624.
[425] Joseph, A.E., Bantock, P.R. (1982). Measuring potential physical accessibility to general practitioners in rural areas: a method and case study. *Social Science and Medicine* 34, 735±746.
[426] Bentham, G., Haynes, R. (1985). Health, personal mobility and the use of health services in rural Norfolk. *Journal of Rural Studies* 1, 231±239.
[427] Bronstein, J.M., Morrissey, M.A. (1990). Determinants of rural travel distance for obstetrics care. *Medical Care* 28, 853±865.
[428] Nemet, G. a. (2000). Distance and health care utilization among the rural elderly. *Social Science and Medicine*, 1197-1208
[429] Cromley, E., Shannon, G.W. (1986). Locating ambulatory medical care facilities for the elderly. *Health Services Research* 21, 499±514.
[430] Yamashita T, a. K. (2010). The association between heart disease mortality and geographic access to hospitals: County level comparisons in Ohio, USA. *Social Science & Medicine*, 1211-1218.
[431] Sampson, R. J., Morenoff, J. D., & Gannon-Rowley, T. (2002). Assessing neighborhood effects: social processes and new directions in research. *Annual Sociological Review* 28, 443e478.
[432] Wilson, W. J. (1987). *The truly disadvantaged.* Chicago: The University of Chicago Press.
[433] Gaskin, D. J., Dinwiddie, G. Y., Chan, K. S., & McCleary, R. (2012). Residential segregation and disparities in health care services utilization. *Medical Care Research and Review* 69(2), 158e175
[434] Smedley, B. D., Stith, A. Y., & Nelson, A. R. (2003). *Unequal treatment: Confronting racial and ethnic disparities in health care.* Washington, DC: National Academies Press.
[435] Kirby, J. B., & Kaneda, T. (2005). Neighborhood socioeconomic disadvantage and access to health care. *Journal of Health & Social Behavior* 46, 15e31.
[436] Massey, D. S., & Denton, N. A. (1998). The dimensions of residential segregation. *Social Forces* 67(2), 281e315.
[437] Williams, D. R., & Collins, C. A. (2001). Racial residential segregation: a fundamental cause of racial disparities in health. *Public Health Reports* 116, 404e416.

poverty and racial discrimination have on local institutions such as social and healthcare services that support health[438]. It is not simply the effects of individual resources linked to socioeconomic status or racial and ethnic identity of community members that constrains accessibility; rather, systemic features of local environments, based largely on community poverty and geographic segregation, have a significant impact[439].

Residential segregation is important when studying healthcare access because it is correlated with disparities in the geographic availability of healthcare providers, networks and information[440]. One important reason that individuals in some communities lack access to healthcare is that community resources inhibit or enable location of healthcare providers[441]. Healthcare service providers' location-decisions are based on client utilization patterns[442], as well as community assets such as reduced labor costs, accessible transportation, number of skilled workers in the area, population size, spatial and social density, and the intervention of elites[443] [444] [445].

Existing Conditions

A 1-mile distance was chosen to analyze the proximity of residential parcels to medical facilities in order understand at a neighborhood level, what areas have access to medical facilities. This includes several types of medical facilities, including primary care physicians, dentists, pharmacies, out-patient surgery centers, and more. No service area analysis was completed for hospitals as they are serviced by multiple ambulatory services, none of which originate from any given hospital when called. Ambulances act in a similar way to the way in which police cars act, whereby they service different areas of town and bring people to their final location, whether that is a hospital or the police station.

There are around 20 hospitals in Oklahoma City, depending upon the breadth of the definition of "hospital". And there are more than 500 non-hospital medical facilities around the city. While these facilities serve all land use types, it is easiest to determine their usefulness relative to residential parcels. Two thirds of the Oklahoma City population (412,694 people) lives 1 mile or less from a health care facility. This does not imply that all of their health care needs can be met with facilities within a mile, but rather that there is a widespread distribution of health care services in the city. Additionally, there are 37 veterinary clinics in the city, which are distributed well, but there seems to be a shortage in the downtown area as well as just south of the Oklahoma River.

Below you can see the hospital complexes and their distribution around the city. Beneath that, you can see the residential parcels that are within 1 mile of a medical facility:

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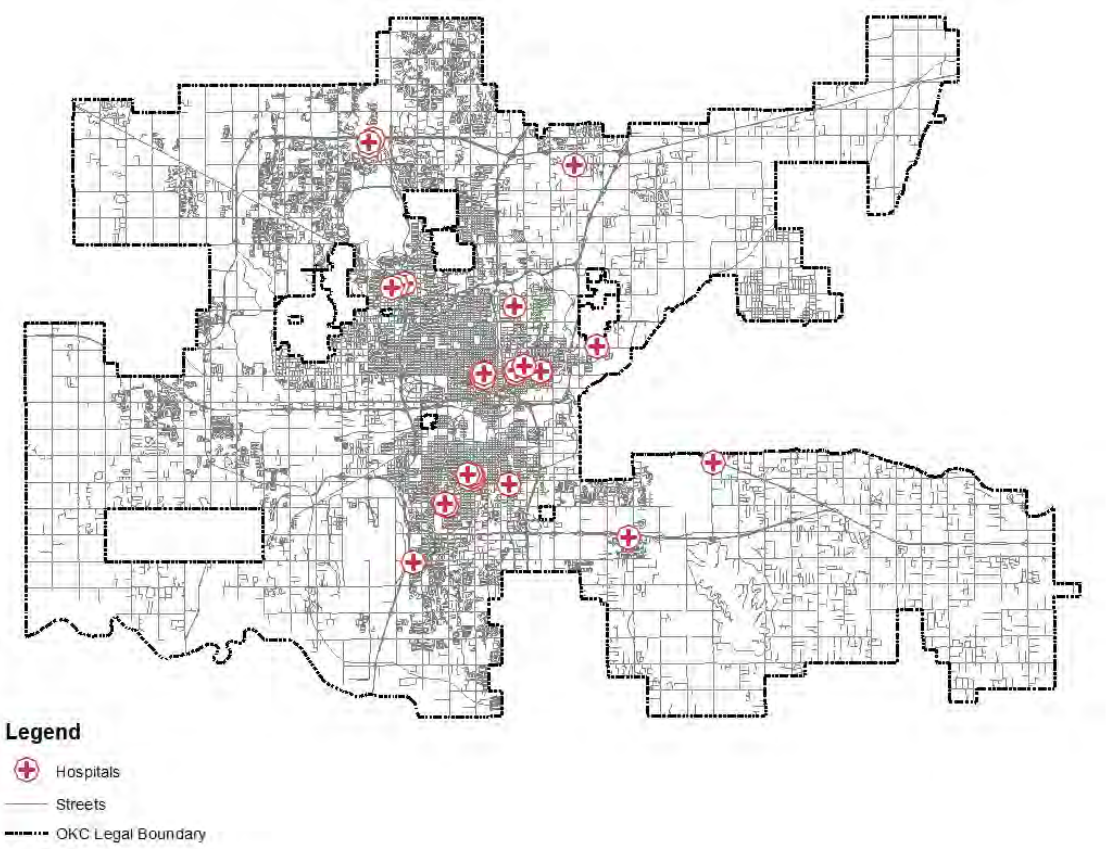
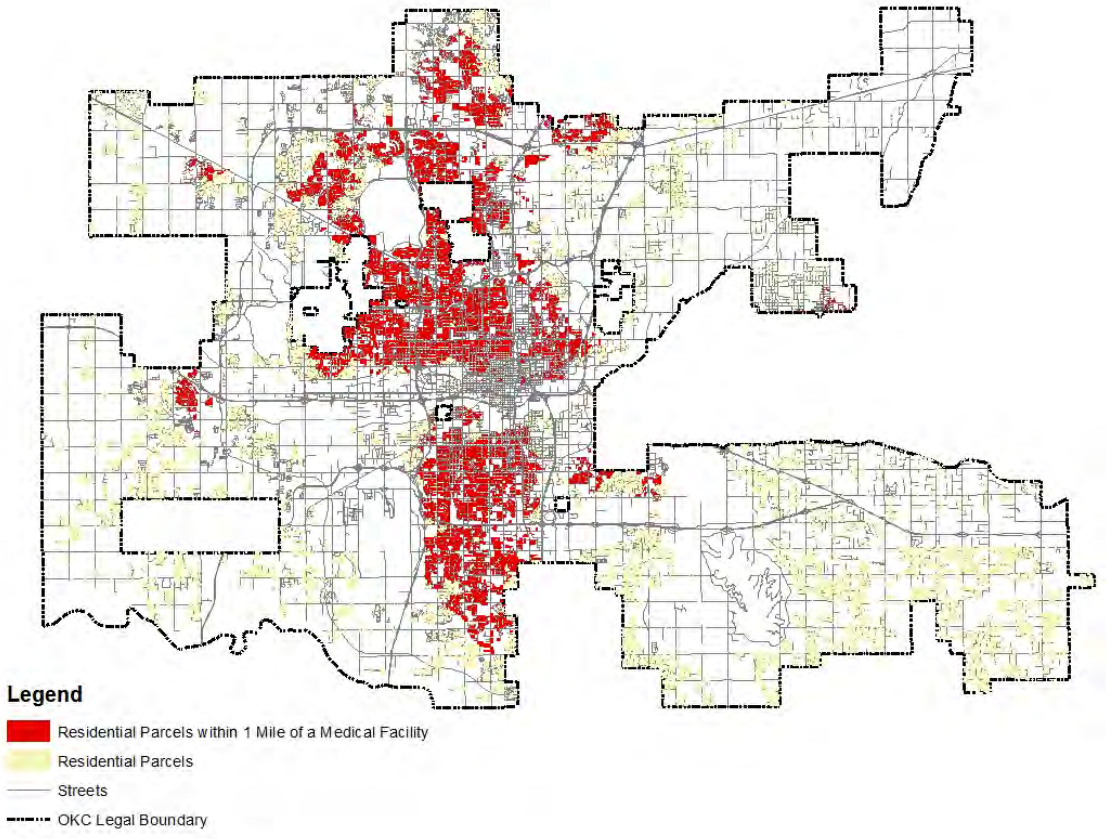
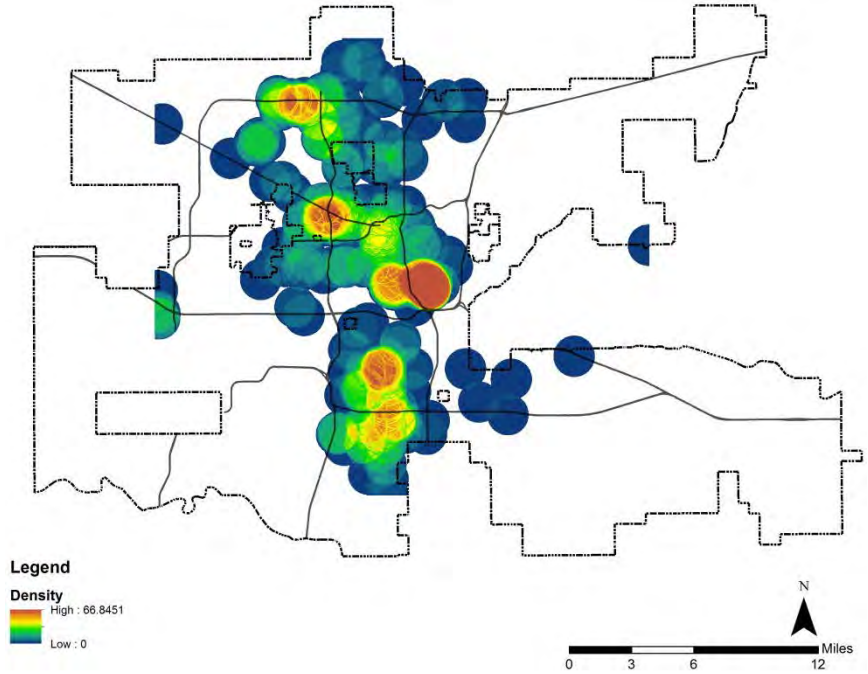
[438] Raphael, D. (2000). Health inequalities in Canada: current discourses and implications for public health action. *Critical Public Health* 10, 193e216.
[439] Archibald, M. a. (2013). *A spatial analysis of community disadvantage and access to healthcare services in the U.S. Social Science & Medicine*, 11-23.
[440] Williams, D. R., & Collins, C. A. (2001). Racial residential segregation: a fundamental cause of racial disparities in health. *Public Health Reports* 116, 404e416.
[441] Archibald, M. a. (2013). *A spatial analysis of community disadvantage and access to healthcare services in the U.S. Social Science & Medicine*, 11-23.
[442] Rohrer, J. E., & Westermann, J. (1998). Definition of service areas for substance abuse treatment agencies. *Administration and Policy in Mental Health* 25(4), 449e454.
[443] Britton, M., & Ocasio, W. (2007). Urbanization and spatial organization: hospital and orphanage location in Chicago, 1848e1916. *Social Forces* 85(3), 1303e1317.
[444] Greve, H. R. (2002). An ecological theory of spatial evolution: local density dependence in Tokyo banking, 1894e1936. *Social Forces* 80, 847e879.
[445] Simonson, J. (1979). A socioeconomic analysis of inter county variation in hospital service capacity. *Growth and Change* 10(2), 40e45.

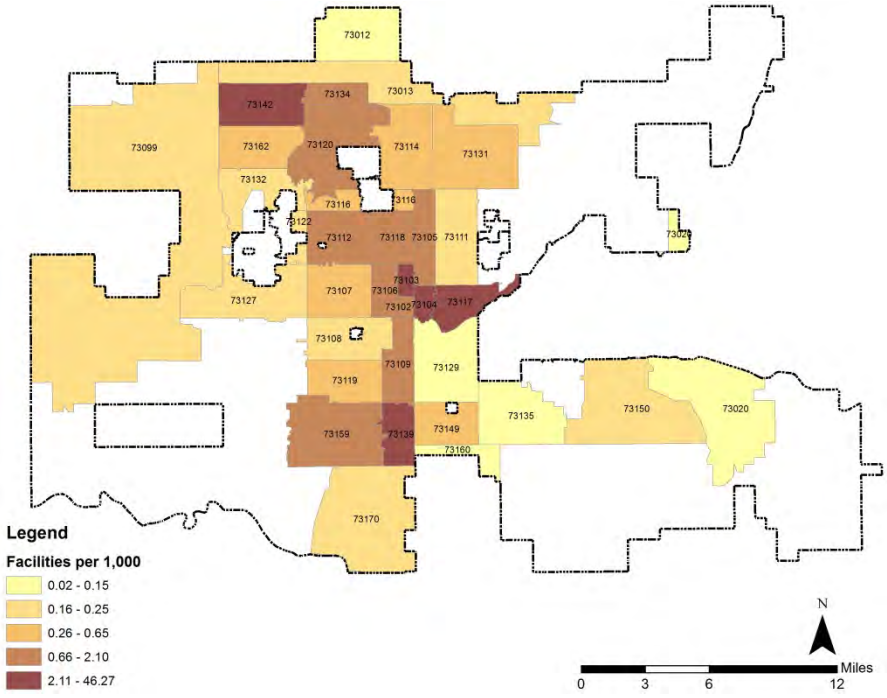

Legend
Hospitals
Streets
OKC Legal Boundary


Legend
Residential Parcels within 1 Mile of a Medical Facility
Residential Parcels
Streets
OKC Legal Boundary

While a large percentage of the population lives within a mile of a medical facility, it is useful to look at the concentration of these medical facilities in order to understand which areas have the greatest access. The heat map below illustrates this concept using a 1-mile radius around each facility. The OU Health Sciences Center is clearly visible, as well as St. Anthony's Hospital, and other major hospital areas.



The map below shows the number of medical facilities per 1,000 individuals for all applicable ZIP codes. There are 28 ZIP codes in the city without a medical facility. ZIP code 73117 has the highest rate due to the numerous facilities that are a part of the OU Health Sciences Center complex.



Scenario Analysis

Each of the three scenarios were evaluated against the existing locations of medical facilities in the city as there is no sound method by which to determine where future medical facilities will be located. The polygrids for the scenarios do not make projections about specific parcel locations, making any proximity study less than reputable; therefore, populations from each polygrid were proportioned to the 1-mile service area for each medical facility. The table below shows the comparison of the scenarios with existing conditions in terms of the number of individuals living within 1 mile of at least one medical facility.

	Existing	Scenario A	Scenario B	Scenario C
# within 1 mile	412,694	500,368	539,242	623,178
% of total population	66.2%	56.1%	60.5%	70.0%
% change	N/A	-10.1%	-6.1%	+3.8%

All three of the scenarios increase the total number of people living within a mile of a medical facility; however, only Scenario C increases the percentage of the total population that lives within the 1-mile radius. Depending upon how many individuals a medical facility can service, new facilities will need to be added in all three scenarios to maintain current levels of service. Scenario A and Scenario B increase the amount of travel necessary to get people to medical facilities.

Conclusions

A) Scenario A increases the total number of individuals that live within a mile of a medical facility but significantly decreases the percentage of the total population that lives within a mile of a medical facility. Scenario A moves more people away from a near proximity to facilities than Scenario B and Scenario C.

B) Scenario B increases the number of individuals that live within a mile of a medical facility but decreases the percentage of the total population living within a mile of a medical facility. Scenario B performs better than Scenario A but worse than Scenario C.

C) Scenario C is the only scenario in which there is an increase in the percentage of the total population that lives within a mile of existing medical facilities. 7 in 10 people in Scenario C would live within a close distance of a medical facility of some kind.

Policy Review

Overview:

An individual's access to medical facilities is a key factor in determining use of the facility. By increasing a community's access to care though location, transit options, and educational knowledge of the facility the greater opportunity Oklahoma City has at positively impacting health. This can be accomplished by increasing the supply of housing for special needs groups near existing medical facilities, locating new facilities close to where a medical need exists, and providing educational materials to the community.

Relevant Policies:

Green.Agriculture and Food.**509**

Live.Housing.**446**

Live.Neighborhood Stability.**528**

Play.Levels of Service and Programming/Needs.**364**

Recommendations

- Increase access to medical facilities by:
  - Increase transportation available to bring people to medical facilities.
  - Increase awareness of existing transportation options.
- Increase access to senior centers by:
  - Increasing awareness about existing senior centers.
  - Building more senior centers.
  - Increasing funding for senior centers.
  - Creating other services for seniors.
  - Increasing transportation services for seniors.
- Include proximity to medical facilities as a criterion in evaluating residential projects and residential density.

greenokc indicators

G.1 Proportion of Land Retained for Potential Farming Uses

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What proportion of the city will be retained for potential farming uses?	GIS parcel data; iTree data; GIS prime farmland data; GIS floodplain data	Local vs. imported products (air quality); pesticides	Healthy food choices; respiratory disease; poisoning

G.2 Total Impervious Areas

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What is the amount of impervious surface? What is the percentage of total land area?	GIS impervious surface data	Sedimentation and run-off; water quality; contamination	Reduction in groundwater storage; death of plant and marine life; poisoning; poor habitat quality

G.3 Air Quality Conditions

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What are the air quality conditions?	EPA data; GIS highway data; GIS land use data; VMT	Air quality; standards and regulations for commercial and vehicular emissions	Respiratory disease; habitat pollution and destruction; mental health

G.4 Urban Heat Island Effect

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What is the impact of the urban heat-island effect in the city?	Landsat; Total Impervious Area	Increased energy usage; air pollution; greenhouse gas emissions; water quality; higher temperatures	Respiratory disease; skin cancer; habitat pollution and destruction; water-borne disease; heat stroke

G.5 Water Quality (Groundwater and Water Bodies)

Health Indicators	*Measure*	*Health Determinant*	*Health Outcomes*
What are the conditions of water quality in the city?	ODEQ data; OWRB data; GIS streams data; GIS sub-watershed data; Total Impervious Area	Contamination; viability for recreation	Water-borne disease; habitat pollution and destruction; death of animal and plant populations

G.6 Average Residential Energy Usage

Health Indicators	Measure	Health Determinant	Health Outcomes
What is the average residential energy usage?	US Dept. of Energy data; VMT	Air quality; climate change due to greenhouse gas emissions; economic impacts	Respiratory disease; chronic disease; infectious disease; injury and property damage due to extreme weather; household well-being

G.7 Light and Noise Pollution

Health Indicators	Measure	Health Determinant	Health Outcomes
What are the levels of light and noise pollution?	Bortle scale; decibel readings	Energy waste; greenhouse gas emissions; un-natural light and noise conditions; disruption of ecosystems; disrupted sleep cycles	Respiratory disease; skin cancer; headaches; fatigue; stress; anxiety

G.8 Oil, Gas and Industrial Sites in Proximity to Residential Property

Health Indicators	Measure	Health Determinant	Health Outcomes
What percentage of the population lives in proximity to oil wells, gas wells, or heavy industrial land uses?	GIS land use data; GIS oil and gas well data; GIS parcel data	Soil contamination; fire and explosion hazard; air quality; light and noise pollution	Cancers; mortality; respiratory disease; stress; fatigue; headaches; anxiety

VIII. greenokc Indicators

G.1 Proportion of land retained for active farming uses.

