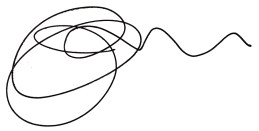

adaptokc
adapting for a healthy future

Adopted by the Planning Commission **6/11/2020**  Janis Powers, Chair

Received by the City Council **7/7/2020** David Holt David Holt, Mayor

Acknowledgements

Work Group Members

(name), (representing)

John Agnitch, the Homeless Alliance
Leon Ashford, Oklahoma Department of Environmental Quality
Mark Bays, Oklahoma Department of Agriculture, Food, & Forestry
Blaine Bolding, Oklahoma City-County Health Department
Matthew Burch, Urban Agrarian
Mary Jane Coffman, American Red Cross
James Cooper, COTPA
Jamie Csizmadia, OLTHIA Prairie & Garden
Brian Dougherty, Oklahoma City Community Foundation
Michael Douglas, Oklahoma Gas & Electric, Co.
Bill Elliot, Oklahoma Bicycle Society
Jeff Everett, Oklahoma Gas & Electric, Co.
Jeri Fleming, Oklahoma Conservation Commission
Mike Grady, YMCA of Greater Oklahoma City
Teri Green, Oklahoma Natural Gas
Crystal Griffis, Allied Waste/Republic Services
Jason Hukill, USGBC OK
Melissa Hunt, AIA Central Oklahoma
Angela Jones, YMCA of Greater Oklahoma City
Dr. Mike Langston, US Geological Survey, South Central Climate Science Center
Tom Lazarski, Oklahoma Gas & Electric, Co.
Heather Lerch, Oklahoma Department of Environmental Quality
Todd Lindley, National Weather Service
Dr. Heather McCarthy, University of Oklahoma
Kylah McNabb, Office of Secretary of Energy and the Environment
Brian McQuown, Oklahoma Gas & Electric, Co.
Shimeka Mack, Oklahoma Department of Emergency Management
Lynn Malley, Oklahoma Recycling Association
Kim Marshal, Oklahoma Department of Emergency Management
Nancy O'Brien, Oklahoma Department of Environmental Quality
Melody Martin, Oklahoma Gas & Electric, Co.
Alicia Meadows, Oklahoma City-County Health Department
Rick Padgett, Waste Management
Christine Patton, OKC Urban Ag Coalition
David Pettyjohn, Preservation OK
Eric Pollard, Association of Central Oklahoma Governments
Fenton Rood, Oklahoma Department of Environmental Quality
Jim Roth, Phillips Murrah P.C.
John Semtner, ADG
John Sharp, Association of Central Oklahoma Governments
Rick Smith, National Weather Service
Lisa Synar, OKC Beautiful
James Tittle, American Red Cross
Josh Trope, Oklahoma City-County Health Department
Dr. Jason Vogel, Oklahoma State University
Shannon Welch, Oklahoma City-County Health Department
Beth Wilhelm, Oklahoma Water Resources Board
Hallie Williams, OSU-OKC Farmers Market

Mayor and Council

David Holt, Mayor
James Greiner, Ward 1
James Cooper, Ward 2
Larry McAtee, Ward 3
Todd Stone, Ward 4
David Greenwell, Ward 5
JoBeth Hamon, Ward 6
Nikki Nice, Ward 7
Mark K. Stonecipher, Ward 8

Planning Commission

Janis Powers, Ward 2, Chair
Nate Clair, Ward 1
Mary Coffey, Ward 3
Mike Privett, Ward 4
Matt Hinkle, Ward 5
Asa Highsmith, Ward 6
Camal Pennington, Ward 7
Scott Cravens, Ward 8
Rusty LaForge, At-Large

City Staff

Craig Freeman, City Manager
Aubrey McDermid, Assistant City Manager
Geoff Butler, Planning Director
T.O. Bowman, Sustainability Manager
Ryan Baker, Associate Planner

Participating City Departments

Development Services
Finance
Fire
General Services
Parks & Recreation
Planning
Police
Public Information & Marketing
Public Transportation and Parking (EMBARK)
Public Works
Utilities

Table of Contents

Photo of Myriad Botanical Gardens water feature, Office of James Burnett (2012)

Executive Summary

Less than a century ago, the longest environmental disaster in the history of the United States left indelible scars on Oklahoma. The Dust Bowl was a decade-long convergence of economic, ecological, and social factors: a disproportionately large agricultural economy; technological advances like mechanized plowing and harvesting; misguided public policy related to westward expansion; severe drought, extreme heat, and ceaseless wind; mass migration; bank failures and business closures; starvation and poverty; topsoil erosion and poor land management practices; and water scarcity.

Millions of acres of farmland were rendered virtually useless and nearly half a million Americans were displaced. But a proportionate response came as across the country people were enlisted in a peacetime war against environmental degradation, mounting hundreds of public works projects including drainage, erosion control, fire, disaster response, development and construction of infrastructure from rural fire roads to urban parks, and a "shelter belt" of nearly 220 million trees planted to reduce the landscape-scouring winds.

It is both these hardships and the resolve to meet them that shaped Oklahoma City's first sustainability plan, adapt**okc**. For present day Oklahoma City, now the country's 27th most populous city, the Oklahoma of the 1930s echoes as a stark reminder of the inseparability of our livelihoods, our environment, and ourselves. adapt**okc** recognizes our need - and ability - to leverage scarce resources, create new partnerships, and use new tools and technologies to meet our needs and deliver a more equitable community not just for today's residents but for generations to come.

The purpose of adapt**okc** is to strengthen our community in the face of economic, environmental, and social challenges. By identifying our risks as well as our opportunities, we can adapt to the complex and cascading threats to our livelihoods and well-being.

Three principles are at the core of adapt**okc**:

- **Position Oklahoma City to lead by example as a steward of public resources.** We must demonstrate approaches to natural resources and conservation to effectively manage risk. While some concepts may seem new, many have been proven over time in our peer cities. We can serve the public good by demonstrating practical and efficient ways to meet needs that will reduce long-term operations and maintenance costs.
- **Adapt our infrastructure, services, and communities to Oklahoma City's changing climate.** We are already experiencing the effects of climate change and, even in the most optimistic scenarios, our climate will continue to change well into the future. Our "new normal" will be anything but. To ensure our resilience, we need to plan and design for instability.
- **Identify how to use technological innovations to our advantage.** Emerging technologies can help us streamline processes and respond proactively to the needs of our residents. From renewable energy to driverless vehicles, we have opportunities to chart new territory that can yield social, economic, and environmental dividends for all Oklahoma City residents.

adapt**okc** investigates four critical areas: how we generate and consume electricity; how vulnerable our infrastructure and natural resources are to a changing climate; how our transportation choices impact the air we breathe; and how our waste affects us all long after it has been discarded.

Some of the significant risks facing Oklahoma City include:

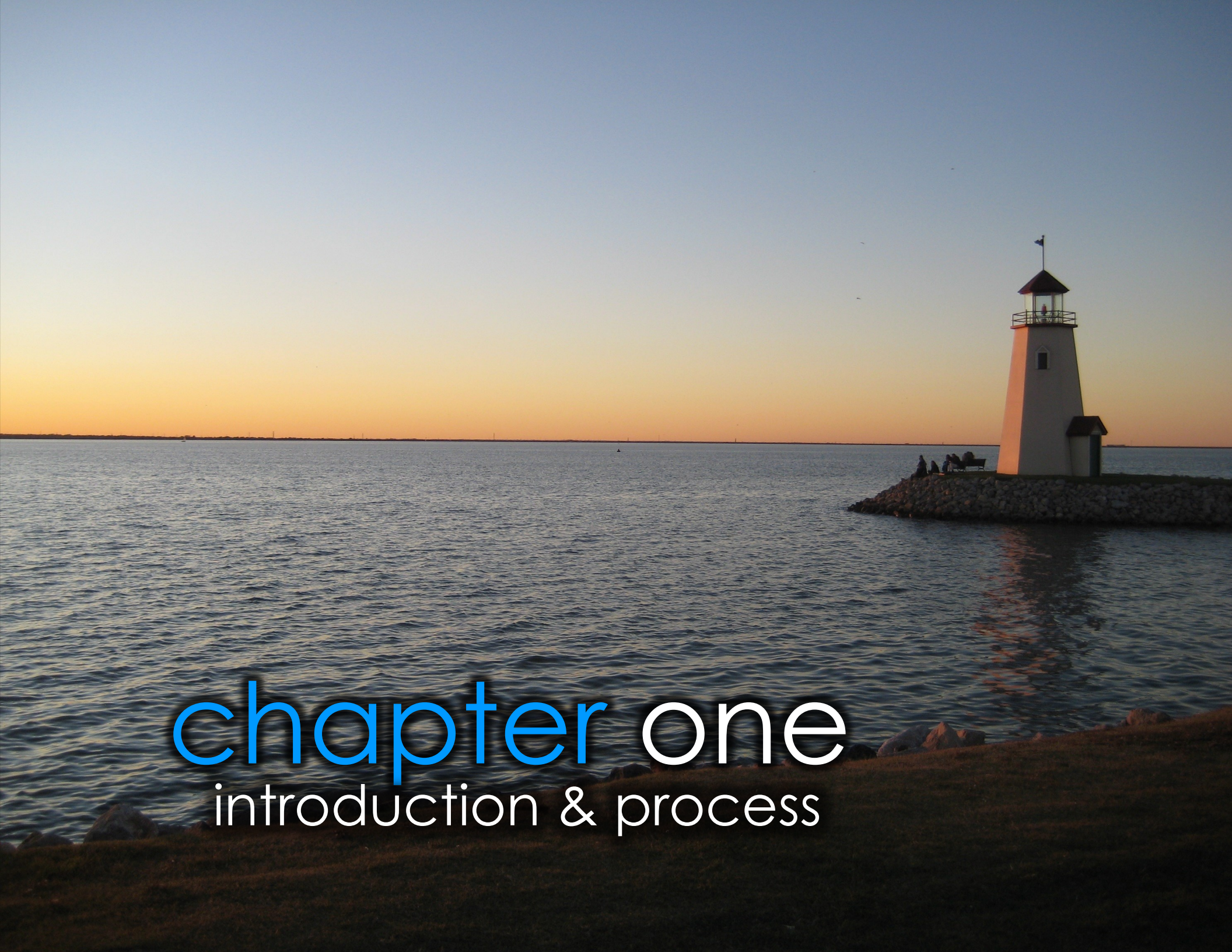
- Increase in temperature marked by drier, hotter summers
- Increase in the cost of and demand for electricity
- Increase of inundating rainfall events and associated flooding
- Increase in the operating and maintenance costs of infrastructure and assets
- Increase in cultural, linguistic, and age-related challenges to public service delivery

To address these risks, adapt**okc** proposes to:

- Reduce electricity costs with increased efficiency and renewable energy use
- Mitigate heat through development requirements and more natural urban environments
- Reduce emissions that threaten our health and economy
- Protect and conserve our water resources
- Enhance our equitable approach to disaster recovery and response
- Strengthen our infrastructure against extreme weather and increasing costs

“Never let yesterday use up too much of today.”