Health-based Rationale

With obesity and complications from diabetes a national concern, many communities are not only going green, but are also attempting to choose healthier lifestyles. Metropolitan residents are re-allocating scarce resources to create roof-top community gardens, shopping at local farmers markets, and choosing healthier eating options, even when faced with fast food restaurants on every city block.

In rural and low-income communities, promotion of such nutritional food outlets could prove to be a successful way to reduce negative health outcomes associated with obesity, diabetes, and heart health. A diet rich in fruits and vegetables is associated with lower body mass index[446]. Zoning ordinances and land-use plans may influence the community food environment by determining placement and access to food outlets, which subsequently support or hinder residents' attempts to eat healthfully. A recent study conducted by the Centers for Disease Control (CDC) determined a strong positive correlation between healthful food zoning scores and the number of fruit and vegetable outlets in 13 northeastern North Carolina counties (r= 0.66, P=.01)[447].

In 2011, 96 percent of U.S. farms with cropland were family farms. They accounted for 87 percent of the total value of crop production, including well over 90 percent of production of major field crops, as well as most fruit, vegetable, and nursery production[448]. Reviews show evidence of links between contact with nature (including gardens), urban green infrastructure, and improvement in overall health and mental well-being[449] [450]. The direct impact of local food production on community health is not conclusive; however, fresh local foods provide higher nutrient value; and increased availability of locally grown, fresh product may encourage healthier choices than it the local option was not offered. Americans would need to substantially increase their consumption of red and orange vegetables by 166 percent, legumes by 76 percent, and starchy vegetables by 29 percent, and other vegetables by 20 percent[451].

Existing Conditions

In order to determine the potential farmland in Oklahoma City several variables had to be taken into account. This was done like so: Property zoned agricultural (AA, RA-1, RA-2) were pared down to include

[446] Azagba S., Sharaf MF. (2012). Fruit and vegetable consumption and body mass index: a quantile regression approach. *J. Prim. Care Community Health* 3(3), 210-20.
[447] Mayo ML, Pitts SBJ, Chriqui JF. (2012). *Associations between County and Municipality Zoning Ordinances and Access to Fruit and Vegetable Outlets in Rural North Carolina*.
[448] McDonald J., Korb P., Hoppe R. (August 2013). *Farm Size and the Organization of U.S. Crop farming*, UDSA, Economic Research Service.
[449] Maller, C., Townsend, M., Pryor, A., Brown, P., St. Leger, L. (March 2006). "Healthy nature healthy people: 'contact with nature' as an upstream health promotion intervention for populations". *Health Promotion International* 21(1), 45-54 doi:10.1093/heapro/dai032
[450] Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kăzmierczak, A., Niemela, J., & James, P. (2007). "Promoting ecosystem and human health in urban areas using green infrastructure: A literature review". *Landscape and Urban Planning*, 81, 3, 167-178
[451] Thornsbury, S., Jerardo, A., Wells, H.F.(September 27, 2012*). Vegetable and Pulses Outlook*. Economic Research Service, United States Department of Agriculture. VGS- 351. Accessed online: http://www.ers.usda.gov/media/922639/vgs351.pdf

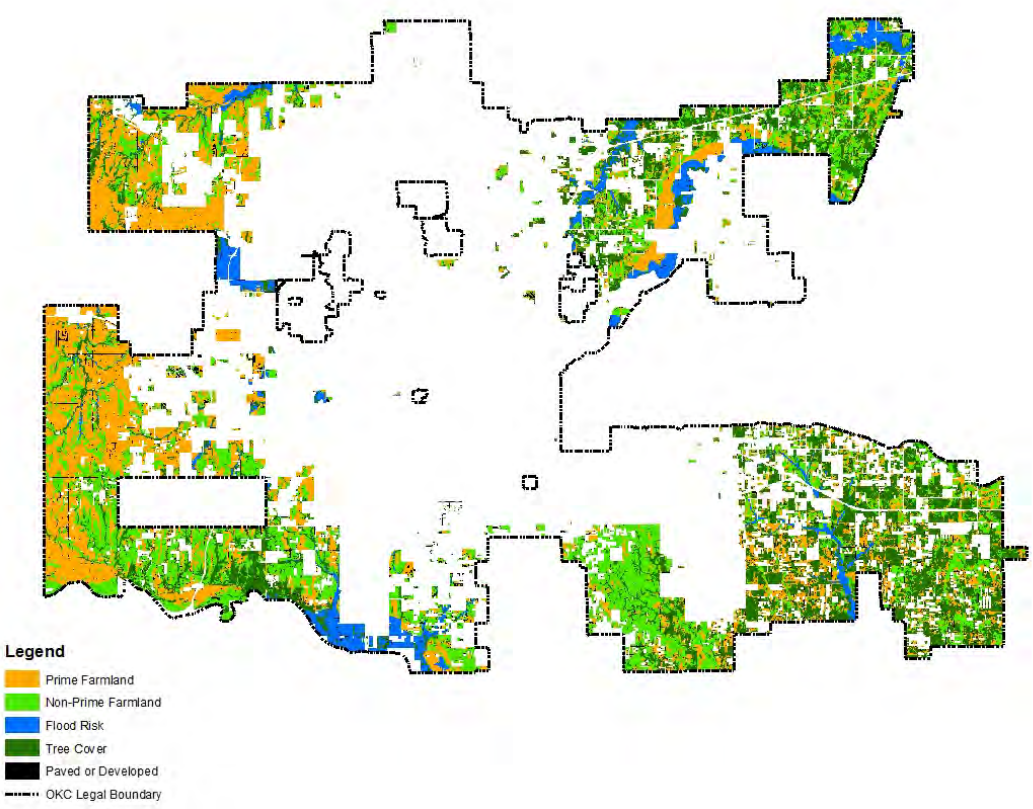
only those properties larger than 5 acres in area. From this 5 sub-categories were derived to illustrate which areas are best suited for agricultural affairs. These categories are:

1. Prime Farmland – Land with no trees, risk of flood, existing development; most suitable soil
2. Non-Prime Farmland – Land with no trees, risk of flood, existing development; less suitable soil
3. Flood Risk – Potential farm land that lies within the 100-year flood zone
4. Tree Cover – Land that is currently forested or would require clear-cutting
5. Paved or Developed – Land that currently has pavement or buildings upon it

With these classifications totals were derived:

Parcels > Five-Acres, Zoned Agricultural	Prime Farmland	Non-Prime Farmland	Flood Risk	Tree Cover	Paved or Developed
152,546 acres	51,505.2 acres	46,732.9 acres	11,307.0	40,103.9	2,897.0
100%	33.8%	30.6%	7.4%	26.3%	1.9%

Nearly two thirds of the possible farming land is either in prime farmland or non-prime farmland, which suggests that it would be unnecessary for anyone to cut into existing tree cover or to build within the 100-year flood zone, which combined account for just one third of the available land.



Scenario Analysis

The Envision Tomorrow software allows for a development of vacant acres rate to be calculated for each of the polygrids that comprise the area of the city. Using this rate in relationship to the existing farmland area (as well as areas that could potentially be used as farmland such as tree-covered natural spaces, and areas within the 100-year flood plain) allows for an equal footing by which to compare the potential impact of each of the three scenarios with regard to the development of farmland into other uses. As the polygrids are not as fine-grained of a constituent part of the city as parcels are, it is not possible to accurately assess which parcels or locations within a polygrid would develop, so it was necessary to assume the worst-case scenario where all development that occurs is located in land that is suitable for farming. If the amount of developed acres exceeded the amount of farmland, it was assumed that there is no farmland within the boundary of that specific polygrid. The table below shows the comparison of the three scenarios.

Loss of Usable Farmland				
	Existing	**Scenario A**	**Scenario B**	**Scenario C**
Farmland (acres)	148,281.34	45,853.03	77,177.07	120,202.28
Percent Change	N/A	- 69.1%	- 48.0%	- 18.9%

Regardless of the scenario, a good deal of usable farmland would be developed into other uses, but Scenario A would potentially remove more than 100,000 acres, enough land to yield more than 1 billion pounds of edible produce per year[452]. This severely limits the ability for Oklahoma City to feed its population with locally-sourced produce or livestock, as well as decreases the internal flow of money between community members. According to the FAO (Food and Agriculture Organization) of the United Nations, the average person requires 0.17 acres of land to produce all the food they need to survive. With this figure we can estimate that Oklahoma City could feed its entire future population of roughly 892,000 (scenario population) with 151,640 acres. Therefore, Scenario A and Scenario B are substantially below this level, while Scenario C comes closer. If future development was planned so as to not impose upon potential farmland, the amount of farmland that exists today could reasonably provide food for the majority of the population.

Conclusions

A) Scenario A would likely retain the least amount of land for active farming uses of the three scenarios, potentially developing more than two thirds of the existing potential farmland. This corresponds to a weaker local economy and less locally-sourced food.

B) Scenario B would likely retain more farmland than Scenario A but less than Scenario C, reducing the amount by around half.

C) Scenario C would likely retain the greatest amount of land for active farming uses of the three scenarios; however, nearly one fifth of the existing potential farmland may be developed for other uses.

[452] Kern, B., & Kern, K. (1974). *The owner-built homestead.* (1st ed.). Charles Scribner's Sons.

Policy Review

Overview:

Using land for farming purposes can be both beneficial and hazardous to a community. By allowing urban gardens, agriculture operations, and small farms citizens have an excellent opportunity to make healthier food decisions, unfortunately, these farming options may also have potential to have harmful side effects such as inadvertent contamination, increased water use, and missed opportunity for other land use. Oklahoma City can combat all of these scenarios through education of residents, improving access to healthy foods, and regulations on land-use and agriculture operations.

Relevant Policies:

Sustain.LandUsePatterns.**252**

Green.Agriulture and Food.**312**

Green.Agriculture and Food.**313**

Green.Agriculture and Food.**504**

Green.Agriculture and Food.**509**

Enrich.Landscaping.**93**

Play.Levels of Service and Programming Needs.**365**

Play.Social and Environment.**383**

Recommendations

- Incentivize the food production cycle for local producers, distributors and consumers.
    - Provide tax rebates for producers that sell a specified proportion of their yields in local markets.
- Utilize zoning and land use designations to protect farm land from development.
    - Restrict the allowed development uses such that they correspond with agricultural uses. Such uses should be limited in size and grouped together to minimize disturbance to agricultural production.
    - Place a high priority on land that is usable and considered prime farmland and a protective constraint against land that is forested or in the flood plain as there is ample land upon which to farm.
- Provide education to the public regarding the benefits of local farming compared to shipping all the food from elsewhere.
- Consider a structure that allows landowners to sell development easements in order to maintain rural character, while allowing denser development in the urban area (Transfer of Development Rights).
- Consider a "Clean and Green Act" like Pennsylvania whereby farmland is taxed according to its production potential rather than its market rate land value.
- Improve access to healthy local foods by improving community gardens and incentivizing grocery stores and convenience stores to sell fresh local produce.

VIII. greenokc Indicators

G.3 Total Impervious Areas

G.4 Air Quality Conditions

G.5 Urban Heat Island Effect Conditions and Causes

G.6 Water quality conditions and causes

G.7 Light and noise pollution

Health-based Rationale

Environmental and natural resources can greatly impact a population's health. Considering natural resources are often shared by the entire community, state, and region many individuals' health outcomes are intertwined. Air and water quality, pollution of all types, and the built environment all contribute to the health of a community.

Environmental noise can affect more than just the obvious auditory system, extending to loss of hearing and other hearing impairments[453]. Hearing damage is related to duration and intensity of noise exposure and occurs at levels of 80 dB or greater, which is equivalent to the noise of heavy truck traffic[454]. Children seem to be more vulnerable than adults. In addition, unwanted or outdoor sounds created by humans also have an impact on non-auditory systems. Studies have shown that noise annoyance from transportation produces a variety of negative emotions including anger, disappointment, unhappiness, anxiety and even depression[455] [456] [457] [458]. Although many cities are providing increased noise pollution protection for communities located near busy thoroughfares, the noise pollution still impacts many stages of health.

Water quality has been a major focus for many organizations since the 19th century. Water system infrastructures are designed to gather, deliver and dispose of water (dams, reservoirs, water treatment facilities, distribution networks and sewage treatment). Bearing in mind that municipal water systems are designed to not only control the water flow throughout the city, they are also concerned with sanitation of water sources to reduce bacteria, contaminates, and pollution that can be detrimental to health.

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[453] Prasher, D. (2003). *'Estimation of hearing damage from noise exposure'* in World Health Organization and European Centre for Environment and Health Report on the Technical meeting of exposure-response relationships of noise on health, Bonn, Germany, 17-19.

[454] Hagler, L. M. (2001). *Summary of Adverse Health Effects of Noise Pollution.* Based on the World Health Organization Guideline for Community Noise. Retrieved from http://www.who.int/docstore/peh/noise/guidelines2.html

[455] Fidell, S., Barber, D.S., Schultz, T.J. (1991). 'Updating dosage-effect relationship for the prevalence of annoyance due to general transportation noise', *Journal of the Acoustical Society of America* 89, 221-233.

[456] Fields, J.M. (1998). 'Reactions to environmental noise in an ambient noise context in residential areas', *Journal of the Acoustical Society of America* 104, 2245-2260.

[457] Miedema, M.E. (2003). '*Relationship between exposure to single or multiple transportation noise sources and noise annoyance'* in World Health Organisation and European Centre for Environment and Health Report on the Technical meeting of exposure-response relationships of noise on health, Bonn, Germany, 17-19.

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Water supplies including lakes, rivers, and wetlands, can be adversely affected by air pollution, specifically nitrogen oxide produced during acid rain. Nitrogen oxides and carbon monoxide are both components of smog and ground level ozone, primarily produced by combustion of fossil fuels, mainly by vehicles, electricity generation and industrial processes. The health impacts of exposure to smog include impaired lung function in the short term as well as accelerated deterioration in lung function over the long term. Children and individuals with respiratory problems are at greater risk[459]. A new study pattern has also emerged on volatile organic compound emissions, which can affect not only those with decreased lung functions, but also children and certain crops are particularly sensitive.

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Existing Conditions

Oklahoma City is very large, and because of this size, it is difficult to find a percentage of impervious surfaces that effectively characterizes the reality of the situation. In order to better illustrate the amount of impervious surface in the city, the urban growth boundary serves as a divide between the urban and rural areas, and numbers have been generated for both.

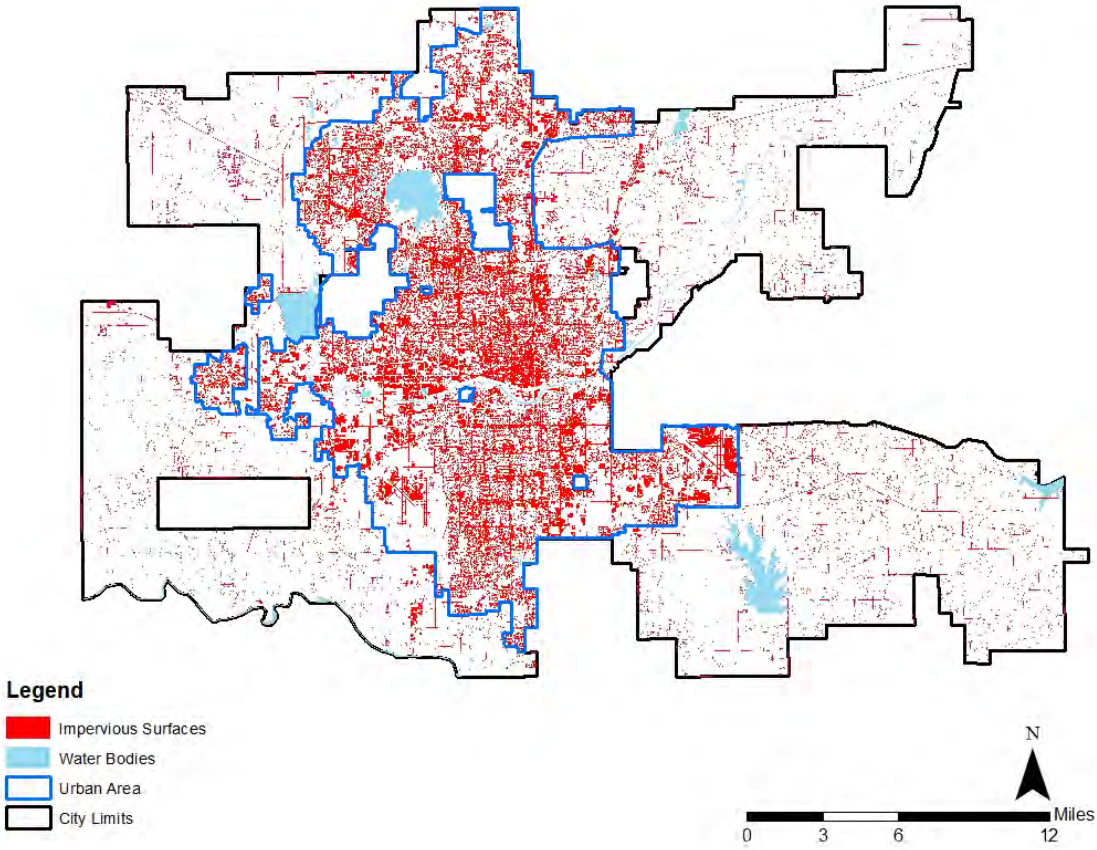
The city has a total acreage of 397,269.2 acres, of which 35.6% (141,235.5 acres) is urban, and 64.4% (256,033.7 acres) is rural. In order to calculate the impervious surface percentage for each of these areas, total pavement and building footprints were added together, and then divided by the total acres for the urban and rural areas (minus water bodies, as these are by definition not land).

All in acres	City		Urban		Rural	
Total Area	397,269.2		141,235.5		256,033.7	
Area Minus Water Bodies	388,188.6		138,244.7		249,943.9	
Percentages below are relative to Area Minus Water Bodies						
Total Impervious	60,644.0	15.6%	49,204.6	35.6%	11,439.4	4.6%
Percentages below are relative to Total Impervious						
Building Footprint	18,668.4	30.8%	16,284.4	33.1%	2,385.0	20.8%
Pavement	41,975.6	69.2%	32,921.2	66.9%	9,054.4	79.2%

[459] Boyd, D. R. (n.d.). *Canada vs. The OECD: An Environmental Comparison*. Retrieved from www.environmentalindicators.com
[460] Kalkstein L.S., Greene J.S. (1997). An evaluation of climate/mortality relationships in large U.S. cities and the possible impacts of a climate change. *EnvironHealth Perspect* 105, 84–93.

Impervious surface in the form of parking lots accounts for 10.9% of the total area (minus water bodies) of the urban area, with a total acreage of 15,089 acres (16,439.3 city-wide). This accounts for 30.7% of the urban impervious surfaces and is the largest single type of impervious pavement in the urban area. Streets account for 11,163.16 acres of impervious surface in the urban area, or 22.7% of the impervious surfaces. The rest of the impervious pavement is made up of sidewalks, driveways, and other miscellaneous slabs.

The map below illustrates the clear distinction of the urban and rural areas of the city, defined by the blue boundary line.



Scenario Analysis

Figures for the possible amount of impervious surface in each of the three scenarios were generated by the Envision Tomorrow tool. This was based upon the new area covered by building footprints as well as streets, sidewalks, driveways, etc. The table below shows the comparative impact of the three scenarios:

	Existing	Scenario A	Scenario B	Scenario C
Total Impervious Surface (in acres)	60,644	84,248	78,345	74,299
Percent Increase	N/A	38.9%	29.2%	22.5%
Percentage of Total Land Area in City	15.6%	21.7%	20.2%	19.1%

Unsurprisingly, the development pattern of Scenario A of greenfield development creates a large increase in impervious surfaces and structures, while Scenarios B and C make better use of existing surfaces. Denser development patterns, particularly those that make use of infill opportunities will leave land in the outskirts pervious, while requiring more robust run-off control in the developed areas.

Conclusions

A) Scenario A has the greatest increase in impervious surfaces and structures.

B) Scenario B has a smaller increase in impervious surfaces and structures than Scenario A, but a greater amount that Scenario C.

C) Scenario C has the smallest increase in impervious surfaces and structures.

Policy Review

Overview:

Impervious surfaces cause great concern for the environment because of their destructive nature. When parking lots, roads, and sidewalks seal the ground to protect erosion, this also eliminates the ground from receiving rainwater infiltration and groundwater recharge. Impervious surfaces also attribute to urban heat islands. Impervious surfaces can be addressed by establishing development regulations, guidelines and incentives that help protect Oklahoma City's water resources and reduce impervious surfaces.