- Will Rogers



chapter one

introduction & process

CHAPTER 1: INTRODUCTION & PROCESS

1.0 Introduction

What is adaptokc?

The first of its kind for Oklahoma City, adaptokc is a policy document that identifies how we can strengthen our community in the face of economic, environmental, and social challenges. Through this plan's research and analysis, our policymakers, businesses, residents, and institutions can work together to face volatility and change with practical solutions.

In 2015, Oklahoma City adopted its first fully-new comprehensive plan since 1977, planokc. As a new vision for policy, infrastructure, and planning, it is within planokc where the seeds of a community-wide sustainability plan were planted. Through adaptokc, many of the environmental and economic components of the comprehensive plan are explored more deeply, especially amid the rapid changes we are continuing to see in every facet of society.

We are, to borrow from Sam Anderson, a boom town. We have witnessed a renaissance on the plains here in Oklahoma City thanks to the renewal of growth and revitalization first catalyzed by MAPS in 1993. Our metro is responsible for approximately 38% of Oklahoma's gross domestic product (GDP) and, at about 1.4 million residents, is home to 35% of statewide population. Through booms and busts, the Oklahoma City metro's GDP has jumped an estimated 101% between 2001 and 2017, a greater pace of GDP growth than that of the Tulsa, Denver, Kansas City, Atlanta, Chicago, and New York City metros during the same period. Throughout this unprecedented growth, however, is a crucial question: how does a city half the size of Rhode Island with a population density below that of Lawton achieve greater growth amid finite resources?

We chose to call this plan adaptokc for several reasons. One, adaptation is a dynamic process of action and refinement that seeks to constantly improve while also allowing for planning and preparation before crises. Second, in nature, organisms that adapt, that respond to external stimuli, do more than just sustain - they flourish. Third, the complexity and rate of challenges we encounter as a community will only grow and it is our responsibility to not just meet those challenges, but ensure a city where all residents can thrive. That means efficient and effective public services, an environment rich with clean air and water, livable wages, unmatched quality of life, fully-funded and maintained infrastructure, and a community of equity and opportunity.

One of the most serious threats confronting us is climate change. Characterized by changes in temperature and precipitation, climate change is a threat multiplier, intensifying existing challenges already facing us through infrastructure, safety and security, and public health. To that end, Moody's Investors Service published a white paper in early 2019 on U.S. cities addressing efforts to mitigate the impact of climate events. Based on the 50 largest Moody's-rated U.S. cities by outstanding debt, 57% have developed sustainability or adaptation plans but, when including those that intend to adopt such plans by the end of 2019, that number jumps to 82%. These plans are seen as "credit positive" as they indicate "how a city manages infrastructure vulnerabilities, current and future capital costs, mitigation of potential economic impacts and risk of population loss." Moody's notes that while the federal government has "traditionally provided strong support for cities contending with the costs of natural disasters," should those funds wane it will result in greater state and/or municipal debt to finance recovery and adaptation.

But our changing climate is not the only challenge to which we must adapt. Exponential changes in technology, labor, law and regulation, taxation and revenue, demographics, and development are slowly demanding new perspectives and approaches. Through adaptokc, we can begin to collectively sustain the growth and success Oklahoma City has seen thus far through the resilience that has come to define us.

> "Cities' increasing focus on climate risks is a credit positive, particularly as climate change is forecast to increase the frequency and severity of extreme weather events. The risks from climate change include economic disruption, infrastructure damage, insufficient health and public safety services, and population displacement."
>
> - Moody's Investors Services, "Cities' heightened focus on mitigating climate risk is credit positive," January 2019

How is adaptokc Organized?

Three core sections of adaptokc make navigation straightforward:

Chapter One: Introduction and Process establishes adaptokc's foundation by defining both adaptation and sustainability in the context of Oklahoma City. It presents an overview of research and development necessary for adaptokc and what prior plans and studies inform it.

Chapters Two - Five: Topics. Each of these four chapters are structured to present an overview of present conditions, policies, and challenges along with initiatives to pursue to accomplish goals laid out in each. The topics include electricity and renewable energy, landfill emissions, ground-level ozone air pollution, the urban heat island effect, green infrastructure, and recycling.

The chapters are:

- Energy Productivity
- Natural & Built Environment
- Air Quality
- Waste Reduction

Each chapter contains Goals, Initiatives to achieve Goals, and Policies to achieve Initiatives.

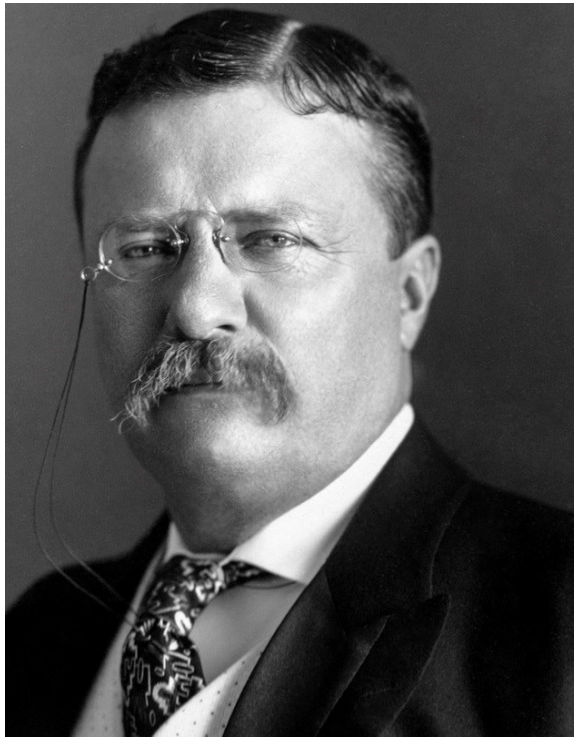
Chapter Six: Policies and Implementation lays out the next steps for adaptokc, merging the goals, initiatives, and policies with prioritized action and data-backed benchmarks to track progress in the near-term and long-term.

Maintaining adaptokc

As a living document, adaptokc requires updates to capture current and accurate progress as well as changing conditions. Such maintenance can range from updates to analysis to modification and addition of policies.

The Office of Sustainability will report accomplishments and progress toward achieving the adaptokc goals through the indicators identified in Chapter Six as well as use of the City's performance measurement platform Leading for Results (LFR). Office of Sustainability staff will aggregate data from specific existing LFR measures and proposed LFR measures to provide a snapshot of progress across City departments.

To remain consistent with the priorities of City leadership and to respond to shifts in economic, social, and environmental policy conditions, the Office of Sustainability will comprehensively evaluate the plan's progress and on-going feasibility every five years. This important evaluation will include not just updates to indicators but proposals to adjust and recalibrate targets, especially as the larger regulatory and political landscape changes. This evaluation will be presented to City officials along with any recommended policy changes.



"I recognize the right and duty of this generation to develop and use the natural resources of our land; but I do not recognize the right to waste them, or to rob, by wasteful use, the generations that come after us."

- Theodore Roosevelt
26th President of the United States, Conferred Statehood to the Oklahoma Territory

1.1 The Office of Sustainability

Oklahoma City is among more than 120 U.S. cities and counties with established sustainability offices and positions. First conceived in 2008 by a taskforce of City leaders convened at the behest of the City Manager, the City of Oklahoma City's Office of Sustainability was created with City Council's adoption of the FY10 budget and began operation on July 1, 2009.

Soon thereafter, the City received a $5.4 million award through the U.S. Department of Energy's Energy Efficiency and Conservation Block Grant (EECBG) program, funded by the American Recovery and Reinvestment Act. The Office of Sustainability led development of an Energy Efficiency and Conservation Strategy to determine how best to apply EECBG funds to meet federal program goals of increased energy efficiency, reduced fossil fuel emissions, reduced total energy use, economic growth, and job creation and retention.

Over a three year period, the Office of Sustainability primarily administered EECBG funds and managed projects and programs including the installation of the City's first fast-fill CNG fueling stations to service fleet CNG vehicles; adoption of the International Energy Conservation Code for commercial properties; development of sustainability guidelines for Historic Preservation districts; start-up capital for a downtown bike share program; installation of solar-powered trash and recycling receptacles throughout downtown; and an all-day Green Roof Symposium with engineers, architects, and experts on the implementation of vegetated roofs.

Upon full expenditure of the City's EECBG award, the Office expanded to policy development to guide the City towards reduced costs while simultaneously providing environmental benefits. These included a City recycling policy which ushered in a deskside recycling program at City buildings; a desktop printer policy to eliminate costly maintenance and paper waste by centralizing department printers and set double-sided printing as default; an update to the City's energy policy beginning the consolidation of City utility account data across all properties and departments; and a procurement policy for City buyers about the City's commitment to the purchase of products less toxic, wasteful, and costly to dispose of.

Public and private grants were also won to launch new projects and extend existing programs. These include the installation of cigarette recycling receptacles on downtown light poles; the installation of 66 bicycle racks, 4 bicycle repair stations, and pedestrian signage in 10 business districts; and an EPA award to assess green infrastructure storm water management within a square mile area of the city's urban core.

The Office of Sustainability has always had a public education component, too, speaking to civic groups, businesses, neighborhood organizations, state and federal agencies, universities and schools, and nonprofits, as well as participating in media interviews, conferences, and forum panels. The Office has also organized public event and education opportunities including workshops to repurpose donated soda syrup barrels into rainwater harvesting barrels for homeowners; walkability workshops and audits with stakeholders in and around neighborhoods, schools, and business districts; and a home energy fair to offer homeowners and property owners opportunities to learn about energy efficiency, renewables, and on-site water conservation.

Yet through all of these programs, projects, and accomplishments, the Office of Sustainability has lacked a unified, large-scale framework to define and guide the integration of sustainability into City policies and procedures. The advent of adaptokc seeks to change that. This plan includes consideration of one-off projects, externally-funded programs, and partnerships, but also mines opportunities to develop policies that codify sustainable practices for the purposes of stability, clarity, and longevity.

With this intent, the Office of Sustainability can work with City leaders, colleagues, businesses, and institutions to move Oklahoma City more strategically into the future by anticipating and adapting to change to ensure a community as resilient as it is prosperous.

The Office of Sustainability is responsible for enhancing Oklahoma City's sustainability efforts throughout the organization and the community by providing technical recommendations, sustainability planning and outreach services to City Departments and the public.

- Office of Sustainability Mission Statement

Spokies Bike Share

Oklahoma City's downtown bike share program was introduced in May 2012 with 95 bikes in a six-station system. Start-up costs were covered by EECBG funds and the system, now under the management of EMBARK, has grown with the addition of more stations and dockless bicycles.

City Energy Efficiency

Police stations, fire stations, City Parks recreation centers, the Cox Convention Center, and many other City facilities were audited for energy efficiency and received retrofits and the installation of automated building control software to reduce wasteful and costly consumption.

Electric Vehicle Parking Ordinance

City Council adopted an ordinance that granted the City's Traffic and Transportation Commission the authority to designate on-street parking spaces for electric vehicles only. Enforcement of this ordinance allows for the ticketing of non-electric vehicles parked in designated electric vehicle only spaces.

Green Home Loans

Approximately $350,000 in EECBG funds established a revolving loan fund to provide fixed interest rate loans of up to $15,000 to qualifying Oklahoma City homeowners for upgrades, retrofits, repairs, and new appliances to increase energy efficiency and reduce energy consumption.

Sustainable Purchasing Policy

Alongside the City's Finance Department, the Office of Sustainability developed an internal procurement policy to guide the purchase of products that are less toxic, wasteful, and costly to dispose of, conserve energy, water, and other natural resources, and last longer.

reBUILD Expo

Months after the devastating tornado outbreak of May 20, 2013, this daylong-event was held to assist home owners, developers, and builders navigate disaster recovery, from storm shelter installation to home energy rating systems. Speakers included the Oklahoma Insurance Commissioner, architects, and City staff.

1.2 What is Sustainability?

The consensus on the meaning of sustainability is that there is no consensus. Varying definitions have been crafted by varying bodies and they are as expansive and comprehensive as imaginable. Unfortunately, this can make discussions of sustainability and sustainable policy troublesome given the lack of a shared, established definition. In practice, however, sustainable policies and practices are common if not ubiquitous among institutions, businesses, and governments.

Oklahoma City itself has a storied, long-standing history of sound approaches to sustainability. A few illustrative examples include establishment of the City's first municipal recycling program in 1973, a second location opening soon thereafter, and the eventual curbside recycling program launched with City Council approval in 1994. Since 1996, the City's Deer Creek Wastewater Treatment Plant has provided up to three million gallons of recycled water per day for irrigation of Gaillardia Country Club's more than 600 acres of greens and landscaped property. In 2003, the City opened Oklahoma's first permanent household hazardous waste collection facility to ensure substances such as motor oil, antifreeze, pesticides, and herbicides remain out of lakes, rivers, and landfills. That same year, the EPA awarded $225,000 to the City for evaluation of reuse options at four Superfund sites, kickstarting the City's nationally-recognized brownfields program. In 2011, alternative fuels arrived to the EMBARK transit fleet with the addition of electric hybrid and compressed natural gas-powered buses. In 2012, the Oklahoma City Police Department added four electric battery-powered vehicles for downtown and Bricktown Parking Enforcement officers.

These select examples demonstrate one element at the core of sustainability: efficiency. Within the constraints of limited resources, limited funding, and expanding need, sustainability is about finding a balance between our environment, our economy, and our community. Central to this is the practice of holistically assessing costs and risks, both short-term and long-term, to resolve a critical question: how do we best achieve the most good with the fewest resources?

> "Sustainability exists at the intersection between environmental stewardship, economic vitality and community needs. To be sustainable is to consider the environmental, financial and human impacts all of our decisions and actions and to find an equitable balance between the health of our community, our economy and our environment."
>
> - City of Oklahoma City, Memo to the City Manager
> Office of Sustainability Report and Recommendations
> December 2008

With that in mind, and through peer city research, stakeholder input, and applicability to Oklahoma City's unique conditions, for the purposes of adapt**okc** we define sustainability as follows: **the quality of preparing for and adapting to disruptions by reducing vulnerabilities and conserving resources in order to strengthen our economy, protect our environment, and foster an equitable future.**

This quality is less about an end state and more about a process to continually assess decisions to refine and ensure maximum dividends are yielded in a way that balances among our environment, our economy, and our community. Many existing City processes are designed to consider these variables. The development review process, for example, is a multifaceted approach to determine how changes to our built environment will affect surrounding neighborhoods, businesses, infrastructure, and ecosystems. Quantitative processes such as population projections, traffic studies, water quality testing, and floodplain mapping inform our decisions today based on our best understanding of tomorrow. Our proposed approach is to recognize new options as opportunities to determine how the City can best use its finite resources.

Additionally, we know that disruptions, from extreme weather to economic disaster, will occur but we can rarely if ever anticipate when. Given that uncertainty, our perspective on sustainability sees Oklahoma City as a city continually engaged in future-proofing whereby we are uniquely positioned to be a leader in commerce, equity, and environmental protection, regardless of the challenges, obstacles, and disruptions to come.

The Foundations of Sustainability

In March 1911, Oklahoma City voters approved the first City Charter. That document endowed the government of Oklahoma City with the responsibility "to protect **health**, **life**, and **property**." This responsibility explicitly mirrors sustainability's "triple bottom line": **environment**, **society**, and **economy**. The duty which we as a city are obligated to fulfill by our own foundation is one and the same with sustainability. These responsibilities, however, do not exist in isolation but are connected, interrelated, and mutually dependent, and the relationship between those three responsibilities should not and cannot be reduced to either-or.

Environment

It is impossible to extricate ourselves from our environment. There can be no community, no economic growth or development without breathable air, uncontaminated soil, and clean water. The cost of environmental degradation is significant, even if not always readily visible. As such it does not simply jeopardize public and economic health but requires public funds at every level of government to ameliorate.

Economic growth and environmental decline need not be synonymous. Responsible, sustainable economic development is a reality; consider the growth in U.S. gross domestic product throughout the latter half of the 20th century as national environmental policies were adopted. Locally, we, too, must realize the balance between these seemingly adverse initiatives to make the most productive use of our finite natural resources while accounting for the socialized risks that can burden residents and institutions.

Society

"What is the city," Shakespeare asked, "but the people?" Societal sustainability can be translated to a phrase familiar to Oklahoma City thanks to MAPS: quality of life. More than just ensuring the basic needs of residents or even the provision of amenities, societal sustainability challenges communities to support entrepreneurship, strengthen economic mobility, foster creativity and curiosity, enhance livability, promote public health, support quality education, build affordable housing, attract and retain a talented workforce, and ensure a built environment accessible by and in service to residents of all ages.

Without a flourishing natural environment and a robust economy for all, the opportunity necessary for the people of Oklahoma City to thrive is out of reach. This social component, while sweeping and daunting, is where the efforts of sustainable programs and policies affect and yield dividends in the day-to-day lives of residents.

Economy

Resilience to market shocks is a pivotal quality of sustainable economies, especially those borne of commodity price volatility. A sufficiently diversified economy supported by a strong education system as a pipeline for skilled, talented workers and entrepreneurs is the foundation of a flourishing economy.

Due to Oklahoma City's overwhelming reliance on sales tax, high employment combined with high wages is optimal to induce local commerce and generate revenue, boosting locally-owned-and-operated businesses and broadening the scope and breadth of services local government can provide.

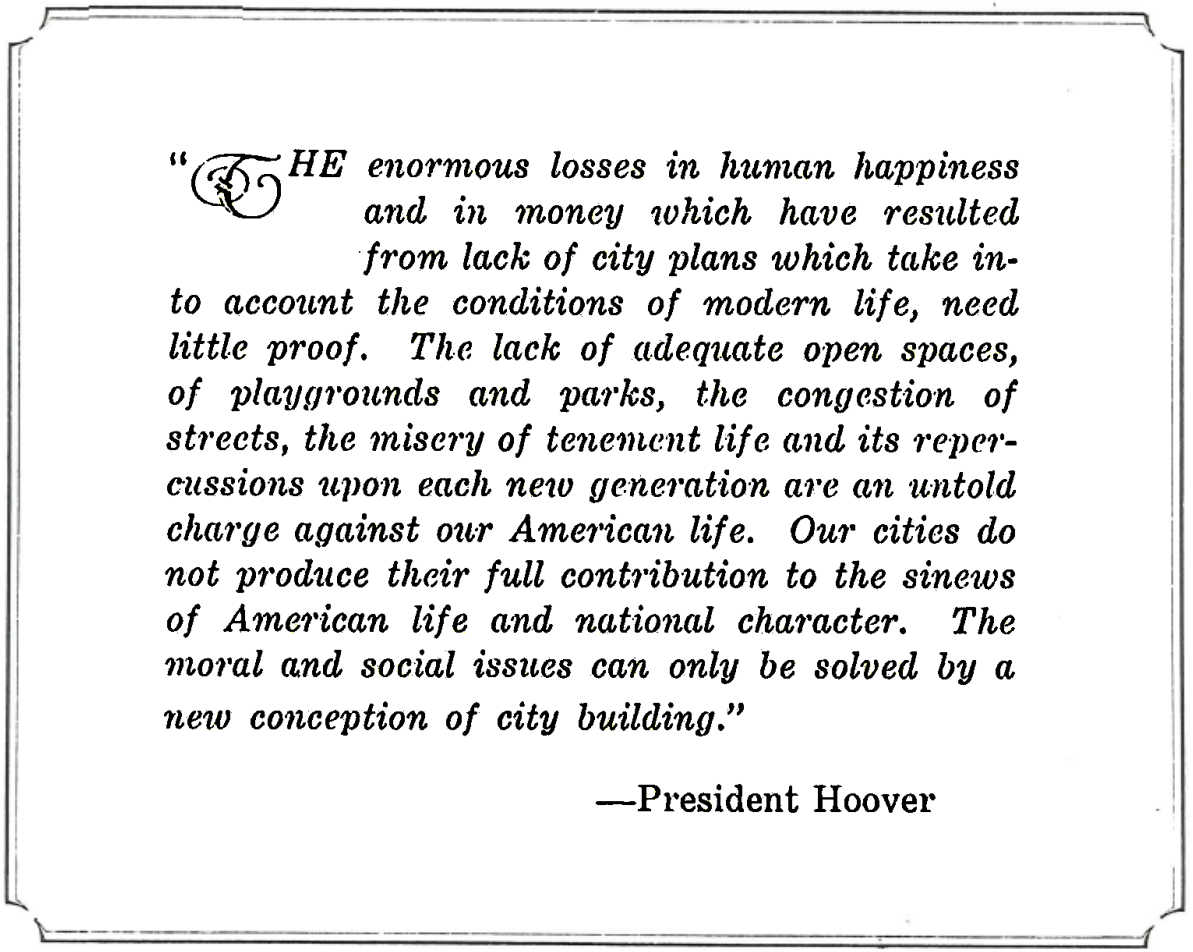
Ensuring as much money as possible is generated and spent within our economy means not just working in partnership with the business community but also unleashing the capacity of Oklahoma City residents to pursue their independence and economic freedom.

1.3 Supporting Plans and Studies

Many core practices of sustainability are central to, if not the subject of, prior City plans and studies. Some of these plans and studies were important resources in the development of adapt**okc**; the City's Hazard Mitigation Plan serves as a prime example. Others, such as bikewalk**okc** and the Water Conservation Plan, are so concentrated on one area that adapt**okc** would only be duplicative in attempting to address those same topics. Rather than trying to integrate, restate, or reproduce the research and analysis of those respective plans and studies, this section provides an overview of those resources.