Relevant Policies:

Sustain.LandUsePatterns:**333**

Green.Water Resources.**288**

Green.Water Resources.**293**

Green.Water Resources.**299**

Green.Open Space, Connectivity and Fragmentation.**316**

Green. Green Building and Sustainable Development.**349**

Recommendations

- Create incentives that transition to regulation over time for the control of run-off by requiring pervious pavers and unpaved areas in development standards.
- Build more densely in order to require fewer new roads and parking lots that will increase the rates of TIA.
- Set limits on TIA in each sub-watershed. Protect non-impaired sub-watersheds.
- Incentivize green roofs and rainwater collection processes to mitigate the threats of excessive run-off.
- Implement policies that decrease or remove parking requirements in non-urban areas.
- Encourage the construction of parking garages to limit the amount of ground surface that becomes used for parking.
- Enhance the tree canopy and other vegetation over impervious surfaces to help reduce run-off.

VIII. greenokc Indicators

G.4 Average Residential Energy Usage, Amount of "Green Homes"

Health-based Rationale

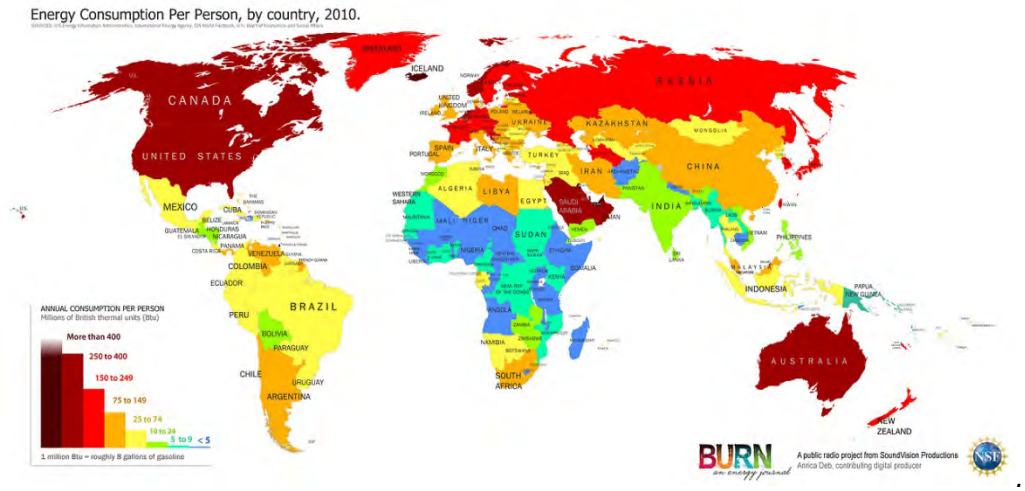
Green developments, which seek to minimize negative environmental effects associated with the built environment[461], incorporate energy-efficient buildings with environmentally sensitive site planning and landscaping[462]. Two types of sustainability associated with green development have been introduced. The first "technical sustainability," which is reflected by things like building materials and construction methods, is used to create developments, and the second is "behavioral sustainability," which is reflected by the behaviors of residents living in them[463].

Non-communicable diseases such as heart disease, strokes, injuries, asthma and other respiratory diseases can be reduced through mitigation measures that reduce exposure to extreme heat and cold, reduce mold and dampness, improve natural ventilation and provide for safer, more energy-efficient home heating and appliances. There is also evidence that housing improvements increase well-being and mental health. In addition infectious diseases, vector-borne diseases such as malaria, waterborne diseases (diarrhea), and airborne diseases, including tuberculosis, can be prevented through low-energy and climate-friendly designs. Improving natural ventilation, limiting vector and pest infestations (e.g. sealing of cracks, window screening), and improving access to safe drinking water and sanitation as part of planning and siting ensure lower risk to personal health. Cleaner home energy also can help avert nearly 1 million deaths annually from pneumonia among children under five. Half of all childhood pneumonia deaths (2004) were due to indoor smoke from biomass and coal cook stoves[464].

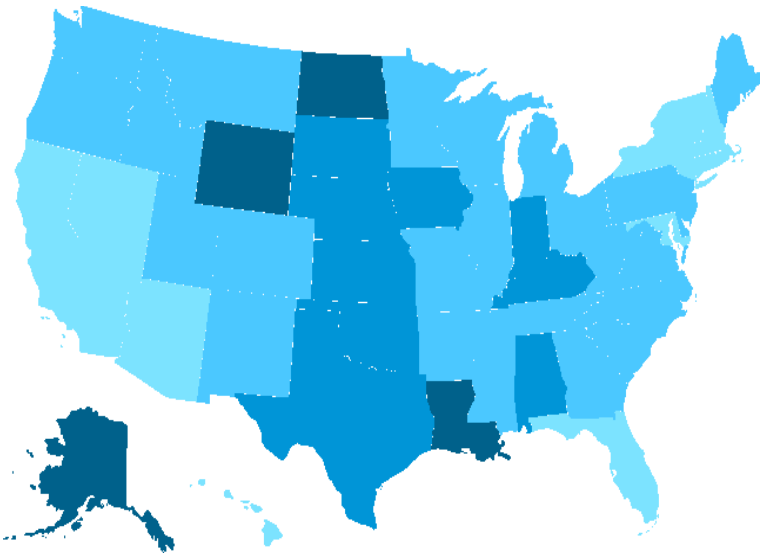
[461] Stromberg, M. (2005). Green grow the buildings. *Planning* 71 (7), 16–21.
[462] Rocky Mountain Institute. (1998). *Green Development: Integrating Ecology and Real Estate*. John Wiley, New York.
[463] Williams, K., Dair, C. (2007). A framework of sustainable behaviours that can be enabled through the design of neighborhood-scale developments. *Sust. Dev.* 15 (3), 160–173.
[464] Röbbel, N. (2011). *Health in the Green Economy – Housing Sector* . World Health Organization (WHO).

Existing Conditions

From a global perspective the United States, Canada, Australia, and Iceland consume the most energy per capita, according to a study produced by the US Energy Information Administration in 2010. The United States consumes on average 334 million Btu's per capita annually.



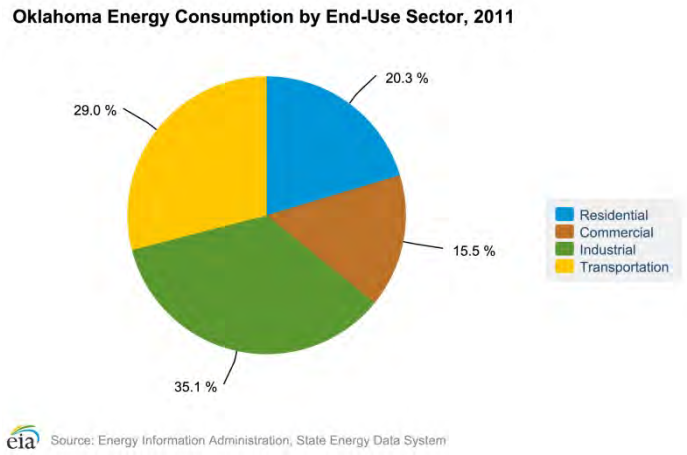
The State of Oklahoma energy consumption, per capita, accounts for roughly 1.60% of total US consumption. Oklahoma's total energy consumption of 1,595 trillion Btu earns it a ranking 23 out of 51 states in the US, while the total energy consumption per capita of 421 million Btu's generates a US ranking of 11 out of 51 states. [465]



Million Btu
<= 250
250 to < 400
400 to < 600
>= 600

Energy Use in Oklahoma by Sector

[465] US Energy Information Administration. (2014). Retrieved 1 12, 2014, from Independent Statistic and Analysis: http://www.eia.gov/state/data.cfm?sid=OK#Economy



End-Use Sector	Oklahoma	Share of U.S.
Consumption		
» Residential	324 trillion Btu	1.50%
» Commercial	248 trillion Btu	1.40%
» Industrial	560 trillion Btu	1.80%
» Transportation	463 trillion Btu	1.70%
Expenditures		
» Residential	$ 3,142 million	1.30%
» Commercial	$ 1,984 million	1.10%
» Industrial	$ 3,103 million	1.20%
» Transportation	$ 11,536 million	1.60%

Green homes can positively affect both the environment and health, but because of the nature of formulation few statistics exist regarding the cumulative benefit of a green home.

Although many Oklahoma City builders, often in conjunction with the Oklahoma State Home Builders Association (OSHBA) now focus on a market niche for green homes, no specific data can be found on the actual number of homes that are considered green homes or homes that have been remodeled as green homes. Oklahoma City does offer an array of options for financial assistance in making your green home a reality by offering financial incentives for corporations and homeowners. Programs offered include corporate tax credits, residential loan programs, property tax incentives, and utility rebate programs[466].

Scenario Analysis

In order to calculate energy usage for the three scenarios a combination of factors were added into a formula. The formulas below represent the steps taken to determine the change in energy usage by household in each of the three scenarios relative to existing conditions.

[466] US Department of Energy & North Carolina Solar Center. (2014). Retrieved 1 12, 2014, from Database of State Incentives for Renewable Energy: http://www.dsireusa.org/incentives/index.cfm?re=0&ee=0&spv=0&st=0&srp=1&state=OK

First, the number of existing and future scenario households ($HH_{ex, a, b, c}$) is multiplied by the ratio of housing types for existing conditions and each of the three scenarios ($HT_{r(ex), r(a), r(b), r(c)}$). The result of this is then multiplied against the energy-use coefficient (EU_C) from the Envision Tomorrow tool, which provides several different coefficients for different housing types. A summation of these figures for each housing type results in an energy-use ratio for existing conditions and all three scenarios ($EU_{r(ex), r(a), r(b), r(c)}$).

$$\sum \left(\left(HH_{ex, a, b, c} * HT_{r(ex), r(a), r(b), r(c)} \right) EU_C \right) = EU_{r(ex)}; EU_{r(a)}; EU_{r(b)}; EU_{r(c)}$$

The energy-use ratio summations for the three scenarios are then divided by the energy-use ratio summation for existing conditions, giving a total energy-use ratio for each scenario relative to existing conditions ($X_{a, b, c}$).

$$\frac{EU_{r(a)}}{EU_{r(ex)}} = X_a \qquad \frac{EU_{r(b)}}{EU_{r(ex)}} = X_b \qquad \frac{EU_{r(c)}}{EU_{r(ex)}} = X_c$$

These total energy-use ratios are then multiplied against the total existing conditions energy usage to give total energy usage for each of the three scenarios ($EU_{a, b, c}$).

$$(X_a, X_b, X_c) * EU_{ex} = EU_a, EU_b, EU_c$$

The total energy usage for each scenario is then divided by the number of households in each of the scenarios to get an average household energy usage for each scenario ($Y_{a, b, c}$).

$$\frac{EU_a}{HH_a} = Y_a \qquad \frac{EU_b}{HH_b} = Y_b \qquad \frac{EU_c}{HH_c} = Y_c$$

The average household energy usage for each scenario is then used to find the rate of change in average household energy usage from existing conditions ($EU_{HH(ex)}$), which results in a percentage change ($\Delta_{a, b, c}$).

$$\frac{Y_a - EU_{HH(ex)}}{EU_{HH(ex)}} = \Delta_a \qquad \frac{Y_b - EU_{HH(ex)}}{EU_{HH(ex)}} = \Delta_b \qquad \frac{Y_c - EU_{HH(ex)}}{EU_{HH(ex)}} = \Delta_c$$

The table below illustrates the results of this math, and shows that energy usage for the city increases regardless of the scenarios (as would be expected with a large increase in population); however, depending on the development pattern, per household energy rates are different.

	Existing	Scenario A	Scenario B	Scenario C
Total Energy Usage *(Millions of BTUs/yr.)*	52,426,826	76,097,755	74,697,451	74,653,691
Household Energy Use *(Millions of BTUs/yr.)*	210.35	213.33	209.41	209.29
Percent Change	N/A	+ 1.41%	- 0.45%	- 0.51%

For transportation it is expected that daily VMT will increase by 56.7% total in Scenario A with a 1.9% increase per capita; increase by a total of 46% in Scenario B with a 5% decrease per capita; increase by a total of 33.8% in Scenario C with a 12.8% decrease per capita. From this we can speculate at the associated energy usage. Assuming an average fuel efficiency of 20 miles per gallon, $3.36 for a gallon of gasoline (current price), and utilizing the VMT numbers generated by the Envision Tomorrow tool, we can calculate total energy usage by motor vehicles.

	Existing	Scenario A	Scenario B	Scenario C
Daily VMT	20,065,125	31,432,465	29,297,021	26,845,349
Gasoline Used *(Gallons per day)*	1,003,256.25	1,571,623,25	1,464,851	1,342,257.45
Household Energy Use *(Millions of BTUs/yr.)*	167.5	183.3	170.9	156.6
Household Cost per Year	$4,936.86	$5,403.41	$5,036.31	$4,614.86
Percent Change	N/A	+ 9.45%	+ 2.01%	- 6.52%

With the fluctuating cost of gasoline, these figures represent more than a fixed cost, but a reference point to a potential range of expenses. The table below combines the energy usage from residential and transportation uses to evaluate a more complete look at what an average person may use in terms of energy.

	Existing	Scenario A	Scenario B	Scenario C
Residential Energy Use	210.35	213.33	209.31	209.29
Transportation Energy Use	167.5	183.3	170.9	156.6
Combined	377.85	396.63	380.21	365.89
Percent Change	N/A	+ 4.97%	+ 0.62%	- 3.17%

There are obvious disparities when calculating energy usage as an average, as there will be people who drive vehicles with much better and much worse fuel efficiency than the 20 miles per gallon used for this analysis. Some people will drive more than others, and likewise, some people will have higher household energy usage due to larger families. Regardless, we can see from the analysis how the scenarios compare to each other.

Conclusions

A) Scenario A results in the greatest increase in energy usage from existing conditions due to the nature of the development pattern and the types of homes that are projected to be built.

B) Scenario B results in a slight increase in overall household energy consumption from existing conditions, mostly due to the increase in transportation energy used, as residential energy usage decreases slightly.

C) Scenario C results in a significant decrease in average household energy consumption. This is due to a slight decrease in residential energy use and a large drop in energy usage due to transportation needs.

Policy Review

Overview:

Energy is no longer being considered an infinite resource and increased production costs are trending. These increased production costs get transferred to the consumer. Oklahoma City in conjunction with utility companies encourages conservation of energy, along with other public utilities. Building and converting homes to "green homes" includes techniques to improve efficiency, conserve energy, and help create a more sustainable environment. Oklahoma City can reduce energy use by partnering with agencies, non-profits, and private entities develop education networking, educate citizens on energy conservation opportunities, and develop a 'healthy building standards code' to encourage renovation and construction of long-lasting, health-promoting and energy efficient homes that incorporate proven green development materials, low flow and low water use fixtures, and innovative design and construction techniques.

Relevant Policies:

Green. Green Building and Sustainable Development.**320**

Green. Green Building and Sustainable Development.**351**

Green. Green Building and Sustainable Development.**476**

Live.Housing.**481**

Live.Housing.**486**

Recommendations

- Engage the Corporation Commission to ensure that additional fees and costs for residential renewable energy operations are warranted. Make sure customers are paid retail rates of net metering on site.
- Encourage multi-family residential developments.
    - Mandate the disclosure of energy use/cost accounting to maintain an active energy management plan.
- Promote energy efficiency in single-family residential properties through education programming, funded by a revolving loan to ensure long-term guidance and support.
- Encourage development that abides by standards such as Energy Star, including active monitoring.
    - Implement and enforce IECC2009 for all new development.

- Explore technologies of, and incentivize the use of wind, photovoltaics, and other renewable energies for residential and commercial uses.
- Lead by example; establish benchmarks and set goals to decrease the City's energy usage each year.
- Use education programs to solidify the connection between water consumption and energy usage by incentivizing efficient water features.
    - Encourage the use of efficient fixtures indoor and outdoor.

VIII. greenokc Indicators

G.3 Total Impervious Areas

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G.6 Water quality conditions and causes

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[468] Hagler, L. M. (2001). *Summary of Adverse Health Effects of Noise Pollution.* Based on the World Health Organization Guideline for Community Noise. Retrieved from http://www.who.int/docstore/peh/noise/guidelines2.html

[3] Fidell, S., Barber, D.S., Schultz, T.J. (1991). 'Updating dosage-effect relationship for the prevalence of annoyance due to general transportation noise', *Journal of the Acoustical Society of America* 89, 221-233.

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Existing Conditions

The U.S. Environmental Protection Agency (EPA) and your local air quality agency have been working to make information about outdoor air quality as easy to find and understand as weather forecasts. A key tool in this efforts in the Air Quality Index, or AQI. EPA and local officials use the AQI to provide simple information about your local air quality, how unhealthy air may affect you, and how you can protect your health.[475]

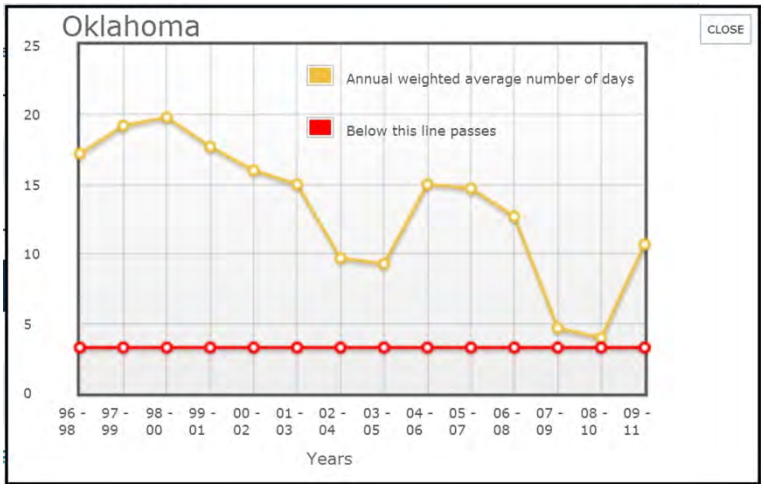
Air Quality Index for Ozone

Index Values (Conc. Range)	Air Quality Descriptors	Cautionary Statements for Ozone
0 – 50 (0-60 ppb)	Good	**No health impacts are expected when air quality is in this range.**
51 – 100 (61-75 ppb)	Moderate	**Unusually sensitive people should consider limiting prolonged outdoor exertion**
101 – 150 (76-104 ppb)	Unhealthy for Sensitive Groups	**Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion**
151 – 200 (105-115 ppb)	Unhealthy	**Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children should limit prolonged outdoor exertion.**
201 – 300 (116-374 ppb)	Very Unhealthy	**Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.**

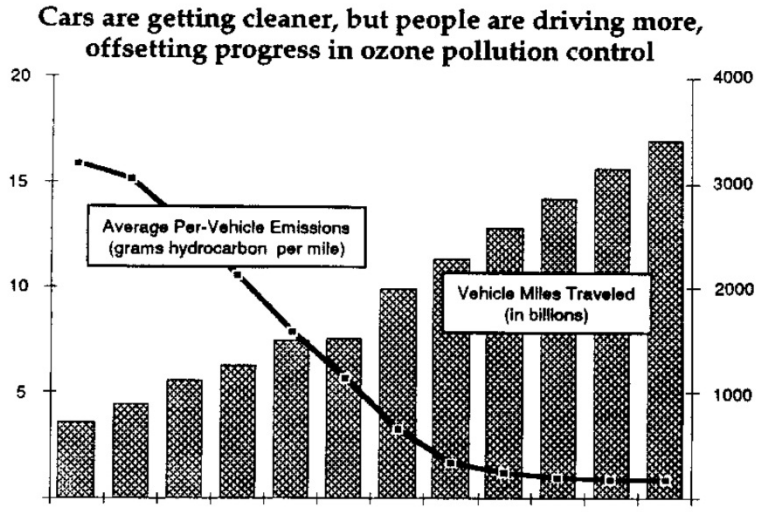
According to StateoftheAir.Org, Oklahoma City ties for 20th worst air quality in the country by ozone amounts, with a score of F for the number of "orange ozone days" at 32 for the most recent testing period[476].

[473] Boyd, D. R. (n.d.). *Canada vs. The OECD: An Environmental Comparison*. Retrieved from www.environmentalindicators.com
[474] Kalkstein, L.S., Greene, J.S. (1997). An evaluation of climate/mortality relationships in large U.S. cities and the possible impacts of a climate change. *EnvironHealth Perspect*. 105, 84–93.
[475] Agency, U. S. (2009). *AQI Air Quality Index: A Guide to Air Quality and Your Health*. Triangle Park, NC: United States Environmental Protection Agency.
[476] American Lung Association. (2013). *State of the Air*. Retrieved from http://www.stateoftheair.org/2013/states/oklahoma/oklahoma-40109.html

During that same time period, Oklahoma City scored an A for particle pollution. The prevalence of ozone in the air of Oklahoma City is a result of a variety of industrial and combustion processes and includes the number of vehicles and vehicle-miles travelled.



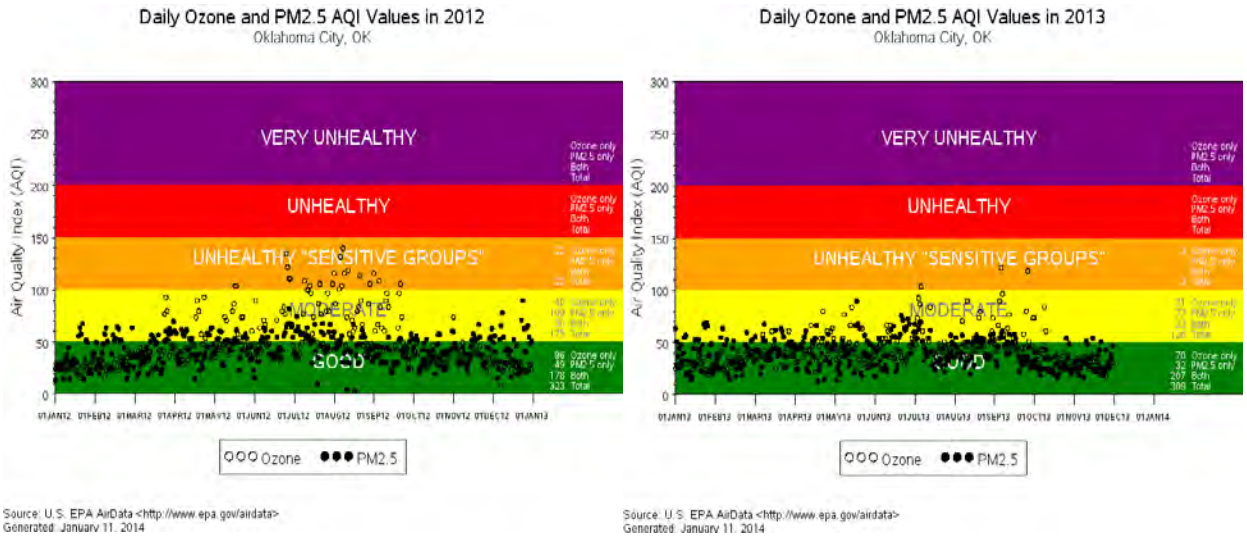
In the past few decades since the Clean Air Act of 1970, cars and gasoline have become cleaner and more efficient, but the number of drivers and total miles driven has increased such that air quality is not improving to healthy levels[477].



However, Oklahoma City averages in the good to moderate range consistantly throughout the seasons. When looking at daily data collected from 2012, focusing on Daily Ozone and Fine Particle (PM2.5) levels Oklahoma City, ozone concentration averaged 0.0485 PPM and the average AQI totaled 47. In addition, PM-2.5 concentration levels averaged 4.0531 ug/m3 and AQI totaled 13. The daily ozone concentrated levels for 2013 indicate 0.0453 PPM with an AQI of 40 while the PM-2.5 concentration level indicates 10.1389 ug/m3

[477] U.S. Environmental Protection Agency, Office of Mobile Sources. (1993). *Automobiles and ozone*. Retrieved from website: http://www.epa.gov/otaq/consumer/04-ozone.pdf

and an average AQI of 40[478]. Compared to the 2013 data collected, daily ozone levels decreased while PM2.5 levels increased.

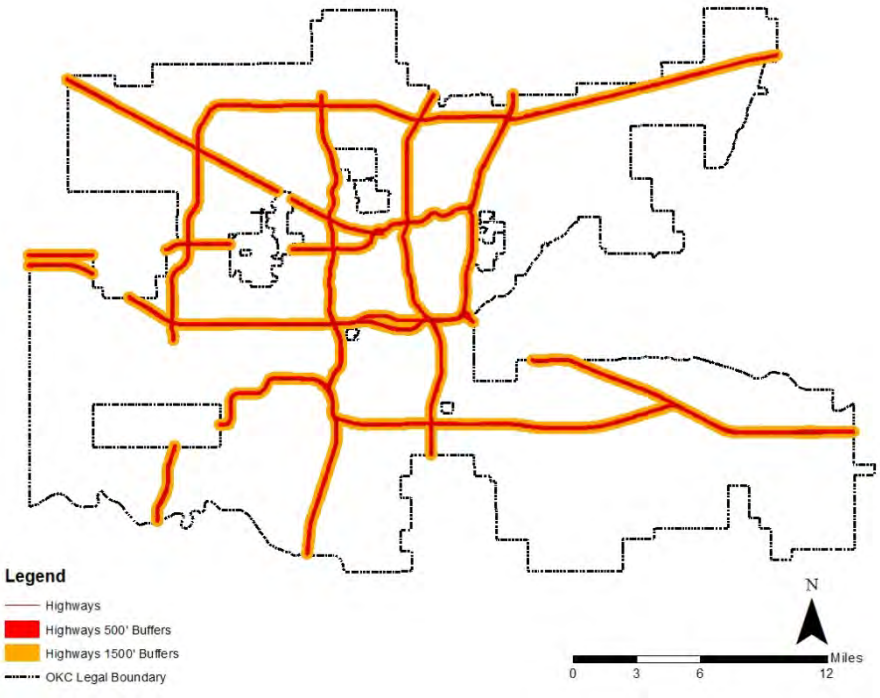


The County of Los Angeles Public Health Department recommends a buffer of at least 500' around highways for schools, housing and other sensitive land uses. Further (out to 1,500'), these land use types should adhere to best management mitigation measures to reduce exposure to air pollution; this includes air filtration within HVAC systems, and the placement of recreation facilities as far from the highway as possible[479]. Though these regulations are not for Oklahoma City, they come from an area of the country that suffers greatly from air pollution due to automobile traffic. Oklahoma City has significant numbers of residences as well as schools within these two buffer distances.

Sensitive Land Uses in Proximity to Major Highways					
Distance	**Residential Units**	**Population**	**Schools**		
500'	17,830	50,416	**8**		
			Elem.	Mid.	High
			7	2	1
1320' (¼-mile)	43,925	109,294	**23**		
			Elem.	Mid.	High
			17	11	8
1500'	50,416	125,445	**28**		
			Elem.	Mid.	High
			19	14	11

[478] Oklahoma Department of Environmental Quality. (n.d.). Retrieved 1 11, 2014, from http://www.deq.state.ok.us/aqdnew/AQIndex/AQI_Archive/OKCAQI2013.htm

[479] County of Los Angeles, Department of Public Health. (2013). *Air quality recommendations for local jurisdictions*. Retrieved from website: http://publichealth.lacounty.gov/eh/docs/AQinFreeways.pdf



Scenario Analysis

Quantitative Analysis:

Vehicular emissions, while not the sole contributor to inflamed air quality conditions, is well suited for making predictions due to the relative consistency in trends with increasing usage. The Envision Tomorrow Travel Application uses constant values for pollutants (VOCs, CO, CO_2, NO_x, PM10, PM2.5, and SO_x) compared with VMT as a variable to arrive at expected levels of each pollutant for each of the three scenarios. The table below breaks down the levels of the different vehicular emissions in metric tons for existing conditions and each of the scenarios:

Substance	Existing	Scenario A		Scenario B		Scenario C	
	(mt/day)	*(mt/day)*	*% Change*	*(mt/day)*	*% Change*	*(mt/day)*	*% Change*
VOCs	3.44	5.40	56.7%	5.03	46.0%	4.61	33.8%
CO	65.1	102	56.7%	95.1	46.0%	87.1	33.8%
CO_2	9,997.9	15,662	56.7%	14,598	46.0%	13,376	33.8%
NO_x	7.82	12.2	56.7%	11.4	46.0%	10.5	33.8%
PM10	0.099	0.155	56.7%	0.144	46.0%	0.131	33.8%
PM2.5	0.090	0.141	56.7%	0.131	46.0%	0.120	33.8%
SO_X	4.73×10^{-10}	7.17×10^{-10}	51.6%	7.29×10^{-10}	54.2%	7.36×10^{-10}	55.5%
Total Organic Gases	4.24	6.64	56.7%	6.19	46.0%	5.67	33.8%

All three scenarios increase levels of potential vehicular emissions, with the majority of substances correlating to the amount of VMT predicted by each of the three scenarios. The one irregular substance is SO_x (Sulfur Oxides) which is higher in Scenarios B and C than in Scenario A. This is due to the levels of sulfur oxides found in diesel fuel that is often used in transit systems. Because transit is utilized more frequently in Scenario C, we see the highest level of sulfur oxide emissions.

Determining the proximity of residential units to the highways and interstates for each scenario reveals an unexpected result. The table below outlines the shift for each scenario from existing conditions:

Distance	Existing		Scenario A		Scenario B		Scenario C	
	Population	% of Total	Population	% of Total	Population	% of Total	Population	% of Total
500'	50,416	8.1%	46,722	5.2%	50,291	5.6%	47,179	5.3%
1,500'	125,445	20.1%	140,249	15.7%	152,878	17.2%	146,920	16.5%

All three scenarios reduce the percentage of residents that live within an unhealthy distance of the highways, and all three reduce the actual number of people living within 500' of a highway. Each scenario reduces the percentage of people living within 1,500' of a highway; however, all three scenarios increase the actual number of residents living within this proximity. Scenario A performs the best of the three, while Scenario B performs the worst.

Qualitative Analysis:

The different development patterns of the three scenarios impact existing natural resources. In particular, deforestation is more likely to occur as a result of the development patterns of Scenario A, somewhat for Scenario B, and less so for Scenario C. Deforestation constitutes 11.3% of carbon emissions by the energy taken to remove forested areas, the resulting lack of a carbon sink, and often the use of timber as a fuel source, releasing the embodied carbon into the atmosphere. In Scenario C fewer trees would be removed from the outskirts of the city due to development, and because of the denser pattern of development, the addition of street trees would be more efficient and easier to accomplish, leaving Oklahoma City with a healthier balance of natural forest growth and curated urban forest growth.

Conclusions

A) The greatest increase in automobile emissions occurs under Scenario A; however, less people live in dangerous proximity to highways in Scenario A than in B or C. Additionally, in Scenario A the most deforestation will occur, compounding the impact of the greater amount of air pollutants. Overall, it is reasonable to expect that Scenario B will increase air pollution and the negative health impacts associated.

B) Under Scenario B there is an increase in harmful automobile emissions that is less than the increase in Scenario A, but greater than the increase in Scenario C. More people live within a dangerous proximity to highways in Scenario B than in A or C. Deforestation will be likely but not as widespread as in Scenario A. Overall, it is reasonable to suspect that Scenario B will increase air pollution and the negative health impacts associated at a similar rate to Scenario A.

C) Scenario C has the lowest increase in automobile emissions out of the three growth scenarios. More people live within a dangerous proximity of highways in Scenario C than in A, but less than in B. Because of the more compact pattern of development in Scenario C, deforestation is kept to a minimum. Overall, it is reasonable to expect air pollution to still be an issue in Scenario C, but to the least extent of all of the scenarios, with the greatest opportunity for mitigation via other policy decisions.

Policy Review

Overview:

Improvements to air quality rely upon the regulation of existing practices in construction, transportation, and business. These can be implemented through zoning performance standards, coalitions between the local and regional government, as well as the City leading by example (alternatively-fueled vehicles, constructions practices, etc.).

Relevant Policies:

Green. Atmosphere and Climate.**165**

Green. Atmosphere and Climate.**304**

Green. Atmosphere and Climate.**307**

Sustain.Land Use Patterns.**252**

Connect.Transportation Systems.**180**

Recommendations

- Implement policies such as Complete Streets that encourage people to use all modes of transportation.
- Continue the transition of City fleets to alternative fuels. Set benchmarks and goals for the reduction of dependency on diesel and unleaded gasoline reported in Leading for Results (LFR).
- Encourage industrial technologies that emit lower levels of harmful chemicals into the air.)
- Establish special development and building standards for development built within a dangerous distance of major highways.
    - Include more rigorous safety and filtration standards for HVAC systems for homes, commercial, retail, etc. within these areas.
    - Disallow the construction of any schools, parks, places for outdoor activities, or places targeted toward children within a dangerous buffer of major highways.
    - Require the monitoring of indoor air quality conditions.
- Incentivize fuel-efficient vehicles and lower-emitting alternative fuels.
- Create a street-tree planting program focusing on creating barriers between areas of industry and high-use transportation corridors from residential and related uses.
- Utilize EECBG standards; institute a recurring review:
    - Quantify greenhouse gas and other emissions, both existing and projected over a specified time period, resulting from activities within a defined geographic area.
    - Identify and analyze the emissions resulting from specific actions or categories of actions anticipated within the geographic area.

- Create standards for generator emissions and incentivize cleaner models.

Traffic-Related

- Synchronize traffic signals to improve traffic flow and minimize traffic congestion. Expand Intelligent Traffic Systems (ITS).
- Improve public transit service to reduce vehicle traffic and increase public transit mode share during peak traffic congestion periods.
- Improve bicycle and pedestrian infrastructure to reduce vehicle traffic and increase bicycle and pedestrian mode share during peak traffic congestion periods.
- Adjust pedestrian crosswalk signal timing to minimize waiting time for vehicles turning right or otherwise sharing green light time with pedestrians. Give pedestrians a head start before traffic signal changes to green.
- Limit heavy-duty truck traffic during peak hours. Designate truck routes that divert truck traffic away from congested intersections.
- Limit left turns or other maneuvers that add to congestion during peak hours.

Construction-Related

- Water all exposed surfaces (e.g., parking areas, staging areas, soil piles, graded areas, and unpaved access roads, building pads) two times per day.
- Ensure and enforce that all haul trucks transporting soil, sand, or other loose material off-site are covered.
- All visible mud or dirt track-out onto adjacent public roads shall be removed using wet power vacuum street sweepers at least once per day. The use of dry power sweeping is prohibited.
- Limit all vehicle speeds on unpaved roads to 15 mph.
- Minimize idling times either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes.
- Ensure that clear signage is provided for construction workers at all access points.
- Ensure that all construction equipment is maintained and properly tuned in accordance with manufacturer's specifications, and checked by a certified mechanic prior to operation.

VIII. greenokc Indicators

G.3 Total Impervious Areas

G.4 Air Quality Conditions

G.5 Urban Heat Island Effect Conditions and Causes

G.6 Water quality conditions and causes

G.7 Light and noise pollution

Health-based Rationale

Environmental and natural resources can greatly impact a population's health. Considering natural resources are often shared by the entire community, state, and region many individuals' health outcomes are intertwined. Air and water quality, pollution of all types, and the built environment all contribute to the health of a community.

Environmental noise can affect more than just the obvious auditory system, extending to loss of hearing and other hearing impairments[480]. Hearing damage is related to duration and intensity of noise exposure and occurs at levels of 80 dB or greater, which is equivalent to the noise of heavy truck traffic[481]. Children seem to be more vulnerable than adults. In addition, unwanted or outdoor sounds created by humans also have an impact on non-auditory systems. Studies have shown that noise annoyance from transportation produces a variety of negative emotions including anger, disappointment, unhappiness, anxiety and even depression[482] [483] [484] [485]. Although many cities are providing increased noise pollution protection for communities located near busy thoroughfares, the noise pollution still impacts many stages of health.

Water quality has been a major focus for many organizations since the 19th century. Water system infrastructures are designed to gather, deliver and dispose of water (dams, reservoirs, water treatment facilities, distribution networks and sewage treatment). Bearing in mind that municipal water systems are designed to not only control the water flow throughout the city, they are also concerned with sanitation of water sources to reduce bacteria, contaminates, and pollution that can be detrimental to health.

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[480] Prasher, D. (2003). *'Estimation of hearing damage from noise exposure'* in World Health Organization and European Centre for Environment and Health Report on the Technical meeting of exposure-response relationships of noise on health, Bonn, Germany, 17-19.

[481] Hagler, L. M. (2001). *Summary of Adverse Health Effects of Noise Pollution.* Based on the World Health Organization Guideline for Community Noise. Retrieved from http://www.who.int/docstore/peh/noise/guidelines2.html

[481] Fidell, S., Barber, D.S., Schultz, T.J. (1991). 'Updating dosage-effect relationship for the prevalence of annoyance due to general transportation noise', *Journal of the Acoustical Society of America* 89, 221-233.

[482] Fields, J.M. (1998) 'Reactions to environmental noise in an ambient noise context in residential areas', *Journal of the Acoustical Society of America* 104, 2245-2260.

[483] Miedema, M.E. (2003). *'Relationship between exposure to single or multiple transportation noise sources and noise annoyance'* in World Health Organisation and European Centre for Environment and Health Report on the Technical meeting of exposure-response relationships of noise on health, Bonn, Germany, 17-19.

[484] Michaud, D.S., Keith, S.E. and McMurchy, D. (2005). 'Noise Annoyance in Canada', *Noise and Health* 7, 27, 39-47.

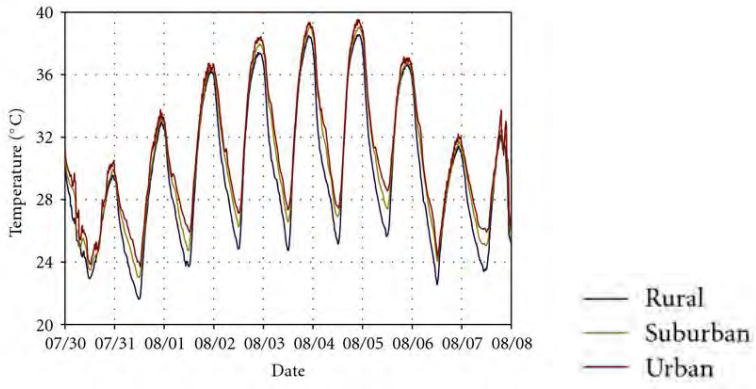
Water supplies including lakes, rivers, and wetlands, can be adversely affected by air pollution, specifically nitrogen oxide produced during acid rain. Nitrogen oxides and carbon monoxide are both components of smog and ground level ozone, primarily produced by combustion of fossil fuels, mainly by vehicles, electricity generation and industrial processes. The health impacts of exposure to smog include impaired lung function in the short term as well as accelerated deterioration in lung function over the long term. Children and individuals with respiratory problems are at greater risk.[486] A new study pattern has also emerged on volatile organic compound emissions, which can affect not only those with decreased lung functions, but also children and certain crops are particularly sensitive.

Urban heat island effects are considered to be the amplified heat sources in metropolitan areas caused by increased population activities and features of the built environment, such as concrete, sidewalks, and lack of impervious surfaces. These features have been shown to increase the risk of heat-related death, including access to transportation, medical care, and cooling centers as well as crime, housing type, and neighborhood land use[487]. In sum, people in warmer neighborhoods were more vulnerable to heat exposure because they had greater exposure to heat and fewer social and material resources.

Existing Conditions

With the dissolution of the MicroNet data collection service, a great deal of insight into the existing conditions of urban heat-island effect in Oklahoma City has been lost. However, we do know the factors that contribute to the urban heat-island effect; impervious surface, vegetation degradation, etc. A study conducted by the Oklahoma Climatological Survey and the Center for Applied Social Research from the University of Oklahoma utilized the now defunct MicroNet data service, finding that there is indeed a UHI effect within Oklahoma City. Interestingly, the UHI effect was not only found in urban areas, but also suburban areas, when compared to rural areas. The UHI effect was more pronounced during the night than during the day.

> "A consistent UHI occurred during the heat wave period as demonstrated in Figure 2(b) whereby conditions in the urban core of Oklahoma City were (a) typically **0.5C warmer** during the day, (b) more than **2C warmer** at night… …At the same time, the suburban areas also displayed a warmer signal than the rural areas, especially during the overnight periods when conditions were typically **1.5C or more warmer**."[488]



[486] Boyd, D. R. (n.d.). *Canada vs. The OECD: An Environmental Comparison*. Retrieved from www.environmentalindicators.com
[487] Kalkstein, L.S, Greene, J.S. (1997). An evaluation of climate/mortality relationships in large U.S. cities and the possible impacts of a climate change. *EnvironHealth Perspect.* 105, 84–93.
[488] Basara, J. B., et al. (2010). The impact of the urban heat island during an intense heat wave in Oklahoma City. *Advances in Meteorology*, Retrieved from http://www.hindawi.com/journals/amete/2010/230365/

Remote Sensing:

Using remote sensing techniques, hot spots can be detected by analyzing LANDSAT satellite imagery by interpreting the thermal infrared spectral band. By classifying these images into hot-spots and other areas, we can then compare the amount of hot spots within the main developed areas of Oklahoma City; as such, rural areas were removed from the imagery so as not to skew the investigation. Another reason to exclude the rural areas is due to UHI effects being more pronounced during the night, and LANDSAT images all being from daylight hours.

1983

1993

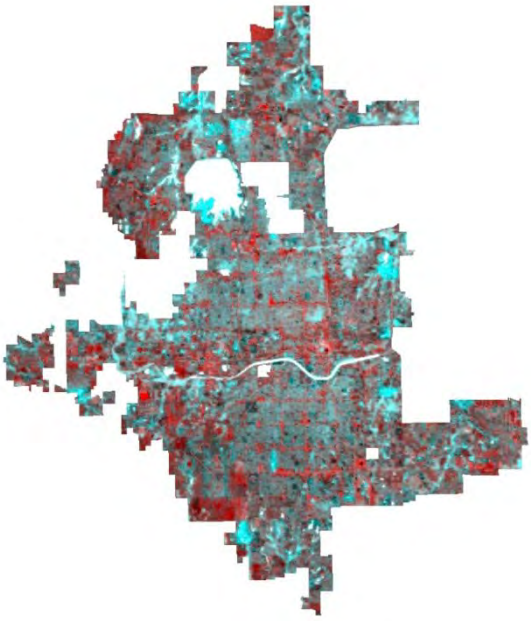
2003

2011

At first glance, these images look the same, but development has been increasing in density in the downtown core area, as well as I-40 north of the river. Additionally, the main arterial street grid has become more and more developed over the years.