An important part of developing adapt**okc** was identifying challenges and opportunities that have yet to be more deeply analyzed or explored by the City. Residents and policymakers should not think that because a larger discussion about bicycle and pedestrian infrastructure, for instance, is not included within adapt**okc** means it is not "sustainable" or a contributor to the City's capacity for adaptation. This is not so; rather, the City and its policymakers have already demonstrated their commitments through the adoption of the plans and studies laid out in this section, frequently doing so with associated funding. The 2017 general obligation bond propositions and the Better Streets, Safer City program both included funding to address much of what is included in these plans including sidewalks, on-street and off-street bicycle infrastructure, additional parklands, expanded transit service, affordable housing, and much more.

These plans and studies served as the building blocks throughout the development of adapt**okc** and combined with adapt**okc** represent broad, established momentum toward sustainable practices.



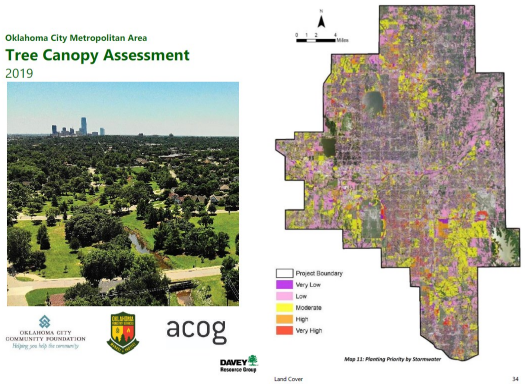
"THE enormous losses in human happiness and in money which have resulted from lack of city plans which take into account the conditions of modern life, need little proof. The lack of adequate open spaces, of playgrounds and parks, the congestion of strects, the misery of tenement life and its repercussions upon each new generation are an untold charge against our American life. Our cities do not produce their full contribution to the sinews of American life and national character. The moral and social issues can only be solved by a new conception of city building."

—President Hoover

This excerpt opened Oklahoma City's first comprehensive plan, 1930's *The City Plan of Oklahoma City.* This plan includes the foundational aspects of municipal planning: topography, population projections, population density, city demographics, street typologies, traffic volume, water and sewer service area, transit routes, and more.

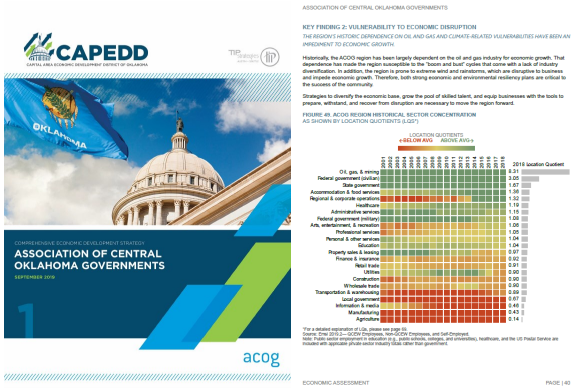
Oklahoma City Metropolitan Area Tree Canopy Assessment, 2019

A first of its kind in this part of Oklahoma, this assessment was conducted within a 536 square mile study area during the spring and summer of 2019. The Oklahoma City Community Foundation (OCCF) in partnership with the Association of Central Oklahoma Governments (ACOG) and Oklahoma Forestry Services contracted with Davey Resource Group Inc. (DRG) to conduct the assessment that determined the study area has an estimated 65 million trees providing as much as $150 million dollars in environmental benefits annually. The assessment includes planting priority maps to address both storm water runoff and the urban heat island effect.



Comprehensive Economic Development Strategy (ACOG), 2019

In 2011, ACOG received a grant from the U.S. Economic Development Administration (EDA) to develop a Comprehensive Economic Development Strategy (CEDS) for Oklahoma, Cleveland, Canadian and Logan counties. A CEDS is a long-range plan that analyzes the challenges and opportunities related to economic and community development. It includes proactive strategies and recommendations for achieving economic development objectives, as well as review infrastructure projects that will help the region attain these goals. The CEDS identifies many goals and strategies that overlap with those outlined in adapt**okc**, including: EP-2, EP-11, EP-22, EP-23, EP-24, EP-19, NB-11, WR-7.

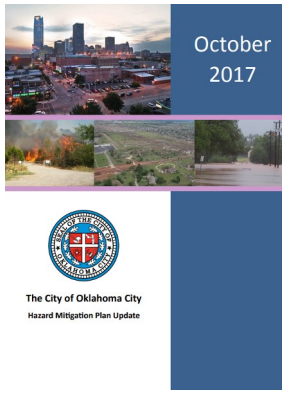


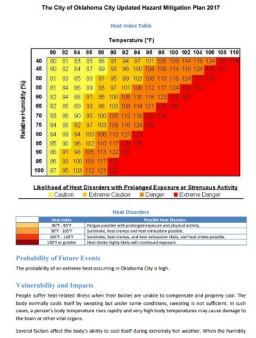
bikewalk**okc**, 2018

Oklahoma City's first bicycle-pedestrian master plan aims to transform the bicycling and walking experience within Oklahoma City to substantially improve the quality of life and health of our residents. This plan was developed to realize the plan**okc** goal to make Oklahoma City a community that offers many safe options for people to travel where they want to go - by foot, bicycle, or motorized vehicle. This requires investment in building and maintaining a multi-modal transportation network, complete with high quality trails, bicycle facilities, and sidewalks.

Hazard Mitigation Plan, 2017

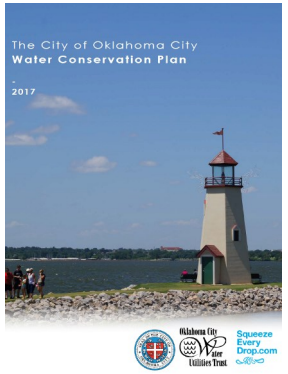
Required by FEMA as a condition of eligibility to receive federal assistance under various hazard mitigation grant programs, the City's Hazard Mitigation Plan (HMP) looks at long-term risks to residents and property in an effort to proactively determine how to best reduce or eliminate those risks. A product of the City's Office of Emergency Management alongside collaborators from all over the private and public sectors, the HMP identifies 12 natural hazards, charts their historical impacts on Oklahoma City, projects their future likelihood, and recommends tactics to mitigate the impact, both in cost and lives, to Oklahoma City.

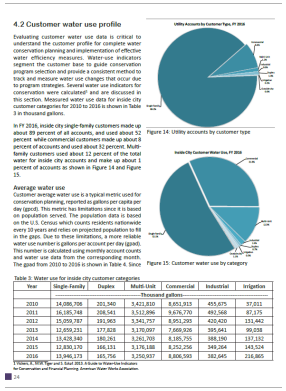




Water Conservation Plan, 2017

After the landmark 2016 settlement between Oklahoma City, the state of Oklahoma, the Choctaw Nation, and the Chickasaw Nation regarding Sardis Lake water rights, the Water Conservation Plan was developed by the City's existing water conservation staff to reflect a dedication to the responsible use of our precious water supply. Formally adopted by both the City of Oklahoma City and the Oklahoma Water Utilities Trust, the Water Conservation Plan includes goals, indicators, and recommendations for both policy and programs shaped by the American Water Works Association's conservation standards and supports specific components of planokc.





Encompass 2040 (ACOG), 2016

Developed by the Association of Central Oklahoma Governments (ACOG), Encompass 2040 is the region's Metropolitan Transportation Plan and long-range plan that guides Central Oklahoma's management, operation, and investment of billions of transportation dollars. Encompass 2040 was adopted by the ACOG Board of Directors on October 27, 2016.

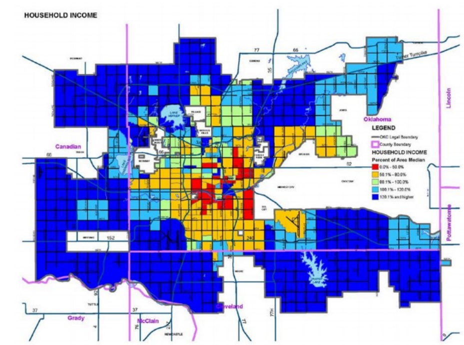
ENCOMPASS 2040
central oklahoma regional transportation plan

planokc, 2015

The City's first fully-new comprehensive plan included greenokc, the environmental and natural resources element, that assessed the impacts of development on ecological systems. The research and recommendations in greenokc served as a point of origin for adaptokc and guided us towards the needs and gaps to be addressed. Over the coming years, much of the land use elements of planokc will be developed via a community-lead process of updating Chapter 59 of the City's code. This will in turn provide us with an opportunity to craft, refine, and ultimately codify components of adaptokc for inclusion in City code to meet the goals of both adaptokc and planokc.

Consolidated Plan, 2015 - 2020

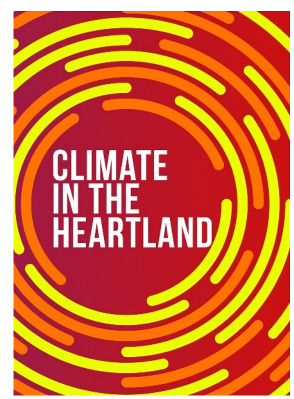
Cities who receive Community Development Block Grant (CDBG) formula funds via the U.S. Department of Housing and Urban Development are required to adopt and publish a Consolidated Plan every five years. These plans require local assessments of housing market conditions, housing costs and affordability, and populations experiencing homelessness to guide where and how localities can best allocate CDBG funds and resources to the principal benefit of low- and moderate-income persons and households. A new Consolidated Plan for the City of Oklahoma City will be developed and adopted in 2020 to comply with federal requirements.

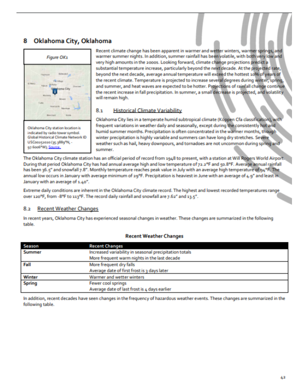


Household Income Concentration

Climate in the Heartland, 2015

As one of five cities involved in this regional study, projections of changes to Oklahoma City's climate are a fundamental and important element of long-range planning. Based on a combination of datasets, including 30-year climate normals, long-term data from the Will Rogers World Airport weather monitoring station, and global climate models, the outputs indicate the likely scenarios facing Oklahoma City through 2080 and serve to inform what hazards are likely to threaten our infrastructure, neighborhoods, and businesses.




8 Oklahoma City, Oklahoma

Health Impact Assessment, 2014

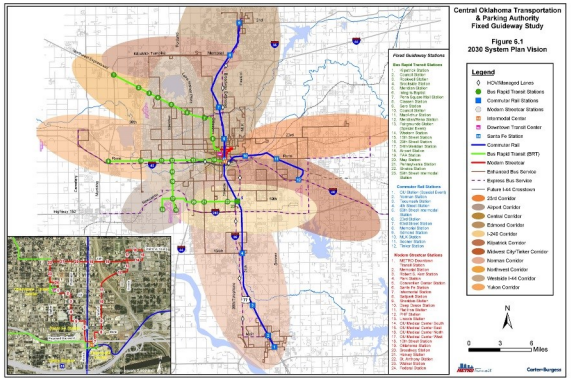
The Health Impact Assessment (HIA) was developed to gauge the overall impact of planokc components on community health in Oklahoma City. The HIA specifically sought to evaluate the effect of city-wide growth scenarios through thirty-five measures/indicators that have potential to change as a result of Oklahoma City growth patterns. The HIA identified several recommended strategies that would have a positive impact on the community, most notably: creating more opportunities for walking and biking, increasing access to fresh, healthy food, improving and protecting water quality, increasing access to parks and schools, and reducing occurrences of abandoned buildings.