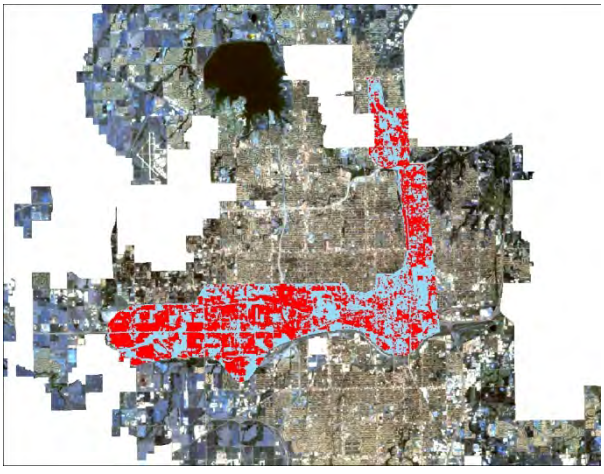
The map below shows a false coloring of the city to bring out the thermal balance of vegetated and non-vegetated areas. The red areas correspond to exposed impervious surfaces and development which have higher temperatures than the areas with vegetation like the visible riparian corridors and fainter neighborhoods.

2003 (bands – R: 4, G: 6, B: 6)

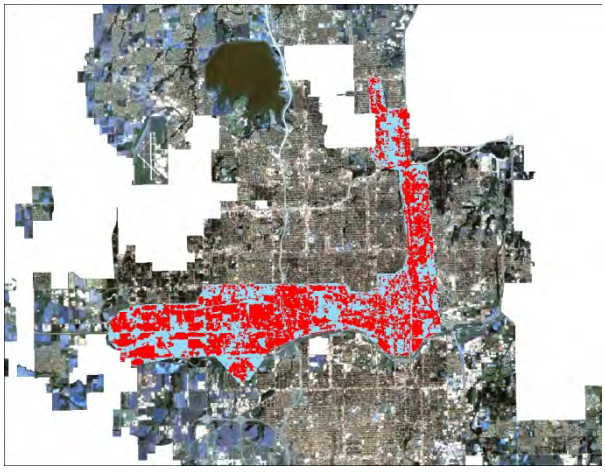


In order to see an example of the difference in terms of potential UHI effect of this development, the urban area was further refined to include the downtown, the Capitol area, and the areas west of downtown to the airport. In the drawings below, the red represents hot spots (derived from the areas that turned up in red in the false-color thermal images). In order to compare the different decades, the amount of red for each decade was subtracted from the 2011 (most recent) image to see how much greater the potential for heat island effect is.

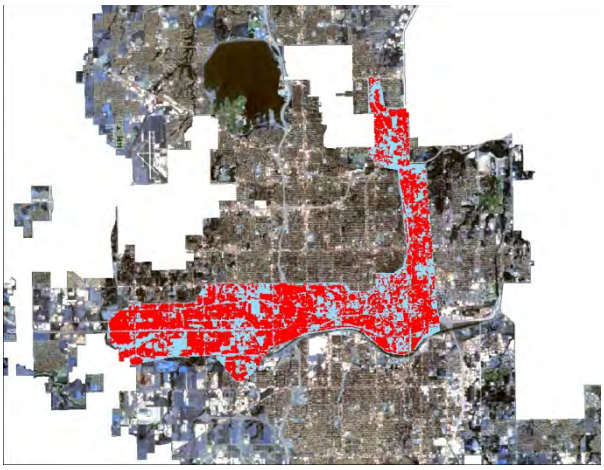
1983



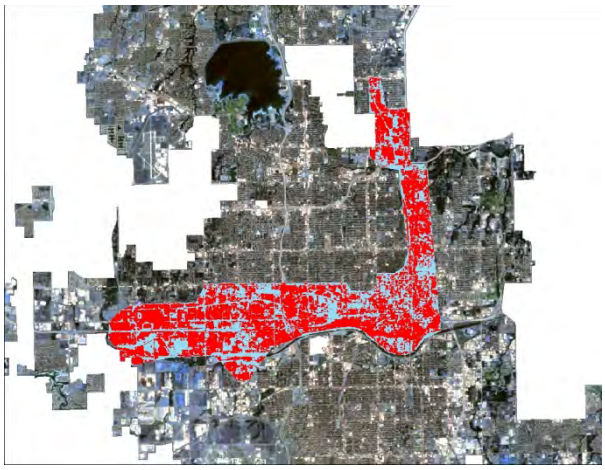
1993



2003

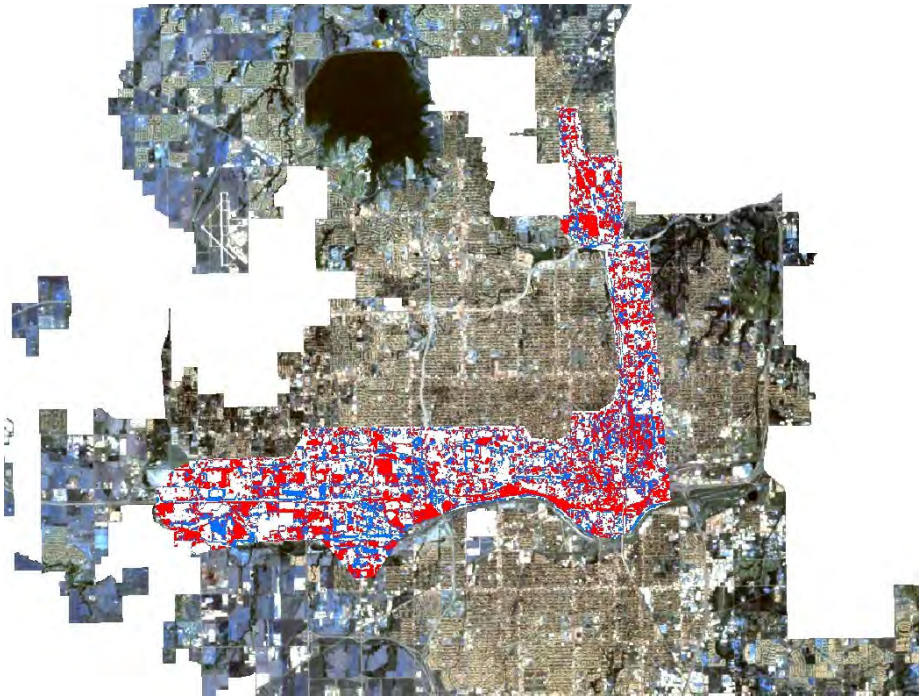


2011



Year	Percent of Present
1983	55%
1993	68%
2003	89%
2011	100%

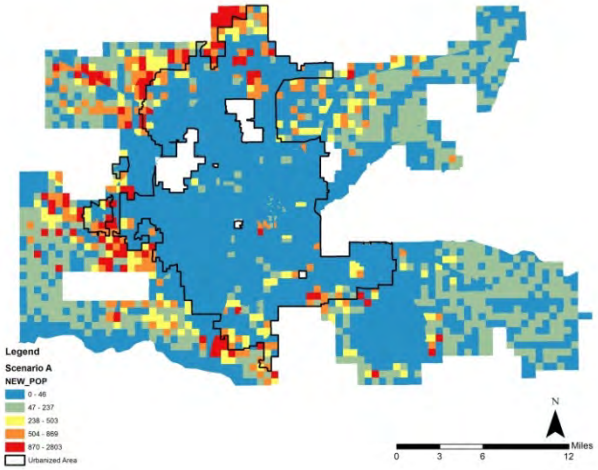
The image below is a combination of the above images to show the areas that are current hot spots (in red) and those that are no longer hot spots (in blue). The new I-40 corridor is clearly recognizable in red, while the former location is now predominantly blue.



Caveat: The remote sensing exercise acts to illustrate thermal changes due to development, but does not necessarily imply that only urban areas contribute to the UHI in Oklahoma City, as suburban areas have been proven to have an impact.

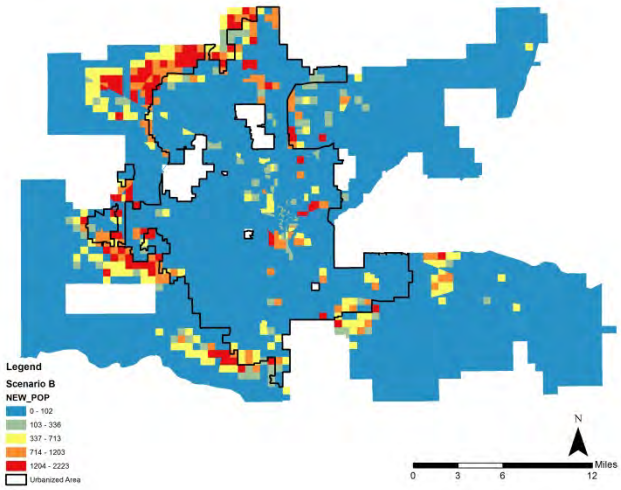
Scenario Analysis

Without access to trending MicroNet data in various locations, there is no way to presently make predictions regarding temperature fluctuations in the rural, suburban and urban areas comparatively. What can be calculated is the increase and location of impervious surfaces, which are generally responsible for the symptoms of UHI effects. Additionally, the location of new residents can help to predict where the extent of the urbanized area within Oklahoma City will extend to in the future.

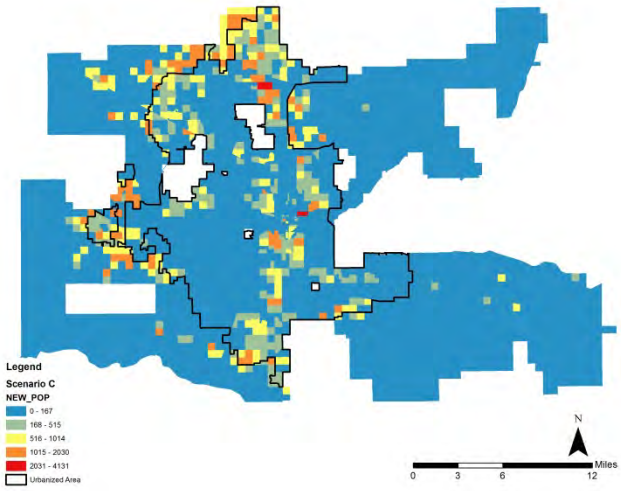


as

Scenario A locates large numbers of people in the outskirts of the city, with very few new residents within what is today considered the urbanized area. This would require a great deal of impervious roads, sidewalks, parking lots, driveways, and buildings.



Scenario B spreads the population less in the outskirts, but does place the majority of new residents outside of the present urbanized area. This pattern is less sprawling than Scenario A and would not require as much impervious surface to accommodate the populous.



Scenario C locates the majority of the population within the urbanized area, taking advantage of existing service areas, adding impervious areas, but within the existing area. This limits growth in a manner that preserves rural character and ecosystems.

In addition to the visible pattern of growth, Envision Tomorrow allows for a comparison between scenarios of new impervious surface area. Based on this capability, Scenario A will add 3.32 times as much impervious surface in the non-urbanized area as Scenario C, and Scenario B will add 2.38 times that of Scenario C. The table below shows the gross area of impervious surface in the city regardless of whether it is in urbanized or rural areas; illustrating again that Scenario A and Scenario B result in higher amounts than Scenario C.

	Existing	Scenario A	Scenario B	Scenario C
Total Impervious Surface (in acres)	60,644	84,248	78,345	74,299
Percent Increase	N/A	38.9%	29.2%	22.5%
Percentage of Total Land Area in City	15.6%	21.7%	20.2%	19.1%

Caveat:

Many elements that mitigate the UHI effect are not specifically dependent upon the pattern of development growth in the city. Trees and other vegetative elements are useful in reducing the temperature in an urban environment, as are reflective surfaces on buildings, sidewalks, and streets.

Conclusions

A) While Scenario A may not result in the highest temperature reading of the three scenarios, Scenario A would likely increase the reach of the urban heat-island effect the most in Oklahoma City as the greatest area of impervious surfaces would be required to service the future population.

B) Scenario B would likely increase the impact of the urban heat-island effect to a greater degree than Scenario C, but less than Scenario A.

C) Scenario C would likely increase the urban heat-island effect the least of the three scenarios as less impervious surface would be added. Because Scenario C would have the highest density of impervious surfaces, higher temperatures could occur over the urbanized area. However, due to the more constrained development pattern of Scenario C, taking steps to alleviate the UHI effect with trees and other vegetation would be more affordable than in the more sprawling pattern of Scenario A and B.

Policy Review

Overview:

While the total impact of an urban heat island on global warming is still being debated, the direct effects of ground level temperatures can be identified. Areas that have a large ratio of impervious surfaces have warmer temperatures, as they capture more sunlight and absorb more heat. Oklahoma City can the impact of the urban heat island effect on Oklahoma City by establishing a minimum canopy coverage requirement over paved surfaces such as parking lots, instating a "continuous canopy" requirement for new streets and street

reconstruction projects, and promoting the use of building and roofing materials that reduce heat island effects.

Relevant Policies:

Green.Green Building and Sustainable Development.**349**

Recommendations

- Increase efforts to plant street trees and other vegetative elements in and around areas with high rates of impervious surfaces (shade trees, green walls, etc.).
    - Establishing a minimum canopy coverage requirement over paved surfaces such as parking lots.
    - Instating a "continuous canopy" requirement for new streets and street reconstruction projects.
- Incentivize the use of green roofs and cool roofs in all areas and land uses within Oklahoma City.
- Promote the use of reflective and permeable pavement materials.
    - Host workshops to explain installation, benefits, etc.
- Reduce vehicle emissions by investing in alternative transportation.
- Encourage community involvement in volunteer efforts, including demonstration projects, urban forestry programs, outreach and education programs, and awards.

VIII. greenokc Indicators

G.3 Total Impervious Areas

G.4 Air Quality Conditions

G.5 Urban Heat Island Effect Conditions and Causes

G.6 Water quality conditions and causes

G.7 Light and noise pollution

Health-based Rationale

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[491] Fields, J.M. (1998). 'Reactions to environmental noise in an ambient noise context in residential areas', *Journal of the Acoustical Society of America* 104, 2245-2260.
[492] Miedema, M.E. (2003). *'Relationship between exposure to single or multiple transportation noise sources and noise annoyance'* in World Health Organisation and European Centre for Environment and Health Report on the Technical meeting of exposure-response relationships of noise on health, Bonn, Germany, 17-19.
[493] Michaud, D.S., Keith, S.E., McMurchy, D. (2005). 'Noise Annoyance in Canada', *Noise and Health* 7, 27, 39-47.

Water supplies including lakes, rivers, and wetlands, can be adversely affected by air pollution, specifically nitrogen oxide produced during acid rain. Nitrogen oxides and carbon monoxide are both components of smog and ground level ozone, primarily produced by combustion of fossil fuels, mainly by vehicles, electricity generation and industrial processes. The health impacts of exposure to smog include impaired lung function in the short term as well as accelerated deterioration in lung function over the long term. Children and individuals with respiratory problems are at greater risk.[495] A new study pattern has also emerged on volatile organic compound emissions, which can affect not only those with decreased lung functions, but also children and certain crops are particularly sensitive.

Urban heat island effects are considered to be the amplified heat sources in metropolitan areas caused by increased population activities and the built environment, such as concrete, sidewalks, and lack of impervious surfaces. Other features of the built environment and urban socio-demographics have been shown to increase the risk of heat-related death, including access to transportation, medical care, and cooling centers as well as crime, housing type, and neighborhood land use[496]. In sum, people in warmer neighborhoods were more vulnerable to heat exposure because they had greater exposure to heat and fewer social and material resources.

Existing Conditions

Currently, in the State of Oklahoma 1,129 systems are classified as community water systems (such as towns and rural water districts), 109 are classified as non-transient, non-community water systems (such as schools or factories) and 374 are classified as non-community water systems (such as rest stops or parks). There are also much smaller systems, which are referred to as minor water systems. These systems are regulated by Environmental Complaints and Local Services (ECLS)[497]. Oklahoma City's three urban reservoirs store the city's water supply which reaches homes as drinking water. The lakes also provide many water recreation activities. Oklahoma City manages the reservoirs to maximize recreational activities while protecting the water supply. In addition, The Oklahoma River also allows for recreational enjoyment.

Lake Overholser measures 1,500 surface acres with an average depth of 6 feet - 13 feet at its deepest. Lake Overholser attractions include a covered fishing pier, boat ramps, tending docks, handicap facilities and fish attractors, and a covered picnic pavilion. Picnicking, fishing, sailing, boating and jetskiing are permitted. Swimming is prohibited.

Lake Draper takes water from Lake Atoka and the McGee Creek Reservoir in southeast Oklahoma. Lake Draper measures 2,900 surface acres with an average depth of 34 feet – 98 feet at its deepest. Attractions include four covered fishing piers, boat ramps, tending docks, handicap facilities and fish attractors. Picnicking, fishing, jetskiing, boating, skiing and sailing are all permitted. Swimming is prohibited.

Lake Hefner is 2,500 surface acres with a depth of 29 feet average and 94 feet deepest. Lake Hefner attractions include enclosed, heated fishing dock, two covered piers, boat ramps, wet slips and dry storage for boats, East Wharf restaurant area, Hefner Trails biking and jogging area, covered pavilion at Stars and Stripes Park and Hefner Golf Course.

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[495] Boyd, D. R. (n.d.). *Canada vs. The OECD: An Environmental Comparison*. Retrieved from www.environmentalindicators.com
[496] Kalkstein, L.S., Greene, J.S. (1997). An evaluation of climate/mortality relationships in large U.S. cities and the possible impacts of a climate change. *EnvironHealth Perspect.* 105, 84–93.
[497] Oklahoma Department of Environmental Quality. (2011). Retrieved 1 12, 2014, from Public Water Supply: http://www.deq.state.ok.us/wqdnew/pws/index.html

A 7-mile stretch of the North Canadian River has been transformed into a series of river lakes bordered by landscaped areas, trails and recreational facilities and known as The Oklahoma River. The Oklahoma River is ideal for man-powered boats such as rowing sculls, kayaks and canoes. Motorized boats are welcome, but are strictly prohibited from operating at speeds that will create a wake. All boats must have both a City permit and State registration. No boats of any kind are allowed in wetlands ponds. Waterskiing, parasailing, paraskiing, swimming, sailboarding and windsurfing are not allowed.

In addition, fishing is available at several neighborhood lakes in the Parks Department's Close to Home program. "Close to Home" fishing waters are bodies of water designated under a cooperative intensive fisheries management program between Oklahoma City and the Oklahoma Department of Wildlife Conservation[498].

There may be an array of reasons as to why recreational activities are discouraged throughout the year to include dangerous weather conditions, such as temperature or wind speeds, low water levels, or poor water quality. Currently no historical data is available for the water bodies' quality conditions relating to viability for recreation, but you can review daily conditions by visiting http://www.travelok.com/checkmyoklake/. In addition the U.S. Geological Survey's (USGS) National Water Information System (NWIS) provides updates on water data and the Oklahoma Department of Wildlife Conservation provide fishing report data. The Oklahoma Water Resources Board published a beneficial use monitoring program report in 2012 which designates Oklahoma lakes as being fully supported or not supported for beneficial use such as Fish & Wildlife Propagation, Aesthetics, Agriculture and Primary Body Contact Recreation. Lake Overholser and Lake Draper were rated as fully supporting of Primarily Body Contact Recreation, while Lake Hefner not enough information was available for determination[499].

Overhosier	Turbidity	pH	Dissolved Oxygen	Meta	TSI	True Color	Sulfate	Chloride	Total Solid	En teri & E. coli	Chlor
Fish & Wildlife Propagation	NS	S	S	S							
Aesthetics					NS*	N/A					
Agriculture							S	S	S		
Primary Body Contact Recreation										S	
Public & Private Water Supply											

Hefner	Turbidity	pH	Dissolved Oxygen	Meta	TSI	True Color	Sulfate	Chloride	Total Solid	En teri & E. coli	Chlor
Fish & Wildlife Propagation	S	S	S	S							
Aesthetics					NS*	*					
Agriculture							S	S	S		
Primary Body Contact Recreation										NEI	
Public & Private Water Supply											

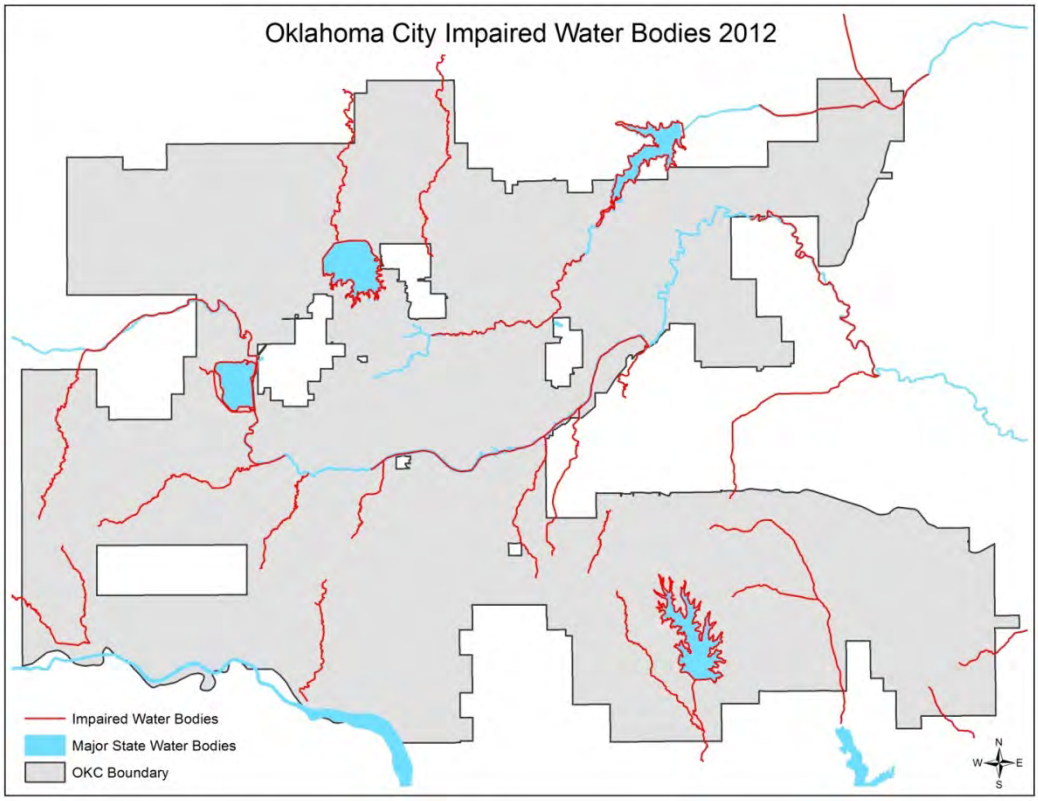
Draper	Turbidity	pH	Dissolved Oxygen	Meta	TSI	True Color	Sulfate	Chloride	Total Solid	En teri & E. coli	Chlor
Fish & Wildlife Propagation	S	S	NS	S							
Aesthetics					S	S					
Agriculture							S	S	S		
Primary Body Contact Recreation										S	
Public & Private Water Supply											

S = Fully Supporting	NTU = nephelometri
NS = Not Supporting	µS/cm = microsiemens per centimeter mV = millivolts µS/cm = microsiemens/cm En = Enterococc
NEI = Not Enough Information	E. coli = Escherichia coli Chlor-a = Chlorophyll-a

*The lake is listed in the WQS as a NLW indicating that the Aesthetics beneficial use is considered threatened by nutrients until studies can be conducted to confirm non-support status
* N/A – parameters not collected in current sample year.

[498] The City of Oklahoma Cty. (n.d.). Retrieved 1 12, 2014, from Lakes & Fishing: http://www.okc.gov/lakes/index.htm
[499] Oklahoma Water Resources Board. (2012). Retrieved 1 12, 2014, from Beneficial Use Monitoring Program: http://www.owrb.ok.gov/quality/monitoring/bump/pdf_bump/Current/Lake_Sites.htm

According to the EPA, a water body is considered impaired when it chronically or recurrently has monitoring violations of the applicable numeric and/or narrative water quality criteria established to protect its set of designated uses. Due to severely high levels of phosphorus and nitrogen, roughly 70% of major water bodies in Oklahoma are considered to be impaired[500]. In Oklahoma City, this includes all of the major lakes and the majority of the rivers. Interestingly, segments of the Oklahoma River are not considered impaired, while others are. In particular, the stretch of the Oklahoma River in the northeast sector of the city was removed from the impaired list after 2010.



Scenario Analysis

Failed septic tanks are a common source of groundwater pollution, and can contribute greatly to the impairment of water bodies. According to a DEQ study in Oklahoma, approximately 5% to 10% of septic systems are presently failing, and that figures rises to 20% in wet months[501]. This rate of failure provides a measure by which to compare the three scenarios in terms of potential impacts upon water bodies. Rural households in each of the three scenarios are assumed to be dependent upon septic systems, and the percentage of households considered rural varies from scenario to scenario. There are potential impacts upon groundwater quality, as well as impacts upon lakes, rivers and reservoirs, which can be condensed to watersheds for more reliable measurement. The table below illustrates the number of households using septic systems in each of the three scenarios, as well as the potential number of failures.

[500] Layden, L. (2013). Few Oklahoma cities filter water for element that causes toxic algae in lakes. *State Impact*, Retrieved from http://stateimpact.npr.org/oklahoma/2013/11/11/few-oklahoma-cities-filter-water-for-element-that-causes-toxic-algae-in-lakes/

[501] Huber, R. G., & Freede, D. Oklahoma Department of Environmental Quality, (2000). *Residential sewage disposal*. Retrieved from website: http://www.nesc.wvu.edu/septic_idb/oklahoma.htm

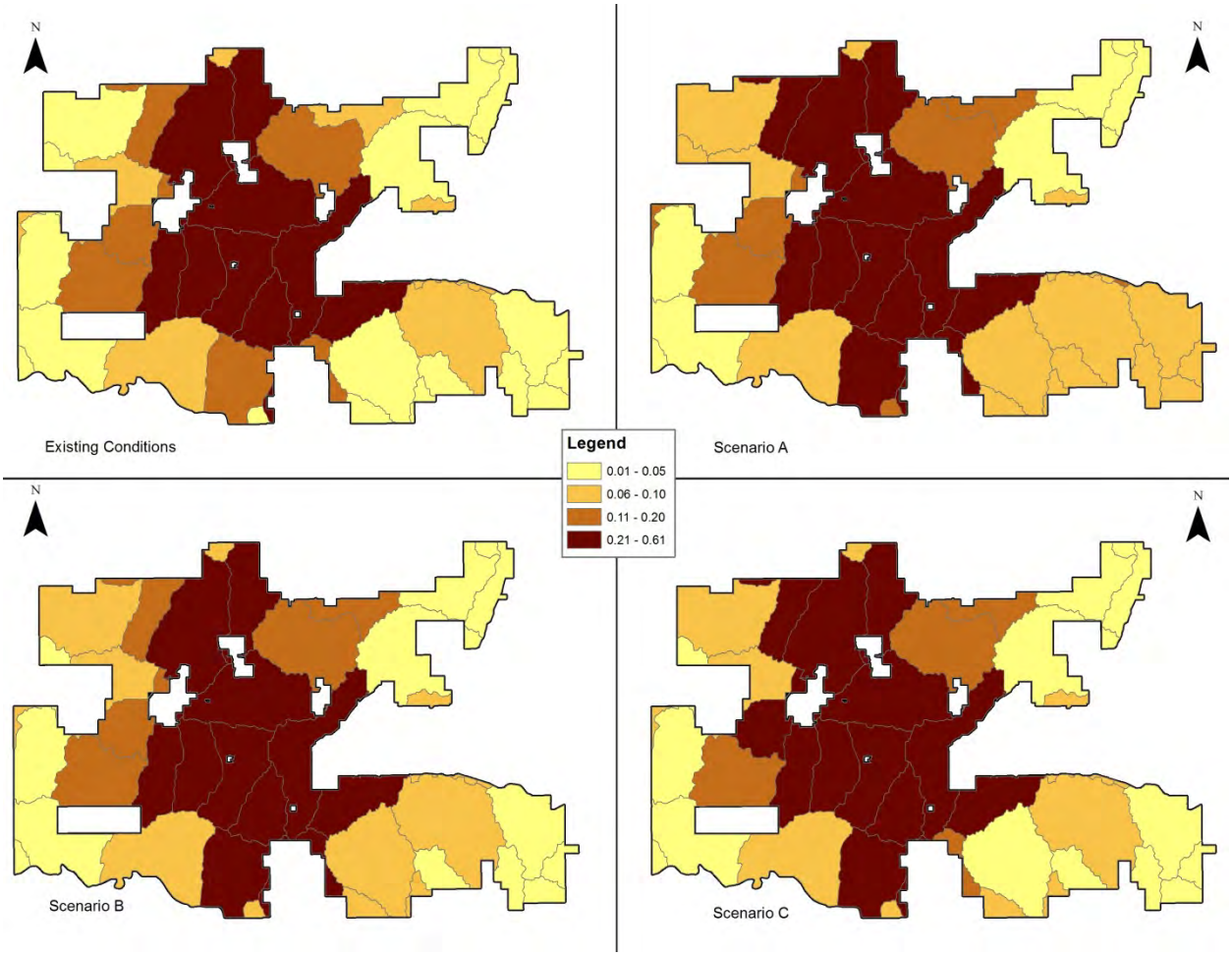
	Existing	Scenario A	Scenario B	Scenario C
Utilize Septic Systems (Households)	43,428	102,314	70,615	53,917
5% Failure Rate	2,171	5,116	3,531	2,696
10% Failure Rate	4,343	10,232	7,062	5,392
20% Failure Rate	8,686	20,464	14,124	10,784
% Change	N/A	+135.6%	+62.6%	+24.2%

The amount of impervious surface in a watershed can impact the quality of water due to pollutants from motor vehicles being caught in water runoff. According to the Oregon Environmental Council, "once about 10% (or less, depending on the watershed's physical and biological characteristics) of a watershed has been converted to impervious surfaces, significant ecological damage has already been done[502]." Using this measure, the scenarios can be compared to existing conditions for watersheds within Oklahoma City, to determine what the impact of introducing new impervious surfaces will be. In order to do this existing pavement and buildings were joined to sub-watershed shapes in GIS, and then a percentage of impervious surfaces was determined. With this base data the amount of new impervious surface in each of the sub-watersheds in the three scenarios was calculated and then added to the existing conditions. The table below shows the comparison of the 40 sub-watershed zones in the city in terms of percent impervious.

Number of sub-Watersheds in Each Percentile Group of Impervious Surface								
	0-5%	*5-10%*	*10-20%*	*20-30%*	*30-40%*	*40-50%*	*50-60%*	*60%+*
Existing	16	8	6	6	1	3	0	0
Scenario A	7	13	7	3	3	5	1	1
Scenario B	12	11	5	5	3	3	1	0
Scenario C	13	10	4	2	4	3	1	3

Sub-Watershed Quality Summary			
	Safe	Vulnerable	Hazardous
Existing	16	8	16
Scenario A	7	13	20
Scenario B	12	11	17
Scenario C	13	10	17

[502] Huntsinger, T. Oregon Environmental Council, (2007). *Stormwater solutions: Turning oregon's rain back into a resource*. Retrieved from website: http://www.oeconline.org/resources/publications/reportsandstudies/sstreport



From this analysis it becomes clear that all of the scenarios will likely degrade water quality for the city as Scenario A impacts a large number of sub-watersheds, Scenario B impacts more than Scenario C, and Scenario C has the highest intensity of impervious surface in the sub-watersheds that it affects.

Caveat:

Impervious surfaces and septic systems are only two of many potential factors that can degrade water quality. Farming and placement of industrial uses also play into the equation, as well as soil types, amount of precipitation, and other natural forces.

Conclusions

A) Scenario A would likely have the greatest negative impact upon water quality. Significantly more homes would use septic systems in Scenario A than the other scenarios. The greatest additional amount of impervious surface would be added in Scenario A, and this would be spread across the most sub-watersheds of the three scenarios.

B) Scenario B would likely have a less negative impact upon water quality than Scenario A but a greater negative impact than Scenario C. Scenario B increases the number of households using septic significantly. Scenario B adds more impervious surface than Scenario C, but has a more balanced

density over the same number of sub-watershed locations; however, a greater number of sub-watershed areas would be considered hazardous or vulnerable.

C) Scenario C would likely have the least negative impact upon water quality of the three scenarios. Far fewer new septic users would be added to the city than in Scenario A and Scenario B. Scenario C negatively impacts the fewest number of sub-watersheds in the city, but the sub-watersheds in the central city are impacted more heavily than in the other two scenarios. This is an intuitive negative impact of denser development.

Policy Review

Overview:

The quality of water bodies such as rivers and streams that eventually make it into Oklahoma City's water supply and the quality of water bodies such as lakes and ponds which offer recreational enjoyment both play a large role in health promotion. It is the goal of city municipalities to provide citizens with clean drinking water through treatment plants and to keep the community informed of dangerous water conditions at local parks, lakes, and ponds. Oklahoma City can help ensure water quality by establishing development regulations that help protect Oklahoma City's water supplies and preservation of existing natural resources. Oklahoma City can impact the use of water bodies by conducting an assessment of security needs during the planning stage of proposed parks and recreation areas

Relevant Policies:

Green.Biological Resources.**284**

Green.Water Resources.**288**

Green. Open Space, Connectivity and Fragmentation.**314**

Play.Saftey and Design.**375**

Enrich.Urban Design and Form.**626**

Recommendations

- Control nonpoint source (NPS) pollution:
    - Continue to promote responsible fertilizer use.
    - Encourage the use of dedicated car-wash facilities and educate why vehicles should be washed on pervious surfaces, and the use of environmentally-friendly cleaning supplies.
    - Continue to promote the usage of rain barrels.
    - Promote the usage of native plant species in landscaping as they have adapted to use reasonable amounts of water.
    - Explore mobile collection facility to pick up household harmful waste.
        - Increase the availability of recycling services.
    - Enforce farming and construction run-off regulation.
    - Incentivize low-impact design features in development, such as pervious pavement, rain gardens, etc.
    - Coordinate with local agencies to educate community members on recreational water quality through;
        - Media campaigns (expand reach of current campaigns)

    - Timely web updates on water conditions, preferably all recreational facilities reporting on one domain.
    - Public service announcements and television commercials encouraging the use of lakes, rivers, and ponds for recreational uses.
- Establish a funding source for remediation and prevention of water body impairments.
- Conduct research at wastewater treatment plants to determine any needs to increase treatment requirements for substances not currently tested (excess nutrients, pharmaceuticals, etc.)
- Research the feasibility of a stormwater disposal rate on sewer bills. The fee could fund education, monitoring, and restoration efforts.
- Create a permitting program to keep track of septic properties; include a mechanism for enforcement. Test periodically.
- Create policies that mitigate the impacts of development on existing natural resources, such as wooded areas, habitat areas, and floodplains, riparian areas, and water quality.
    - Work with partners, such as the Environmental Protection Agency, Oklahoma Biological Survey, Oklahoma Department of Wildlife and Conservation, and Oklahoma Department of Environmental Quality to develop strategies and programs that protect and preserve environmentally sensitive areas, such as native prairie, cross timbers, wetlands, and riparian areas.
    - Require new development to maintain or decrease the site's predevelopment run-off rate.
    - Incentivize green infrastructure in new development in an effort to reduce flows into treatment systems.

VIII. greenokc Indicators

G.3 Total Impervious Areas

G.4 Air Quality Conditions

G.5 Urban Heat Island Effect Conditions and Causes

G.6 Water quality conditions and causes

G.7 Light and noise pollution

Health-based Rationale

Environmental and natural resources can greatly impact a population's health. Considering natural resources are often shared by the entire community, state, and region many individuals' health outcomes are intertwined. Air and water quality, pollution of all types, and the built environment all contribute to the health of a community.

Environmental noise can affect more than just the obvious auditory system, extending to loss of hearing and other hearing impairments[503]. Hearing damage is related to duration and intensity of noise exposure and occurs at levels of 80 dB or greater, which is equivalent to the noise of heavy truck traffic[504]. Children seem to be more vulnerable than adults. In addition, unwanted or outdoor sounds created by humans also have an impact on non-auditory systems. Studies have shown that noise annoyance from transportation produces a variety of negative emotions including anger, disappointment, unhappiness, anxiety and even depression[505] [506] [507] [508]. Although many cities are providing increased noise pollution protection for communities located near busy thoroughfares, the noise pollution still impacts many stages of health.

Water quality has been a major focus for many organizations since the 19th century. Water system infrastructures are designed to gather, deliver and dispose of water (dams, reservoirs, water treatment facilities, distribution networks and sewage treatment). Bearing in mind that municipal water systems are designed to not only control the water flow throughout the city, they are also concerned with sanitation of water sources to reduce bacteria, contaminates, and pollution that can be detrimental to health.

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[503] Prasher, D. (2003). *'Estimation of hearing damage from noise exposure'* in World Health Organisation and European Centre for Environment and Health Report on the Technical meeting of exposure-response relationships of noise on health, Bonn, Germany, 17-19.
[504] Hagler, L. M. (2001). *Summary of Adverse Health Effects of Noise Pollution.* Based on the World Health Organization Guideline for Community Noise. Retrieved from http://www.who.int/docstore/peh/noise/guidelines2.html
[504] Fidell, S., Barber, D.S., Schultz, T.J. (1991). 'Updating dosage-effect relationship for the prevalence of annoyance due to general transportation noise', *Journal of the Acoustical Society of America* 89, 221-233.
[505] Fields, J.M. (1998). 'Reactions to environmental noise in an ambient noise context in residential areas', *Journal of the Acoustical Society of America* 104, 2245-2260.
[506] Miedema, M.E. (2003). *'Relationship between exposure to single or multiple transportation noise sources and noise annoyance'* in World Health Organisation and European Centre for Environment and Health Report on the Technical meeting of exposure-response relationships of noise on health, Bonn, Germany, 17-19.
[507] Michaud, D.S., Keith, S.E., McMurchy, D. (2005). 'Noise Annoyance in Canada', *Noise and Health* 7, 27, 39-47.

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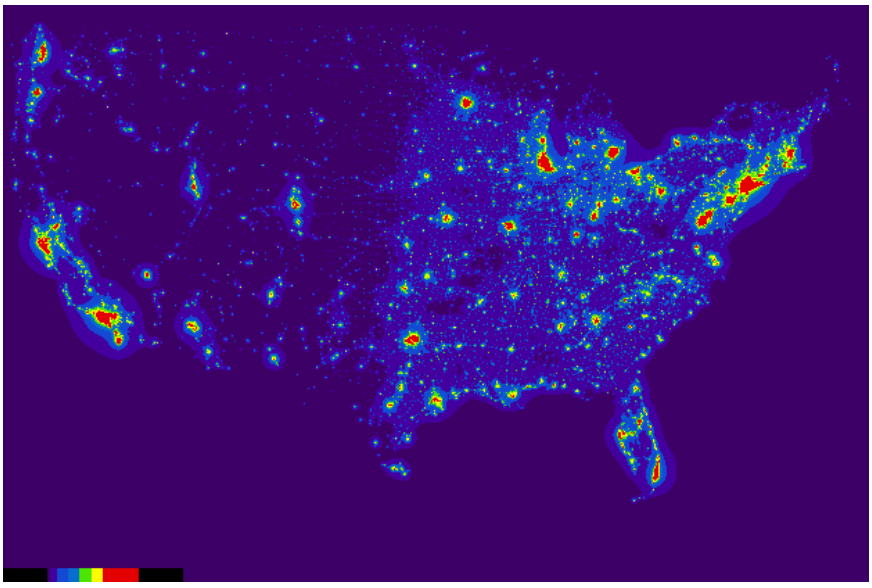
Urban heat island effects are considered to be the amplified heat sources in metropolitan areas caused by increased population activities and the built environment, such as concrete, sidewalks, and lack of impervious surfaces. Other features of the built environment and urban socio-demographics have been shown to increase the risk of heat-related death, including access to transportation, medical care, and cooling centers as well as crime, housing type, and neighborhood land use[8]. In sum, people in warmer neighborhoods were more vulnerable to heat exposure because they had greater exposure to heat and fewer social and material resources.

Existing Conditions

Light pollution:

Although highly investigated by astronomers, scientists, and weather experts around the globe, light pollution is difficult to measure quantitatively. Currently, experimental image modeling is used to map light pollution in the United States. No specific data exists on city or regional levels. The image is a plot of expected sky glow at the zenith.