Oklahoma City Parks Master Plan, 2013

Funded in part through the generosity of the Oklahoma City Community Foundation, the City's Parks Master Plan serves as a guide to the establishment of new policies and programs to maintain, improve, and leverage the park system for greater community benefit. Reflective of the city's growth, the Parks Master Plan seeks improved access to the park system across the city's 621 square mile area. Portions of the Plan build upon other plans and studies including the park typologies and standards developed in the 2005 Parks and Recreation Comprehensive Plan, planokc issues and goals, and the Oklahoma City Park System Study conducted in 2011.

Fixed Guideway Transit Study, 2006

The Fixed Guideway Transit Study identified potential regional transit solutions that improve connections among the Oklahoma City metro's growth centers, enhance economic development opportunities, improve mobility, expand transportation options and improve air quality. Those solutions included a combination of local bus, BRT, streetcar, commuter rail and other options. This plan was the foundation for the later Commuter Corridor Study and has shaped the Central Oklahoma region's approach to regional transit since; because of the analysis and input as part of the Fixed Guideway Transit Study, the region's Regional Transit Authority now exists and continues work towards an eventual realization of regional transit.



2.0 Challenges

Oklahoma City is not unique in the challenges it faces in the 21st century. An estimated 80% of the U.S. population now lives in cities and the resulting concentrations of people, resources, and investments are becoming more diverse, more connected, and more unpredictable. Whatever differences there are between Oklahoma City and other urban centers throughout the country, we are similar in that we are all competing for jobs, workers, investment and access to resources. Without a look towards the challenges that are here with us now as well as on the horizon, our ability to compete will only diminish.

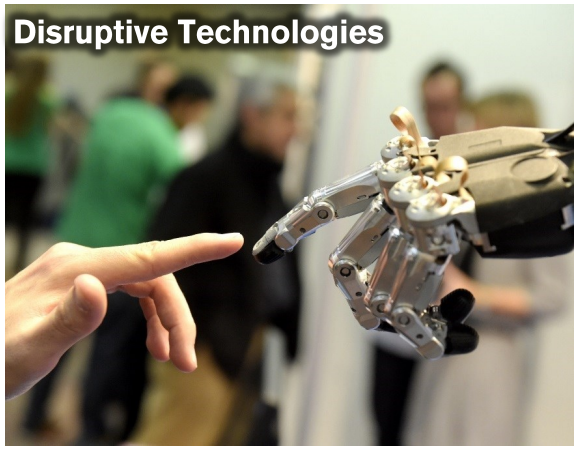
These challenges underscore how our city is changing. They are problems of scale and growth, of balancing finite resources with demands. They should not, however, be seen in isolation. Rather, they are all interrelated, each connected and dependent on one another. There are no easy answers, no one-size-fits-all solution to the formidable challenges that are already with us and threaten to loom ever larger in the years to come. However daunting they may seem, these challenges are more than surmountable - they are opportunities for Oklahoma City and its residents to meet a bright and prosperous future.

Oklahoma City's expansive system of roads and streets will continue to face challenges in the decades to come. Population growth, urbanization, fuel efficiency, freight traffic, extreme weather, and alternative fuels will all contribute to the shifting and rising costs of expanding and maintaining our infrastructure.

Urban growth is synonymous with the expansion of impervious surfaces. Given Oklahoma City's historic and projected increases of heavy precipitation events, development policies should reflect the need to mimic the natural environment to protect lives and property.

Oklahoma City is expected to see an increase in average annual temperature and, with it, heatwaves of more frequency, severity, and duration. With such an increase comes significant risk to our residents, our infrastructure, and our vital water resources.

Emerging sectors can provide livable wages, enhance workforce retention, and expand opportunities. The more diverse Oklahoma City's corporate landscape, the more resilient our economy will be, shielding us from the historical boom and bust cycle and its effect on revenue and employment.



Advances in robotics and artificial intelligence portend unprecedented shifts in employment. Drastic changes to the transportation, manufacturing, and service sectors could dramatically alter our economy.

Our health and wellbeing is directly affected by the condition of our natural and built environments. The design and structure of our city is itself a social service powerful enough to influence - for better or worse - the wellness of our residents.

All are vulnerable to disaster, be it natural or manmade. The consequences, however, are not borne equally. Small business owners, seniors, populations with limited English proficiency, rural residents, and others may face a greater struggle to recover from unexpected crises.

From ice storms and tornadoes to earthquakes and drought, extreme weather has proven costly to our community. Opportunities to harden against and mitigate the impacts of such events can be proactively included in the design and growth of Oklahoma City.

"The future is already here – it's just not very evenly distributed."

- William Gibson

Issue Focus 1: Transportation Costs

Oklahoma City's continued growth is projected to include the addition of approximately 300,000 people by 2050. Commensurate with that population increase will be new development, added lane miles of streets, greater transit service demand, increased congestion, increased vehicle miles traveled, increased emissions, increased freight traffic, and increased maintenance needs for our roads and streets.

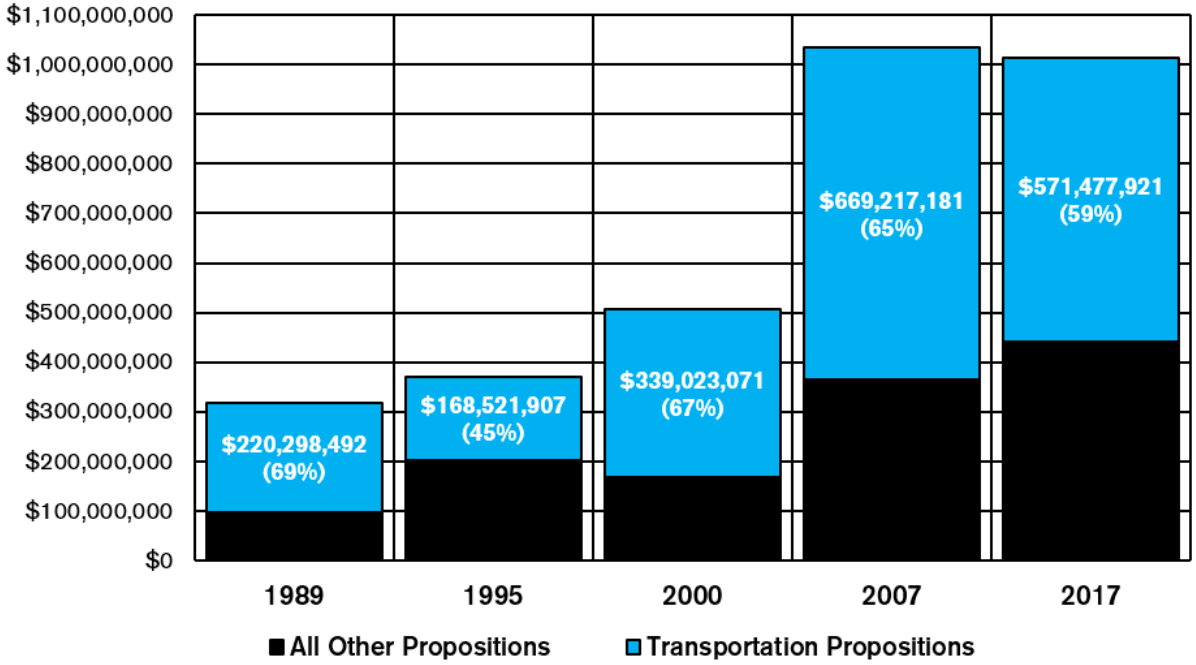
Presently, the City uses local, state, and federal dollars to support transportation infrastructure projects. Local general obligation bonds have, since 1989, put an inflation-adjusted total of $1.9 billion towards roads, streets, bridges, and traffic control. State gas tax remittances average just $1 million annually. Federal surface transportation dollars have supported Oklahoma City projects with a minimum of $44.5 million between federal fiscal years 2009 and 2017. Despite these investments, residents express consistent dissatisfaction with our streets and roads, identifying their condition as the single most important issue in every Oklahoma City Citizen Survey conducted thus far.

Over time, federal and state funding sources will at best rise and fall but likely diminish. State gas tax remittances will erode due to increased vehicle fuel efficiency as well as wider adoption of alternative fuels not subject to a volumetric fuel excise tax. These same factors have and will continue to reduce federal transportation dollars available as the Highway Trust Fund, the federal government's primary repository of federal gas tax revenue, continues to flirt with insolvency. Within the Central Oklahoma region, federal funds will grow more competitive as regional communities similarly continue to grow. More frequent extreme weather will escalate maintenance needs and costs across all sizes and levels of government, from routine maintenance to catastrophic destruction.

As illustrated in **Figure IF-1**, Oklahoma City's streets and highways cumulatively consume approximately 30 square miles. While some interstates and highways are the responsibility of the Oklahoma Department of Transportation, the vast majority are local roads and streets. For context, 30 square miles is larger than virtually every city and town in the metro with the notable exceptions of Edmond, Norman, Piedmont, and El Reno. If the funds for streets and roads from the 2017 general obligation bond were apportioned across all 30 square miles equally, the investment would equate to about $140,000 per square mile.