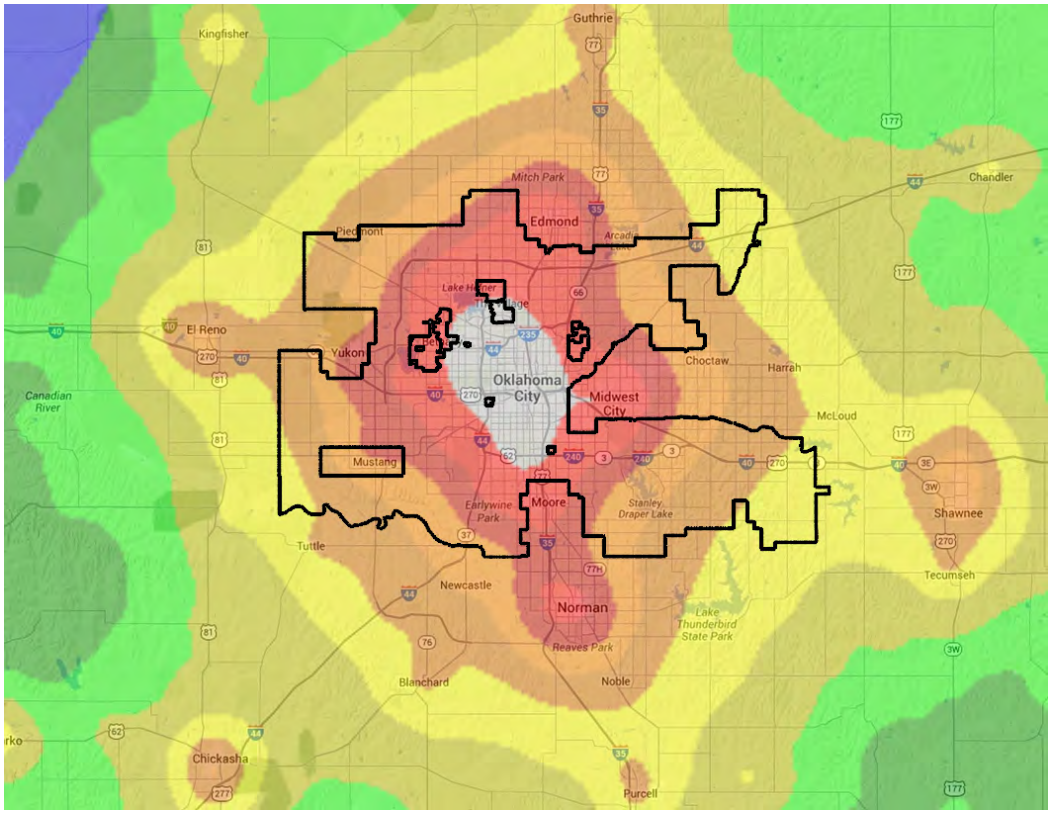


Light pollution from a city is assumed to be related linearly to the population and the inverse 2.5 power of the distance (as in Walker's law). The relation used here is I = 11,300,000 x population x r^-2.5, where I is in nano-Lamberts and r is in meters. This is corrected for earth's curvature at large distances. This is currently done by calculating what fraction of the air molecules and other scatterers over the observer lie within the earth's shadow as seen from the city. The overall scale height for these scatterers (defined as the incremental

height required to see a drop-off by a factor of 2.718) is currently set to 4000m. This is less than the "clear air" value of 8000m to account for a modest amount of aerosols[509]. Artificial night sky brightness at Zenith, at sea level, for standard clean atmosphere as fraction of the natural night sky brightness has been increasing exponentially and is predicted that light pollution will continue to increase unless additional measures are taken[510].

This measurement correlates with a more understandable measure called the Bortle Dark-Sky Scale, which uses a scale based upon visible celestial bodies: an excellent dark sky is a Class 1, and an inner city is Class 9. Oklahoma City itself has quite a bit of light pollution but is not in the same class as places like Los Angeles, New York, Houston, and Dallas. Below I-44 and North of I-240 between Lake Overholser and Midwest City qualify as a Class 8 on the Bortle Dark-Sky Scale, meaning:

> "Entire sky is grayish or brighter. Familiar constellations are missing stars. Fainter constellations are absent. Less than 20 stars visible over 30 degrees elevation in brighter areas. Limiting magnitude from 3 to 4.CCD imaging is still possible. But telescopic visual observation is usually limited to the moon, planets, double stars and variable stars."



Edmond, Moore, Norman, and Midwest City all fall within Class 7 light pollution area, and only in the rural regions to the southeast toward Shawnee and to the northeast along I-44, do you reach areas within the city limits that are Class 4.5 and outside the dome of light pollution.

[509] Albers, S., Duriscoe, D. (2001). Modeling Light Pollution from Population Data and Implications for National Park Service Lands. *George Wright Forum* 19, 1.
[510] Cinzano P. (2002). *The growth of the artificial night sky brightness in North America in the period 1947-2000: a preliminary picture*, in Light Pollution: a Global View, ed. H. Schwarz, Kluwer, Dordrecht, p. 39-48

Noise pollution:

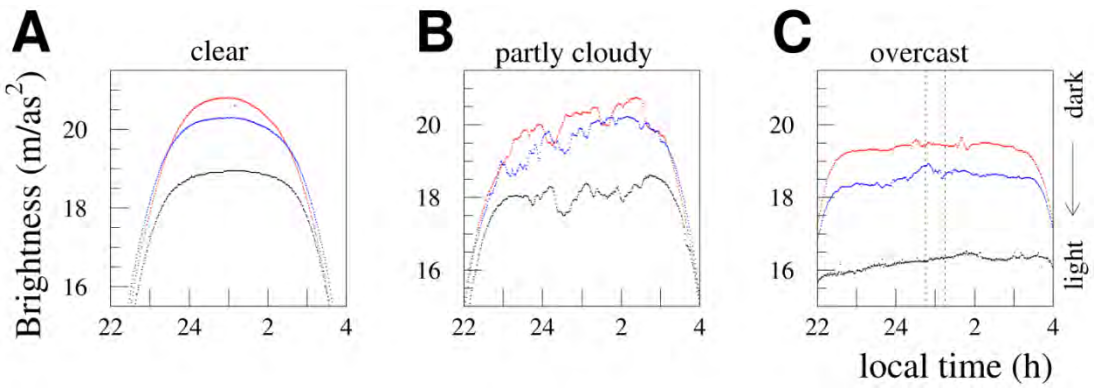
If we look at the United States for example we can see that there are federal standards for highway and aircraft noise, many states and local governments have specific statutes on building codes, urban planning and roadway development but the U.S. still doesn't have a single body that regulates noise pollution. Although new technologies are allowing cities to measure levels of noise pollution, there is little data available, and none for Oklahoma City[511].

Scenario Analysis

Light Pollution:

The different development patterns of the three scenarios may have different implications for the impact of light pollution on public and environmental health. No direct quantitative analysis is possible; however, qualitative discussion of the different character types of development patterns can provide insight into the impact of light pollution.

In Scenario A the majority of development fills in presently undeveloped areas of the city, while Scenario C increases development density in the existing developed areas; Scenario B falls between these two patterns. It is reasonable to suspect that Scenario A would result in a larger area of impactful artificial light pollution, while Scenario C will result in a smaller total area of high-impact light pollution, but the areas that are developed will have a higher brightness than in Scenario A or B. This presents a situation whereby there is a trade-off for each scenario; on the one hand, in Scenario A, the average residence will be in a less light-polluted area than in Scenario C, but in Scenario C there will be a clear distinction between developed and undeveloped areas, resulting in a less light-polluted rural area. The graphs below show this relationship relative to the amount of cloud coverage, where the red line represents rural areas, the blue line represents suburban areas, and the black like represents urban areas. [512]



Light fixture choices can play an important role in the amount of light pollution because of the direction and quality of light produced, as well as the amount of energy needed to power the fixture. It would be reasonable to expect that if fixture selections are the same for each scenario that Scenario C would require the least amount of total investment due to a more compact street light network and less lights to illuminate the developed area. With proper light fixture choices, the brighter light pollution of Scenario C could be mitigated

[511] Morrow, J. (2009). *Pollution Articles*. Retrieved 1 12, 2014, from http://pollutionartides.blogspot.com/2009/10/noise-pollution-definition-and-causes.html

[512] Kyba, C.C.M., Ruhtz, T., Fischer, J., Hölker, F. (2011). Cloud Coverage Acts as an Amplifier for Ecological Light Pollution in Urban Ecosystems. *PLoS ONE* 6(3): e17307. doi:10.1371/journal.pone.0017307

to have minimal negative impacts upon public health; likewise in Scenarios A and B, modern directional street lighting can help alleviate the light pollution issues that have arisen from non-directional, high-energy lighting fixtures.

Noise Pollution:

Caveat: Noise pollution is quite difficult to measure and is reliant upon many variable factors such as the amount of noise buffering, building and infrastructure design, and more.

From a qualitative perspective, there are different ratios of modal share in each of the three scenarios, and motor vehicles are a key contributor to noise pollution. The scenario with the lowest percentage of motor vehicle trips is Scenario C, followed by B, and Scenario A has the highest percentage of trips made in personal motor vehicles, including existing conditions. Transit can contribute to noise pollution, but the frequency of transit and fixed routes lower the overall impact relative to personal motor vehicles.

Modal Share				
	Existing	**Scenario A**	**Scenario B**	**Scenario C**
Motor Vehicle	96.63%	96.90%	94.56%	92.59%
Walk	2.13%	1.91%	3.23%	4.34%
Bicycle	0.45%	0.42%	0.55%	0.69%
Transit	0.78%	0.77%	1.66%	2.38%

There are many potential sources for noise pollution, particularly from transportation. In a 1981 Environmental Protection Agency study on the annoyance level of different noise pollutants motorcycles, automobiles (individual and constant traffic flow), large and small trucks, buses, airplanes and helicopters all made the top of the list. The only two activities that were not specifically transportation related were construction and yard work, both of which will be more likely to occur in Scenario A than Scenario C, with Scenario B falling in-between. The table below from the EPA study is broken into three categories based upon density; Scenario A would result in 34.2% of the population living at a density above 3,000 people per square mile, Scenario B at 34.7%, and Scenario C at 47.5% (there would be no density above 20,000 people per square mile in any of the scenarios).

TABLE III-4

RANK ORDER OF SOURCES BY PERCENT HIGHLY ANNOYED

$\rho \leq 3{,}000$ (37%)				$3{,}000 < \rho < 20{,}000$ (51%)				$\rho \geq 20{,}000$ (12%)			
Rank		%H.A.	Avg. % Std.Dev.	Rank	Source	%H.A.	Avg. % Std.Dev.	Rank	Source	%H.A.	Avg. % Std.Dev.
1	Motorcycles	9.4	2.9	1	Motorcycles	13.2	6.6	1	Motorcycles	12.7	4.1
2	Helicopters	5.3	3.8	2	Large Trucks	10.0	12.1	2	Autos	9.4	4.7
3	Autos	4.2	3.1	3	Autos	7.4	5.8	3	Large Trucks	7.3	5.6
4	Construction	3.7	2.2	4	Construction	7.2	9.0	4	Construction	6.5	3.4
5	Airplanes	3.2	3.5	5	Sport Cars	7.0	4.3	5	Sport Cars	5.9	4.7
6	Sport Cars	3.1	2.9	6	Constant Traffic	5.5	6.1	6	Constant Traffic	4.7	5.6
7	Large Trucks	2.6	0.8	7	Small Trucks	4.1	4.0	7	Buses	4.7	3.5
8	Power Garden	1.8	1.1	8	Buses	3.5	4.4	8	Small Trucks	4.1	4.0
9	Small Trucks	1.5	1.3	9	Airplanes	3.4	3.8	9	Helicopters	3.9	3.4
10	Constant Traffic	1.5	1.5	10	Helicopters	3.1	3.9	10	Airplanes	3.6	1.4
11	Buses	1.1	1.5	11	Power Garden	2.1	1.6	11	Power Garden	1.2	1.5
L_{dn}		55.9	3.7			62.2	6.1			66.0	3.5

ρ = population density in people per square mile

In conversations with the Health Impact Assessment steering committee and the City of Oklahoma City's urban forester, another key noise pollutant is oil and gas wells. The activities of pumping, fracking, drilling and flaring result in noise pollution of varying decibel levels and lengths of time. Flaring also results in light pollution as the gas that is burned glows at all hours of the night. Additional sources of sound at these sites include the large trucks that come and go from each location and the compressors utilized at natural gas wells. Due to the sheer number and distribution of oil and gas wells in the city, it is not likely that there would be any discernible difference among the three scenarios in terms of the negative effects of noise and light pollution.

Conclusions

A) In Scenario A there would likely be the greatest area of the city suffering from light pollution, albeit at a lower luminosity than the light pollution of Scenarios B and C.

   Due to the greater VMT and percent of trips made by automobile, amount of new construction, and the maintenance of larger single-family residential lots, Scenario A is likely to have the highest levels of noise pollution of the three scenarios.

B) Scenario B would likely have a smaller overall area of light pollution than Scenario A, but larger than Scenario C; however, it would likely have a higher luminosity than Scenario A, while fainter than Scenario C.

   It is likely that Scenario B will have lower levels of noise pollution than Scenario A, but higher levels than in Scenario C.

C) In Scenario C there would likely be the smallest area suffering from light pollution; however, the area of the city with light pollution would likely be at the brightest luminosity.

   Due to lower levels of VMT and a greater percentage of trips made by non-automobile modes of transportation, as well as less construction and lower levels of yard maintenance, Scenario C would likely have the lowest levels of noise pollution of the three scenarios.

Policy Review

Overview:

Light and noise pollution can impact the livability of a city and the comfort of a community, especially those located near highly traffic areas or areas with an abundance of artificial lighting. Oklahoma City can positively impact noise and light pollution by promoting the use of performance standards in place of existing zoning methods, mitigating negative impacts of compactness by updating nuisance code to better address noise, smell, vibration and animal control, and improving lighting design standards to include methods for glare control, placement, and shielding.

Relevant Policies:

Sustain.LandUsePatterns.**252**

Sustain.LandUsePatterns.**266**

Enrich.Urban Design and Form.**117**

Play.Funding, Maintenance and Operations.**357**

Recommendations

Light Pollution:

- Replace light fixtures throughout the city with shielded directional LED fixtures like those implemented through Project 180.
    - Create a policy to require street and public space light design standards that mitigate the negative impacts of light pollution.
    - Update street lighting policy, and work with electricity providers to use LED fixtures.
- Increase education for residents to use efficient lighting and indoor motion sensors.
    - Potentially use this methodology for public parks and schools as well.
- Consider and research the positive and negative effects of the temperature of light fixtures. Utilize the hue that has the least negative health consequences. (warm vs. cool)
- Set more stringent regulation on the size of illuminated signage and the times at which they may be illuminated.

Noise Pollution:

- Plant trees and other vegetative elements or other barriers around noisy transportation corridors.
- Limit large truck routes to avoid primarily residential areas.
- Enact legislation to limit the noise levels of motorcycles based upon speed limits or a fixed noise level; many states set the limit at 82 decibels. This could include noise-limiting mufflers.
- Create a "Quiet Zone" along the active railroad tracks through the City of Oklahoma City.
- Require increased levels noise-mitigating strategies for land uses that produce a high level of noise, such as heavy industrial and oil/gas extraction sites.
- Educate the public regarding what is included in the nuisance code to better address noise, smell, vibration, property maintenance, panhandling, animal control, delivery hour limits, and other possible negative effects.
- Require limitations on the auditory volume of generators.

VIII. greenokc Indicators

G.10 Oil, Gas and Industrial Sites in Proximity to Residential Property

Health-based Rationale

The number and location of oil and gas wells in residential areas are of great concern to community health, surpassing the negative visual appeal. Although some may not be operational, they still may pose a risk to the surrounding community. A California study suggests that the following health impacts could result from oilfield expansions: air-borne and water-borne disease, noise pollution, loss of green space/resources for recreational physical activity, and geologic events[513].

Air-borne dust and particles could cause or exacerbate asthma and reactive airway syndrome of downwind residents and park visitors and releases into the atmosphere of toxic or carcinogenic components of petroleum from currently operating wells and facilities, and from accelerated migration of these constituents to abandoned or "sealed" wellheads that are leaking. Additional air-borne toxins include release of hydrogen sulfide, which acute exposure to 500 ppm can cause death[514]. Although a limit of 10 ppm (parts per million) has been set for occupational settings, exposures as low as 1 ppm can cause neurological damage and can exacerbate asthma and reactive airway disease. Surface and sub-surface water may become contaminated with drilling muds and petroleum constituents. Run-off, particularly during rainy periods, may carry contaminants to other waterways. Health risks of oil field operations in urban areas pose special risks due to reduced safety margins. Technical mitigation measures (i.e. engineering controls) cannot be assumed to be failsafe. In an urban environment where people's homes and daily activities are in close proximity to oil field operations safety margins may be significantly less than in an area far from population centers[515].

Existing Conditions

There are 1,403 oil and gas wells within the city limits of Oklahoma City, for an average of more than two wells per square mile. 1,097 of these are active wells, while 306 are plugged. People who live in residential areas in proximity to these wells are at a higher risk for negative health and safety impacts. Of these 1,403 wells, 970 are within ¼-mile of a residential parcel. These 970 wells are in proximity to 126,221 individuals, more than 20% of the population of Oklahoma City. The majority of the oil and gas wells in the City of Oklahoma City are within ¼-mile of residential properties.

At the low end of the proximity scale, more than 2,000 individuals live within 50' of one of 111 oil and gas wells, making them next-door neighbors. At the high-end of the proximity scale, approximately 481,500 individuals live within 1 mile of an oil and gas well – about 80% of the population of Oklahoma City. Roughly half of the population of Oklahoma City (288,161 out of 599,199) lives within ½-mile or about a 10-minute walk with ideal pedestrian infrastructure conditions of an oil or gas well. The graph below illustrates more fully the number of oil wells in proximity to residential areas in 50' increments up to ¼-mile. And the following graph shows the number of wells from ¼-mile to 1 mile in ¼-mile increments.

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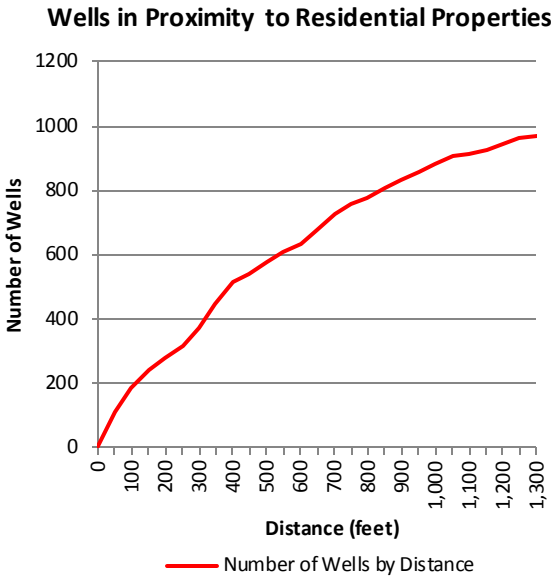
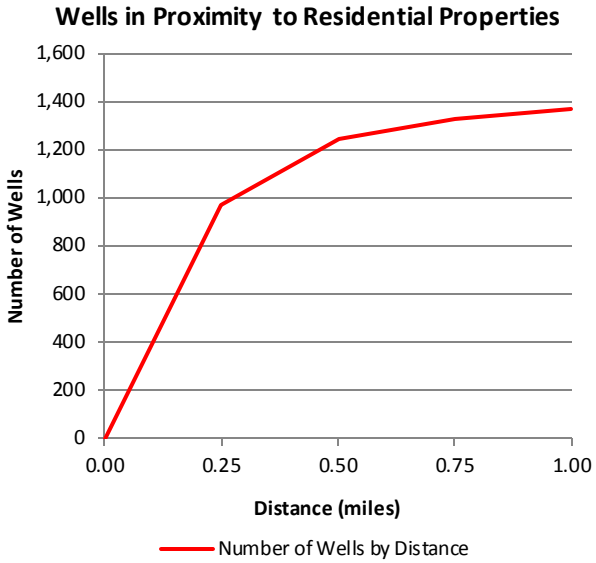
[513] Department of Conservation, Divisions of Oil and Gas. (1986). *A study of abandoned oil and gas wells and methane and other hazardous gas accumulations*. Retrieved from GeoScience Analytical, Inc. website: ftp://ftp.consrv.ca.gov/pub/oil/A Study of Abandoned Oil and Gas Wells and Methane and Other Hazardous Gas Accumulations.pdf

[514] Beauchamp Jr., R.O., Bus, J.S., Popp, J.A., Boreiko, C.J., Andjelkovich, D.A. A critical review of the literature on hydrogen sulfide toxicity, *Crit. Rev. Toxicol.* 13 (1984) 25–97

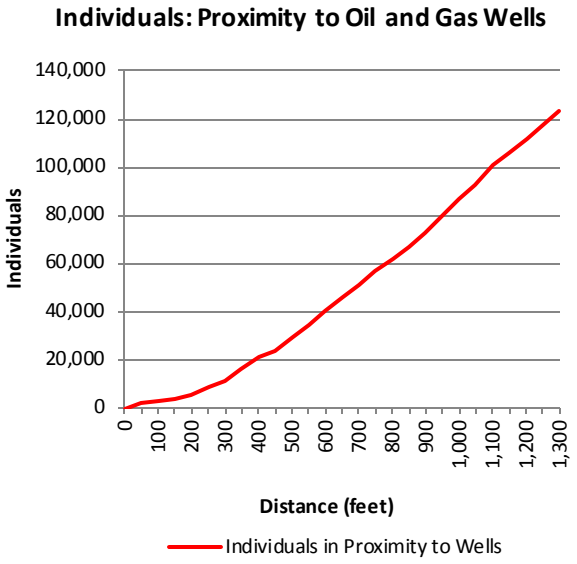
[515] Cole, B. (2007). *Health Concerns Related to Proposed Expansion of Oil Operations in Baldwin Hills*. Los Angeles, CA: The City Project

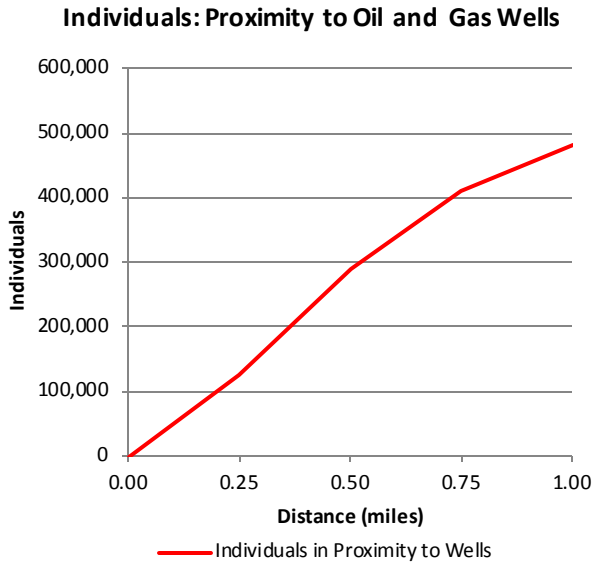




The above graphs illustrate a surprising tendency that oil and gas wells are primarily located in residential areas. This could be due to several things, and may be a "chicken or the egg" situation, but it could be inferred that the oil wells have made the land cheaper, which is attractive to developers and people looking to buy land, and with minimal restrictions in place in terms of environmental and health concerns, development does in fact occur around existing oil wells. Conversely, oil wells drilled during the discovery of the Oklahoma City oil field in the early 20th century mostly occurred on residential properties, and could still be a potential threat today. While there is a special zoning category for oil and gas wells, U-7, the sheer number of oil and gas wells ensures that the majority of parcels, regardless of whether they are residential or not, are within a proximal distance.

The graphs below show the number of individuals within specific distances of oil and gas wells; the first graph illustrates an unsurprising inflection, with greater numbers of individuals living at greater and greater distances. The second graph shows a steady increase until ¾ of a mile when the number of individuals begins to taper off; this is due mostly to the fact that such a large percentage of the population has been accounted for and there's no statistical way to continue the trajectory of the graph.





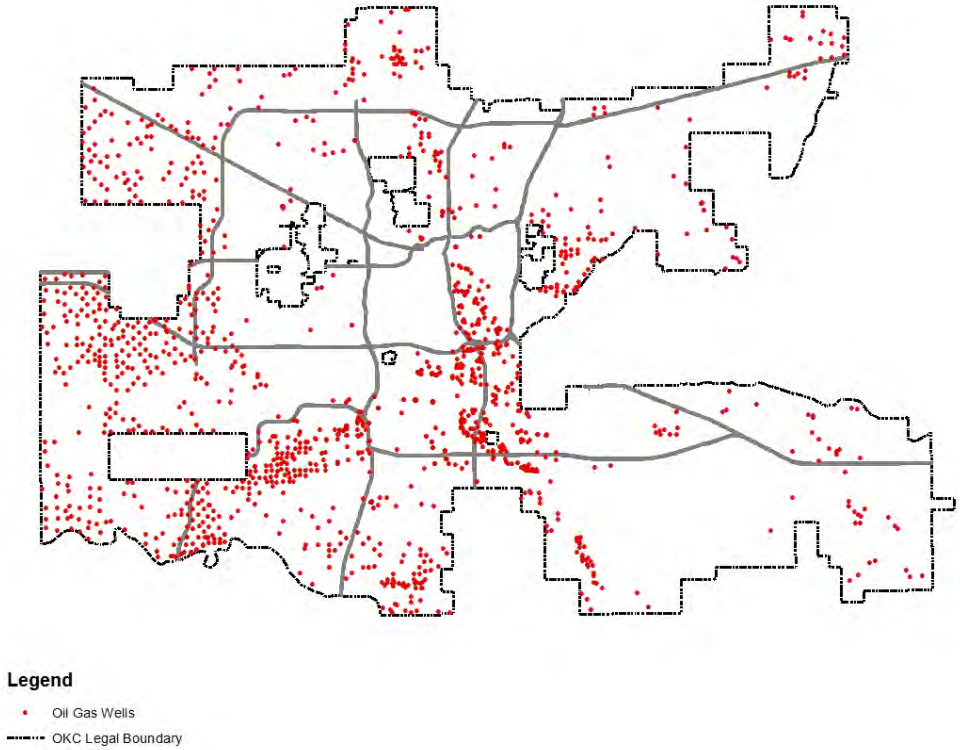


Figure 40: Location of Oil and Gas Wells

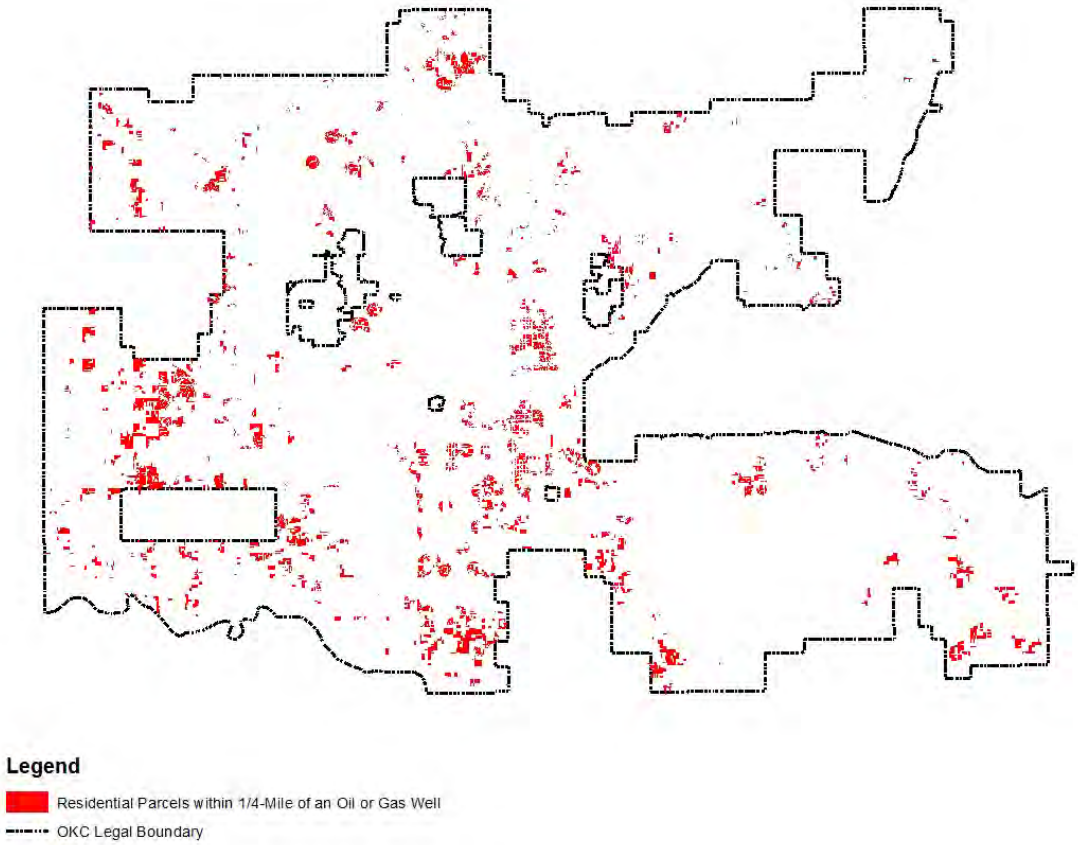


Figure 41: Residential Parcels within 1/4-Mile of an Oil or Gas Well

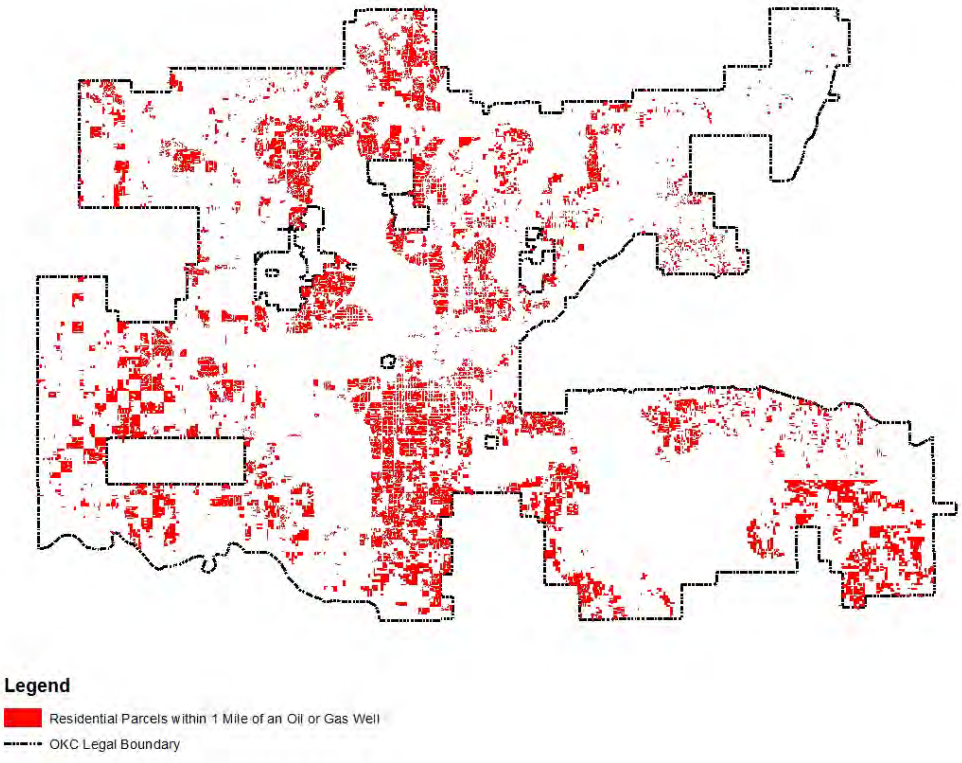
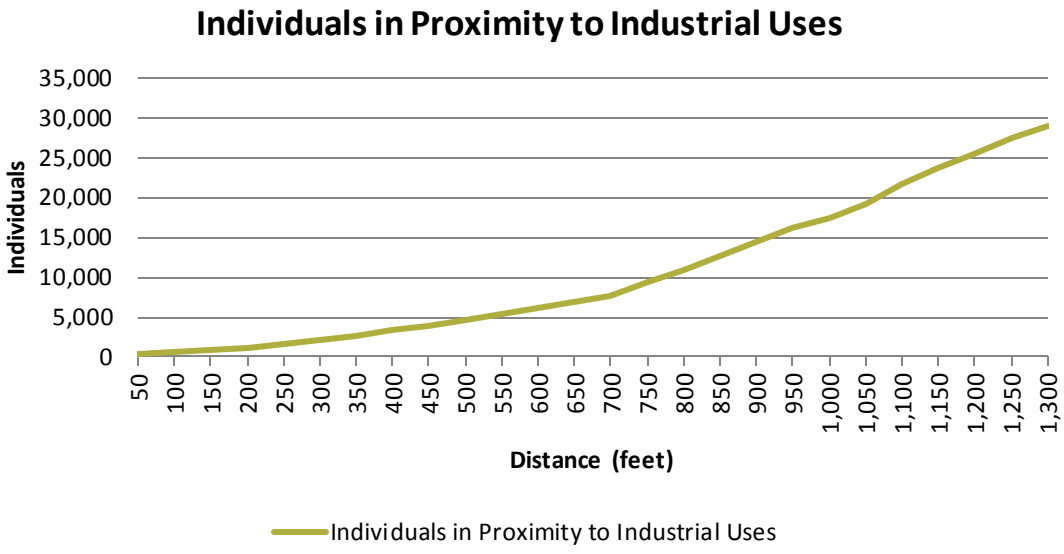
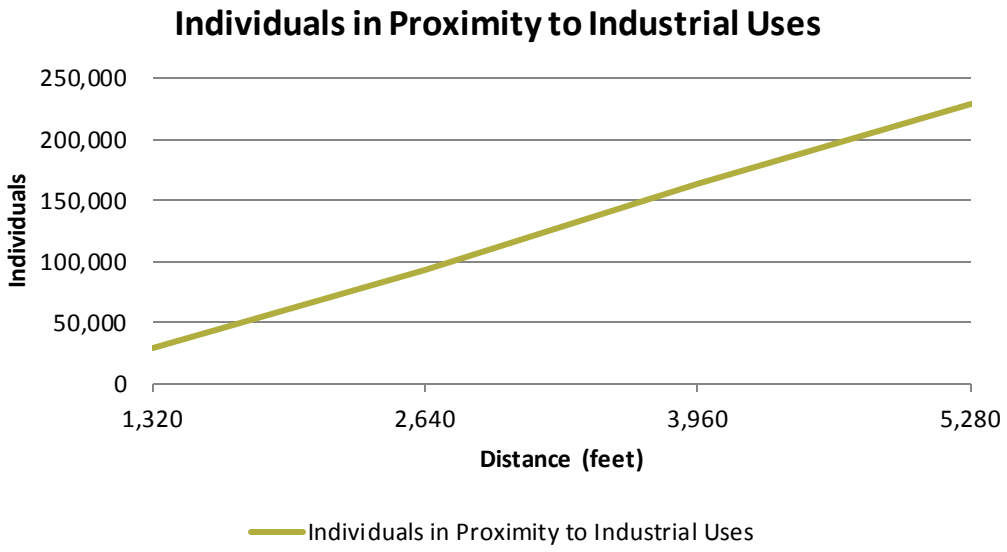


Figure 42: Residential Parcels within 1 Mile of an Oil or Gas Well

Industrial Land Uses:

Utilizing the City's parcel data allows for mapping of industrial sites that could potentially contaminate soil or become a health hazard to neighboring residential parcels. For this study parcels of heavy industrial land uses, and select medium and light industrial uses (concrete batch plants, salvage yards, sand pits, landfills, lumber yards, and grain elevators) were compared in proximity to residential parcels in the same way that oil and gas wells were compared. This resulted in 183 unique locations. The graphs below illustrate the proximal relationship the industrial parcels have to residential areas.





Unlike the proximity graphs for oil and gas wells, the curvature of these graphs is what you would expect; the rate at which larger numbers of people are considered in proximity to industrial uses increases as the distance increases.

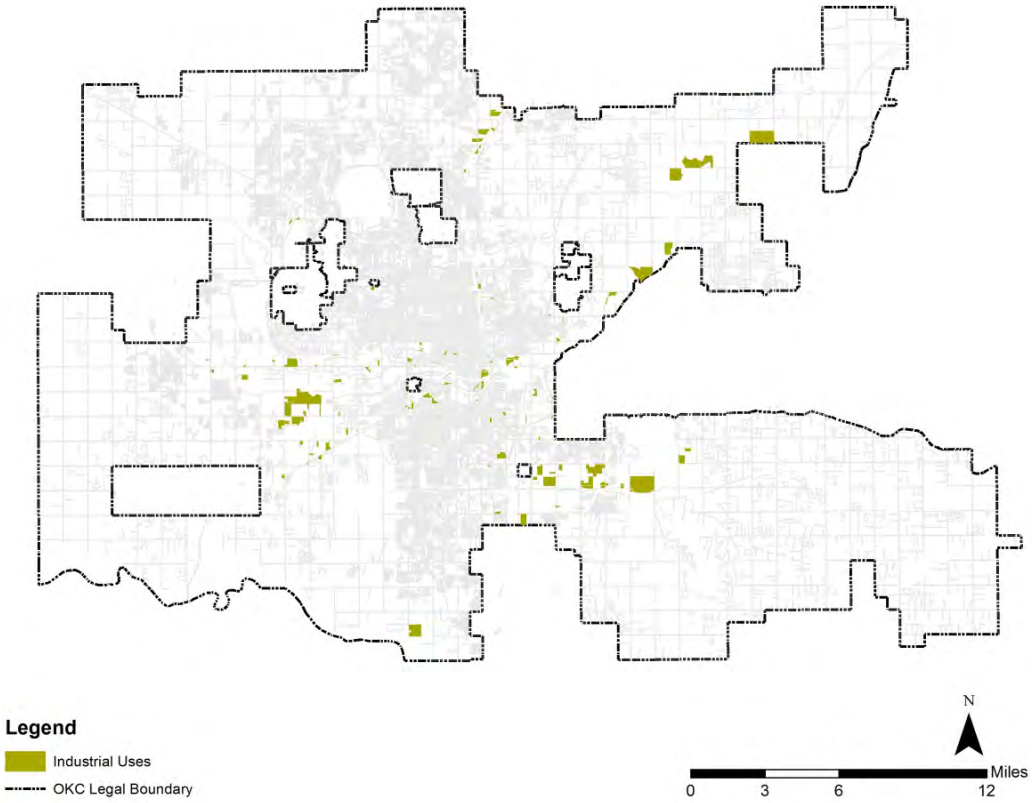


Figure 43: Industrial Sites with Potential for Negative Impacts upon Residential Areas

Scenario Analysis

As there is no sound method to predict the growth and placement of future oil and gas wells nor harmful industrial land uses, the three scenarios were compared to the existing locations for proximity. The table below illustrates the number of households at several distances from oil and gas wells, as well as industrial uses, and the total percentage of the population affected.

Proximity to Oil/Gas Well	Existing		Scenario A		Scenario B		Scenario C	
	Individuals	*Percent of Total Population*	*Individuals*	*Percent of Total Population*	*Individuals*	*Percent of Total Population*	*Individuals*	*Percent of Total Population*
¼ - Mile	126,221	21.1%	220,746	24.7%	216,198	24.2%	214,301	24.0%
½ - Mile	288,161	48.1%	458,053	51.4%	452,240	50.7%	448,818	50.3%
¾ - Mile	410,541	68.5%	621,395	69.7%	619,596	69.5%	616,091	69.1%
1 Mile	481,438	80.3%	725,137	81.3%	728,839	81.7%	723,232	81.1%
Plus Industrial								
¼ - Mile	147,785	24.7%	244,793	27.4%	244,151	27.4%	245,696	27.5%
½ - Mile	331,886	55.4%	500,235	56.1%	499,683	56.0%	500,494	56.1%
¾ - Mile	459,511	76.7%	668,793	75.0%	673,483	75.5%	673,808	75.5%
1 Mile	529,436	88.4%	771,912	86.5%	778,553	87.3%	777,485	87.2%

All of the scenarios increase the population that lives within ¼-mile and ½-mile of an oil/gas well or industrial use, and increases those within ¾-mile and 1 mile of oil and gas wells, but decreases slightly for those within ¾-mile and 1-mile of oil/gas wells plus industrial uses. Essentially, because such large percentages of the population are subject to the consequences of proximity, there can be only slight variation in the number of people affected. It is fairly evident that any pattern of growth, unless specifically aimed at placing residential uses as far from oil and gas wells and heavy industrial uses as possible, will result in a large percentage of the population living within a mile of these potentially dangerous uses.

Conclusions

There is a negligible difference in the number of people living in proximity to oil and gas wells or heavy industrial land uses among the three scenarios; all three result in very high percentage of the total population. Scenario A performs the worst for oil and gas wells; however, adding in industrial uses causes Scenario A to marginally perform better than Scenario B and Scenario C. Steps should be taken to secure oil, gas, and industrial facilities such that pollution risks are mitigated on site, as there appears to be no suitable development pattern to avoid interaction altogether.

Policy Review

Overview:

Oil wells located in residential areas can have physical and mental impacts on the community such as danger of leaking or explosion and the visual deterrence of the obstruction. Oklahoma City has an

abundance of oil wells in residential areas, but there are no policies in the comprehensive plan that directly relate to removal, regulation, or education of these obstructions.

Relevant Policies:

Sustain.LandUsePatterns.326

Recommendations

- Sufficient barriers to noise and light pollution should be required at every active oil or gas wells, or industrial site to protect residential areas and natural habitats. Explore the use of temporary sound walls.
- Soil testing should happen frequently and be conducted by a government-approved third party to ensure that contamination is controlled.
- Groundwater quality testing should be conducted within a buffer distance to be set by the Oklahoma Conservation Commission and Water Resources Board.
- Oil and gas well locations should not be built within a 300' linear buffer of residential uses, schools, or other locations of "public concourse", and should not be located within residential neighborhoods.
- Ensure new residential land developments will be appropriately located away from existing or proposed oil drilling locations.
- Air quality tests should be conducted each year to ensure that pollution from oil and gas wells or industrial sites are within a standard to be set by the OKDEQ.
- Create impact fees for roads and potential environmental impacts for oil, gas, and industrial uses.
- Require a closed-loop system of material usage, whereby contaminated materials are not left on site or underground.
- Require the disclosure of injection contaminants, including proprietary and trade secret ingredients, to allow environmental review and impact assessment.