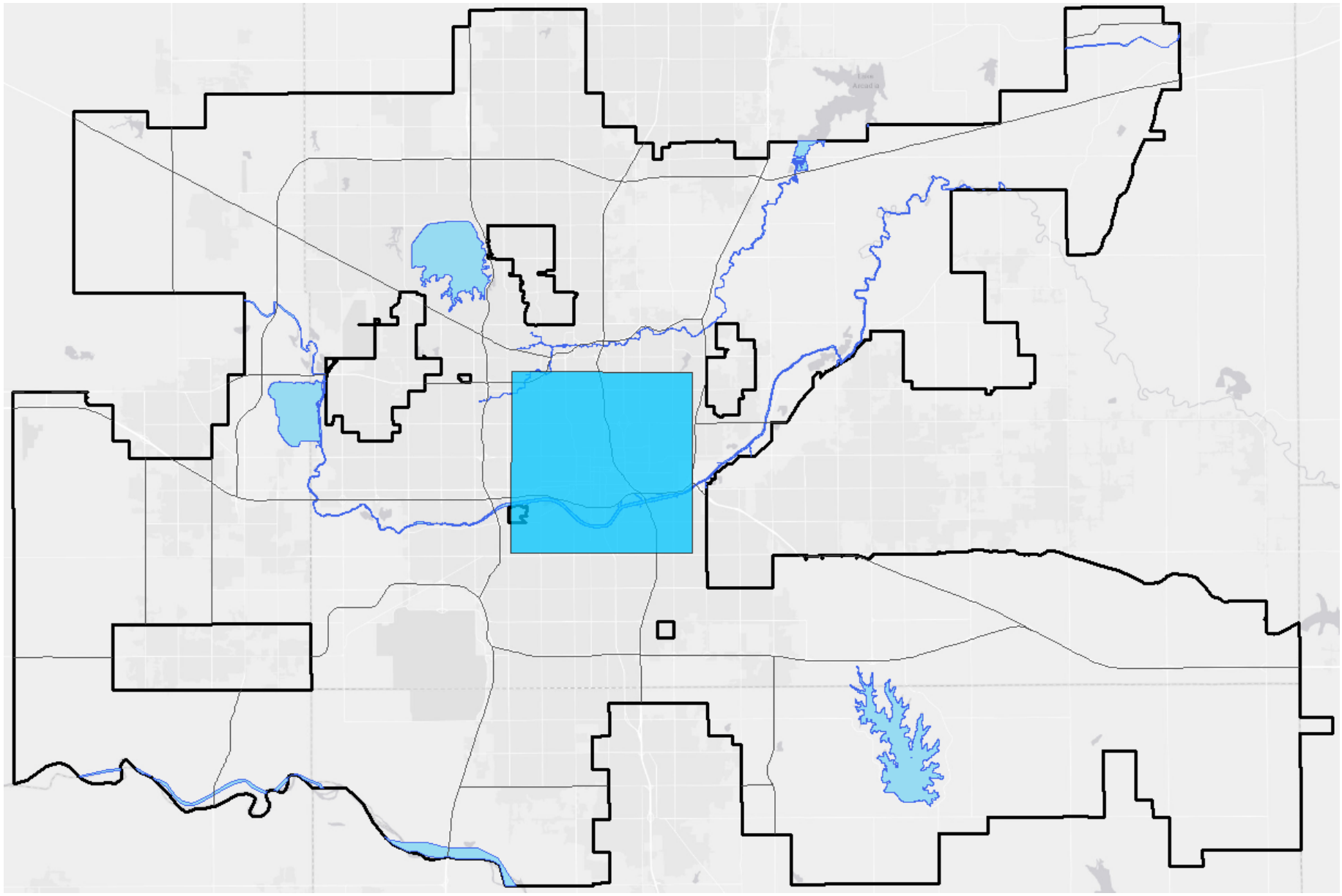
As evidenced by the Better Streets, Safer City program, Oklahoma City residents know our streets and roads are core but costly infrastructure. The daunting task of maintaining the scale of a small municipality of asphalt and concrete will only grow more of a fiscal burden if we continue to grow with our historical approach to land use and transportation.

Oklahoma City General Obligation Bonds, 1989 - 2017



City general obligation bonds between 1989 and 2017 were adjusted for inflation based on 2019 rates from the U.S. Department of Labor's Consumer Price Index. "Transportation propositions" includes totals for streets, traffic control, and bridges, and in the 2017 bond, notably included costs for sidewalks. During this 28-year period across five bonds an inflation-adjusted total of $1.9 billion has been approved by voters for expenditure on transportation infrastructure.

Figure IF-1, Representative Scale of Consolidated Street and Highway Pavement



Planimetric data was used to estimate the total quantity of land area consumed by transportation infrastructure (excluding sidewalks) across Oklahoma City's 621 square miles. The blue square above represents the approximate 30 total square miles - about 5% of the city - covered by roadway of which public dollars are responsible for maintaining.

Issue Focus 2: Urban Flooding

Development is synonymous with impermeable surfaces, be it asphalt, concrete, roofs, parking lots, sidewalks, streets, driveways, or slabs. These surfaces disrupt and alter the landscape's natural hydrology - where and how water flows - and, if not properly mitigated, contribute to flooding conditions both in and out of federally-designated flood zones.

Approximately 5,000 buildings, predominately residential, are located within Oklahoma City's 100-year floodplains. Since 1977, Oklahoma City residents have made more than 1,300 claims to FEMA's National Flood Insurance Program with a total inflation-adjusted payout of $22.5 million. Of those claims, 380 - about 28% - have come from structures within the floodplain. Another 12% were filed for structures within the 500-year floodplain. That means about 60% of claims were outside of designated floodplains.

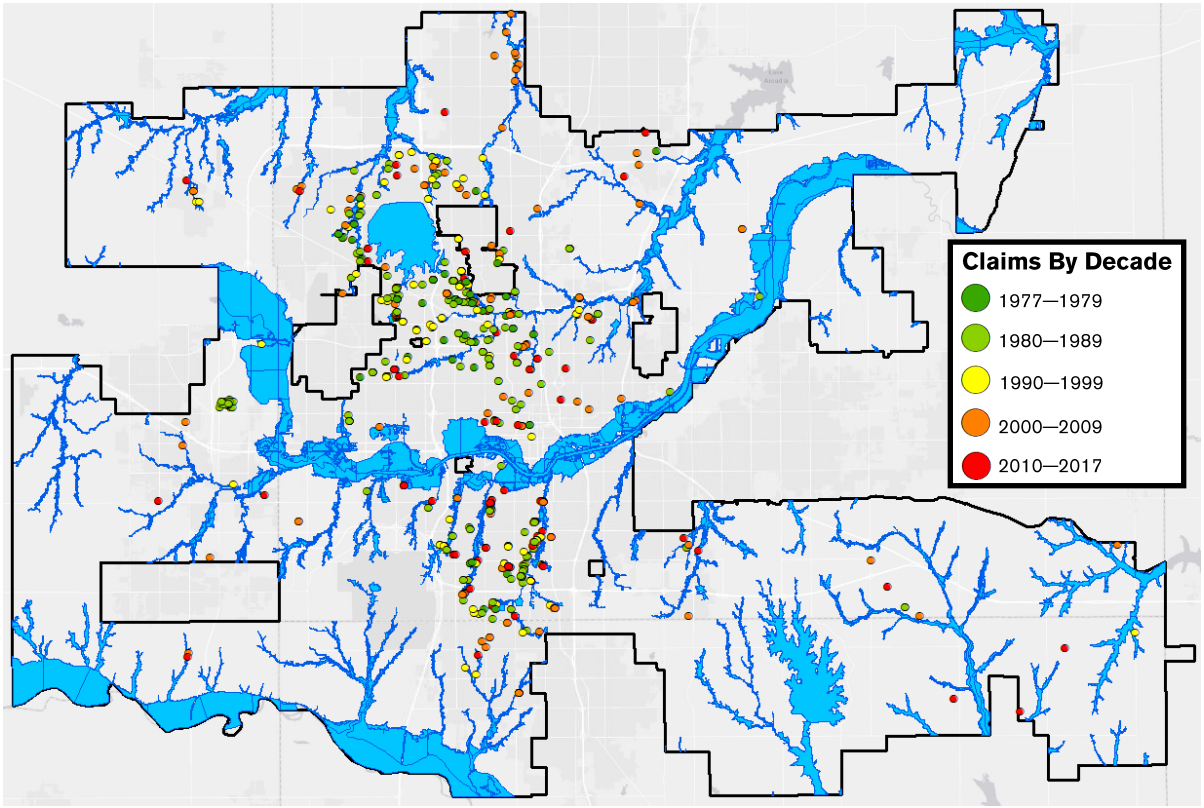
Heavy rain events have been part of Oklahoma's historical climate, but the frequency and intensity of events are increasing. According to the U.S. Global Change Research Program's 2017 Climate Science Special Report, heavy rainfall, defined as the top 1% of annual events, increased by 12% in the Southern Great Plains between 1958 and 2016. The frequency and intensity of heavy precipitation events are also projected to continue to increase over the 21st century. Seasonally, rainfall is projected to increase in winter and spring and decrease in summer and fall by the end of the 21st century, but projected seasonal changes are small compared to natural variations in a highly-variable climate like Oklahoma City's.

In short, when rain events happen in Oklahoma City, they are more intense than historical rainfall events. This increase in intensity of precipitation coupled with a growing footprint of impervious surfaces, increases flood risk in more parts of the city.

Between 2010 and 2015, development added about 13 square miles of pavement, a 19% increase. This amount of pavement is equivalent to adding a surface parking lot the size of the city of Mustang plus one more square mile to Oklahoma City' s land area. By comparison, Oklahoma City's population during that same period grew 8%, meaning development added approximately 7,400 square feet of pavement for every person added to our population.

Flooding is no longer an issue about where we build but how we build. Future development must be sensitive not only to designated areas prone to flooding but how contributions to our infrastructure can exacerbate urban floods.

Oklahoma City FEMA Flood Claims Outside of Flood Zones, 1977 - 2017



Source: FEMA

ABOVE: MAP OF FLOOD CLAIMS OUTISDE OF FLOOD ZONES

The map above highlights the importance of flash flood preparedness by illustrating the nearly 60% of flood claims since 1977 originating outside of a designated floodplain.

Issue Focus 3: Disruptive Technologies

Innovations in technology have historically driven revolutions in commerce, from the steam engine to the smart phone. Those innovations, however, can swiftly challenge existing practices, procedures, and regulations that were developed in a past era.

No example is more germane than that of e-commerce. Online transactions began in the early-to-mid 90s yet barriers to taxation were not removed until a U.S. Supreme Court decision in 2018. Consider, too, how Oklahoma City has had to respond and adapt to home sharing and ride sharing platforms. Policies must be crafted to ensure a changing, technology-driven market does not outpace important sources of revenue such as the hotel/motel tax, sales tax, and use tax.

A more structural disruption has gradually emerged on the horizon: job automation. A 2017 study by the McKinsey Global Institute estimates that in the U.S. alone, 39 to 73 million jobs - about a third of total national employment - could be automated by 2030. Joint research by Citigroup and the Oxford Martin School at the University of Oxford estimates 47.1% of Oklahoma City jobs are at high risk of automation. A 2019 report from the Brookings Institution similarly estimated about 46% of Oklahoma City metro jobs are susceptible to automation. This workforce vulnerability comes as automation expands to the service sector whereas, historically, it has been limited to manufacturing.

Oklahoma's largest employer is Walmart with an estimated 31,845 jobs statewide. In conjunction with the McKinsey Global Institute, in 2019 Walmart published "America at Work: A National Mosaic and Roadmap for Tomorrow" to examine "resiliency, or the capacity to respond to change - in this case, automation." The estimated "range of automation potential," defined as "the proportion of time spent on job activities that current technologies can automate," is expressed on a county-by-county basis. Oklahoma County is 33% to 45% with all surrounding metro counties at a range of 36% to 54%. While Walmart is just one employer, and certainly not singular in its investment towards job automation, their demonstrated intent speaks to how fundamentally the labor market will not just change but will continue to change. As their report says, "All agree that automation has arrived and is quickly changing the American workplace."

Generally, more specialized cities have a larger share of jobs at high risk of automation, while diversified cities are more resilient to the expanding scope of automation. In other words, economic and industrial diversification can make cities more resilient to negative demand shocks in any specific industry. The Oklahoma Office of Workforce Development identified 100 "critical occupations" based on several factors that include being "vital to the success of Oklahoma's" economy. Cross-referenced with a 2013 study by Carl Frey and Michael Osborne, 38 of the 100 critical occupations have a greater than 50% risk of being automated.

Those 38 occupations include several estimated to grow the most within Oklahoma between 2016 and 2025 including heavy and tractor-trailer truck drivers, accountants and auditors, operating engineers and other construction equipment operators, and industrial machinery mechanics. The majority of the 38 occupations - 56% - require a high school diploma or equivalent, which translates to severely reduced opportunity for those without college degrees or advanced education. As a result, automation is likely to lead to increased income inequality with high-paying creative and cognitive jobs at a premium while middle- and low-skill opportunities are gradually displaced. For example, were automation to replace just 20% of Oklahoma City metro jobs that pay below the full-time livable wage threshold of $11.31 for a single adult, that would eliminate 29,482 jobs from the economy - more jobs across the regional economy than employees at Tinker Air Force Base.

The reverberations to labor markets and regional wages due to disruptive technologies would be far-reaching. We are not alone in grappling with the uncertainty of the U.S. workforce nor the uncertainty of how best to respond through the mechanisms of public policy. But the effects are significant enough to warrant closer attention as Oklahoma City continues to grow.

LEFT: GROCERY AUTOMATION

The 2017 addition of a 20-foot by 80-foot "Pickup Tower" to the parking lot of an Oklahoma City Walmart Super Center location marked the retail giant's first U.S. foray into automated shopping. Consumers can select more than 30,000 grocery items online and retrieve them from the unattended kiosk. In 2018, Walmart intended to make Pickup Towers available to nearly 40% of the U.S. population.

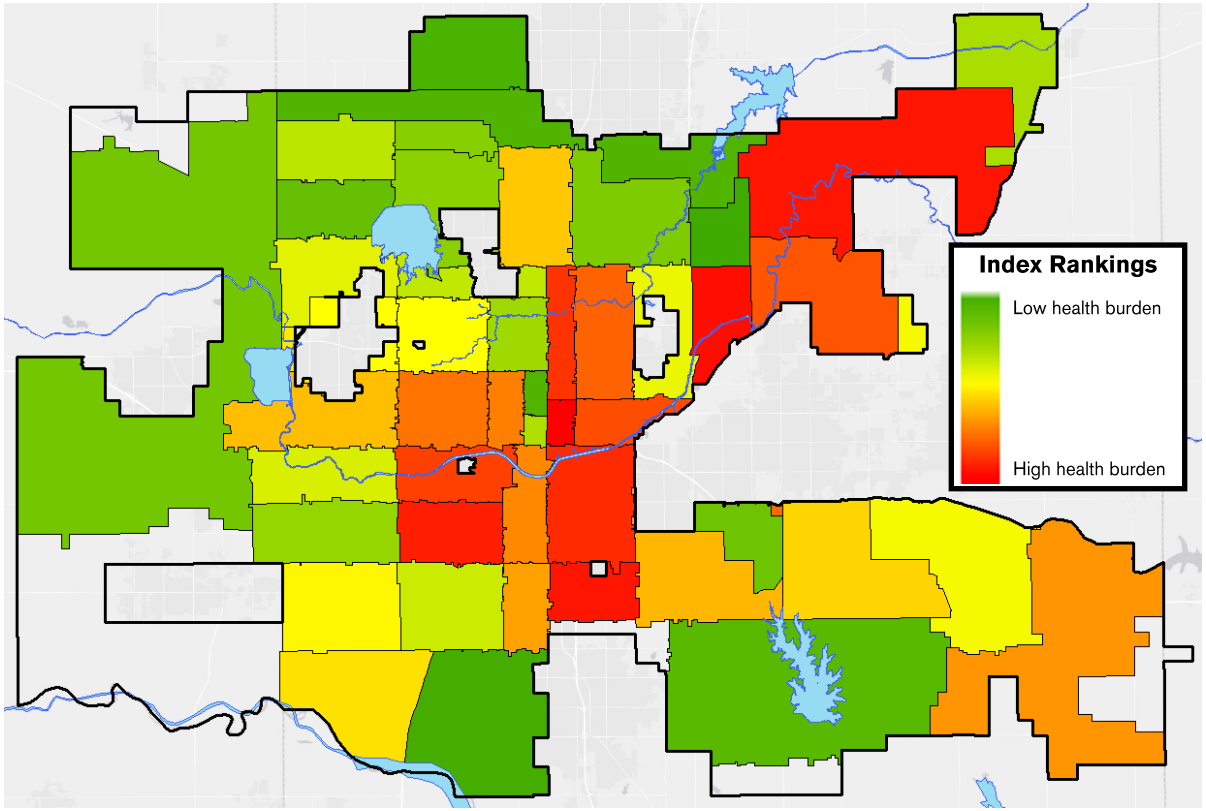
Issue Focus 4: Environmental & Public Health

The world we live in is the cumulative product of deliberate choices. Through the decades, both public policy and market forces have driven the growth and decline, spurred by technology, population, economics, and many other variables. All of those choices have and continue to shape our built environment as well as alter our natural environment in ways that affect and influence us every day. These effects and risks of exposure are part of a mosaic of factors that affect our well-being.

The Oklahoma City-County Health Department (OCCHD) found an "18-year gap in life expectancy" between "those living in the Oklahoma City ZIP codes with the best health outcomes versus those living in the one experiencing the poorest health outcomes." As illustrated by their data, the ZIP code an Oklahoma City resident lives in determines their life expectancy. Per the OCCHD 2017 Wellness Score, mortality rates for cardiovascular disease, diabetes, chronic lower respiratory disease, cancers, and Alzheimer's disease within the City-County area all exceed both the statewide and national rates. Overall life expectancy within the city-county area is 74.9 years, which is 3.9 years fewer than the national average. Our land use requirements are at the crux of these issues as they instruct the design and placement of development, both of which can have immense consequences that may not be reflected in the development review process. A closer relationship with OCCHD to collaborate on design review through the lens of public health policy could provide a more comprehensive perspective on our built environment.

There is no panacea for the public health issues that face Oklahoma City. Efforts to better integrate considerations of environmental health can, however, contribute to improvements in addition to crafting a better, more sustainable built environment that enriches and extends life for residents.

Oklahoma City Health and Wellness Index Rankings by ZIP Code, 2013 - 2015



Source: Oklahoma City-County Health Department

A multitude of population, public health, and land use data was combined by the Oklahoma City-County Health Department to express ZIP code-level insight based on factors including education, income, maternal and child health, mental health, mortality, healthcare access, crime, infectious disease and the built environment.

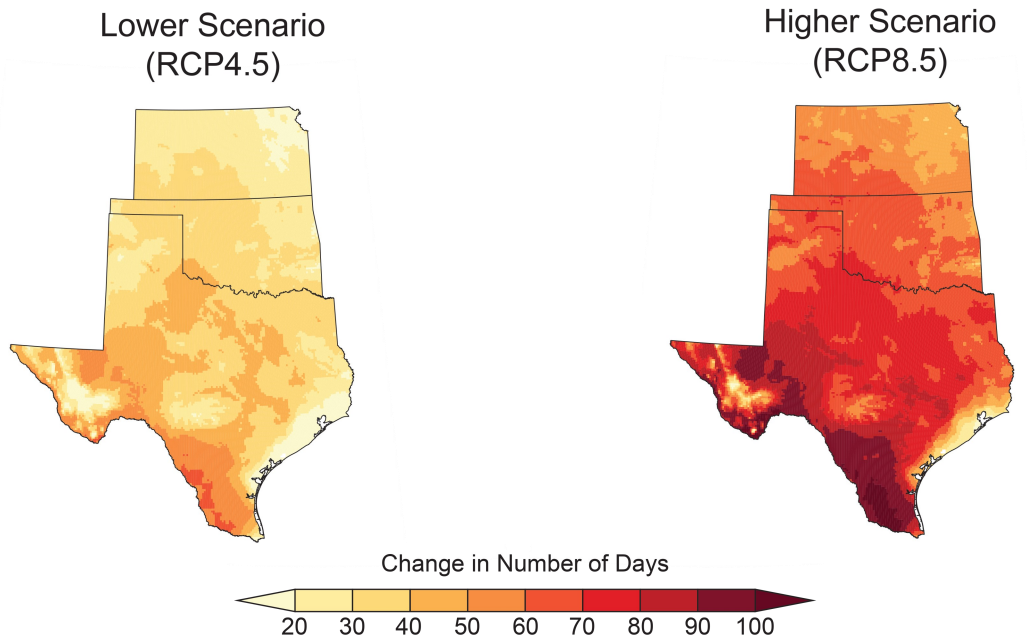
Issue Focus 5: Extreme Heat

The summers of 2011 and 2012 in Oklahoma City were so hot they overtook temperature records set during the Dust Bowl. At 113°F, August 3rd, 2012 is now tied with August 11th, 1936, for Oklahoma City's all-time highest temperature. Similarly, the sheer quantity of hot days broke records; 2011 alone had 21 days greater than or equal to 105°F. More than a quarter of calendar days in 2011 were at or above 90°F. The extreme heat of these consecutive summers stressed the electricity grid, damaged infrastructure and agriculture, threatened water supplies, contributed to wildfires, and cost some Oklahomans their lives. They serve as warnings not only for the threat of extreme heat today, but also the threats projected for tomorrow.

The U.S. Global Change Research Program's (USGCRP) 2017 Climate Science Special Report identifies an increase in frequency and intensity of heatwaves and extreme heat events across the U.S. since 1960 and projects this trend to continue as global temperatures continue to rise. At present, annual temperature data for Central Oklahoma from NOAA's Southern Regional Climate Center show a significant warming trend since 1998, the longest since the Dust Bowl, during which extreme drought was also present. In 2012, the state saw its highest average annual temperature ever recorded, 63.2°F. Central Oklahoma, which contains the Oklahoma City metro, has an average annual temperature of 60.3°F, which is higher than the average statewide annual temperature of 59.8°F.

Extreme heat is relatively common in Oklahoma City, but is projected to get worse. Synthesizing findings from National Climate Assessment publications, the Southern Climate Impacts Planning Program's *Simple Planning Tool for Oklahoma Climate Hazards v 1.5* indicates that by mid-century, Oklahomans will see a 20- to 27-day increase in the number of days that reach 95°F and 100°F (the historical top 2% of hot days each year). In addition, the number of nights per year that do not drop below 70°F to 75°F (the top 2% of warmest nights) are expected to increase by an additional 35 nights per year.

Projected Increase in Number of Days Above 100°F, Late 21st Century



Under both lower– and higher-scenario climate change projections, the number of days exceeding 100°F is projected to increase across the Southern Great Plains by the end of the century (2070-2099 as compared to 1976-2005). Source: The USGCRP 2017 Climate Science Special Report.

Residential energy consumption is highly correlated with heating and cooling degree days, both of which would see significant change via these projections. The Residential Energy Demand Temperature Index (REDTI) designed by NOAA estimates residential energy demand by way of annual heating and cooling degree days. During the 122 years between 1895 and 2017, Oklahoma's residential energy demand surpassed that of the contiguous U.S. during 43 of those years when normalized by population. Having become more common in recent years, 21 of those years occurred since 1980 whereas 22 occurred in the 85 years prior.

Impacts of extreme heat include community-wide costs to augment the electricity grid and the risk of higher heat-related mortality. When people are exposed to extreme heat, they can suffer from potentially deadly illnesses such as heat exhaustion and heat stroke. Warm nights are also problematic for those without air conditioning, since the body has a hard time cooling off. Hot temperatures can also contribute to deaths from heart attacks, strokes, and other forms of cardiovascular disease, all of which are established public health challenges in Oklahoma City.

Issue Focus 6: Economic Diversification

The oil and gas sector has long served as Oklahoma City's economic base, evidenced by the presence of companies like Devon Energy, Continental Resources, Chesapeake Energy, and SandRidge Energy. Analysis of 2015 employment data by the Brookings Institution estimates Oklahoma City has at least 11.61% greater concentration of oil and gas extraction jobs than the U.S. as a whole. Economic diversification is necessary to increase resilience to market shocks like commodity price volatility, specifically oil and gas.

What Oklahoma City experienced in 2015 and 2016 is illustrative in that a downturn in the oil and gas industry, despite otherwise low unemployment, reverberated throughout the local economy with job losses, reduced wages, and ultimately dramatic impacts on sales and use tax revenue. The price of West Texas Intermediate crude oil dropped about $75 between mid-2014 and early 2016, a 70% reduction per barrel.

As a result, City sales tax collections for FY16 were 1.9% below projections with the proposed budget citing "the energy sector contraction as rig counts declined and service providers to the energy sector experienced lower sales." In FY17, collections fared even worse with sales tax revenue 3.1% below projections. While the City has seen annual sales tax collections below revenue - FY10, for example, was 7.25% below projections - FY16 and FY17 marked the first consecutive years below projections since FY86 and FY87.

The effect of the oil and gas industry contraction was not exclusively quantifiable by the City's sales tax collections. Between 2015 and 2016, the Oklahoma City MSA saw an inflation-adjusted decline in real GDP of 2.22%. By comparison, the MSA experienced real GDP growth of 2.38% between calendar years 2008 and 2009. In other words, the plummeting price of oil caused a local recession with economic effects far more severe than the national recession that saw U.S. GDP contract by 4.2% between 2007 and 2009 and approximately 8.7 million jobs lost across the country.

The Oklahoma City metro's major employers demonstrate the challenge of economic diversification is not necessarily the concentration of jobs in any one sector, but the concentration of high wages. Based on data from the Greater Oklahoma City Chamber, regional employer centers are predominately public institutions. Between the State of Oklahoma, Tinker Air Force Base, the University of Oklahoma (including the Health Sciences Center and OU Medical Center), the Federal Aviation Administration, the University of Central Oklahoma, Oklahoma City Community College, and Rose State College, government and publicly-funded institutions represent approximately 109,000 jobs. Comparatively, the region's major oil and gas employers supply about 7,000 direct jobs.

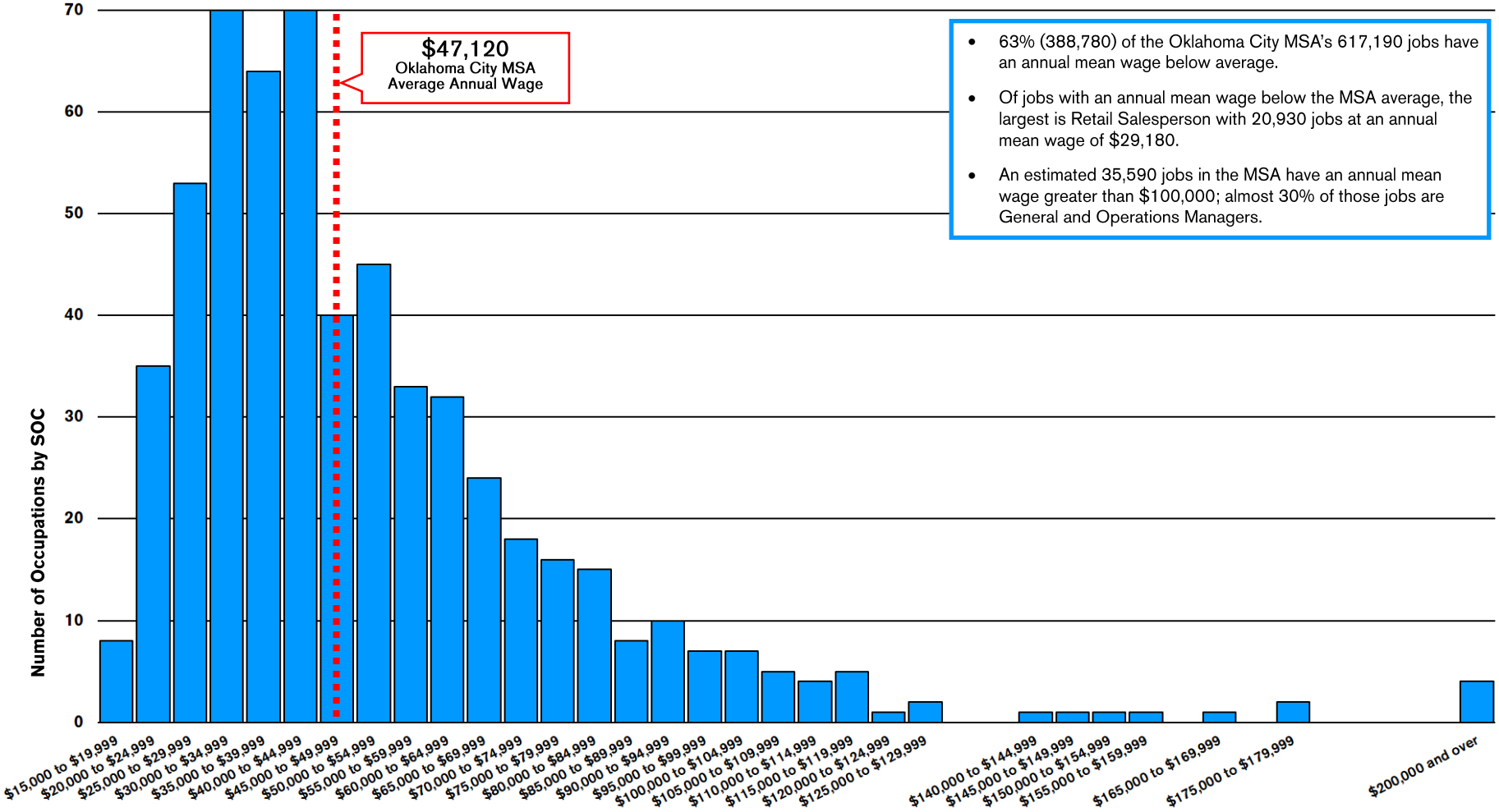
The Oklahoma Employment Security Commission's (OESC) Wage Report for 2018 found that within the Oklahoma City MSA, petroleum engineers have the second highest annual mean wage of any job outside of the medical/healthcare sector after chief executives ($157,730 and $176,340, respectively). Based on OESC data, the Oklahoma City MSA has 583 occupations based on classifications from the Standardized Occupational Classification system; of those 583, almost 60% - 340 occupations - make the regional annual average wage of about $47,000 or below.

The two most common occupations in the Oklahoma City MSA are Retail Sales Person (20,930) and Customer Service Representatives (14,330) with annual mean wages of $29,180 and $32,930. Under the assumption of full-time employment of 40 hours per week for 52 weeks, these annual mean wages each translate to hourly wages of $14.03 and $15.83. Applying MIT's Living Wage Calculator to the Oklahoma City metro, these gross hourly wages would be below a living wage for a single working adult with any children, a two-adult household with children where only one adult works, or a two-adult household with three or more children where both parents work.

In 2014, the Oklahoma Legislature passed and then-Governor Mary Fallin signed SB1023, which preempted all municipalities from increasing the minimum wage. Yet strong wages are vital for macroeconomic strength given Oklahoma's unique reliance on sales tax for municipal operations. **Economic diversification is more than just range of occupations, but a depth of wages; if high wages are too consolidated within a particular sector, the ebb and flow of that sector can have a disproportionate and cascading impact on the entirety of the local economy.** Tools at the state and local level do exist to encourage economic diversification, particularly the Quality Jobs Program administered by the Oklahoma Department of Commerce and the City's Strategic Investment Program (SIP). The SIP is an especially robust program, supported by voter-approved bond packages in 2007 and 2017, as it is not limited to specific sectors and is structured as a pay-for-performance job creation program with requirements for each eligible company to be awarded incentives "based on an economic impact analysis to provide meaningful measures, accountability and a level playing field." The SIP's Standard Program requires applying companies "to pay 90% of the most current" Oklahoma City MSA average wage.

Continued economic development can cultivate higher wage opportunities but cannot comprehensively accomplish this goal singlehandedly. Investment in and support of education - primary, secondary, higher, and vocational - is a crucial method of producing a skilled workforce better able to navigate high wage occupations. While this has proven challenging given the City's constrained role in education, there remains both public and political will for broader involvement in public education. Additionally, companies themselves are seeking to

Oklahoma City MSA Distribution of Annual Mean Wages by Occupation, 2018



Source: Oklahoma Employment Security Commission

address workforce gaps through dedicated training programs, especially in the aerospace and aviation sectors driven by Tinker Air Force Base, the state's largest single-site employer.

We must also look to emerging technologies - as in, both those new to market and those new to the Oklahoma City market - as opportunities to expand good wages and capitalize on the region's resources. The Bureau of Labor Statistics (BLS) found the two occupations with the fastest growth rate between 2018 and 2028 are solar photovoltaic installers (63%) and wind turbine service technicians (57%) with 2018 median wages of $42,680 and $54,370, respectively. Of the 20 occupations BLS projects through 2028, those two are the only ones with a highest percent change of employment greater than 50%. While occupational growth is certainly not exclusive to the renewable energy sector, it does underscore a need to look to markets and industries thus far unestablished in Oklahoma City to foster employment opportunities that provide strong wages for a wider swath of our residents. While a greater diversity of wages does to an extent insulate the City from commodity price volatility, it more importantly provides means for our residents to flourish and continue positive momentum for Oklahoma City's future.

Issue Focus 7: Disproportionate Vulnerability

There are differing degrees of vulnerability in Oklahoma City. These differences can change based on a myriad of variables but are predicated on the fact that the distribution of risk is highly uneven. Just as we seek to better understand the likely disasters Oklahoma City will face in the future, better understanding the degrees of our community's vulnerability will further enable us to provide meaningful resources.

Facets of vulnerability include but are not limited to structurally substandard housing, low income, low proximity and/or low accessibility to basic services, low educational attainment, exclusion from community decision-making and/or social marginalization, homelessness, disability, and proximity to sources of pollution and environmental hazards. These factors interact and impact one another in addition to basic indicators such as age, income, gender, race, and ethnicity.

The increase in frequency and severity in extreme weather is the primary motivator behind a better understanding of vulnerability in Oklahoma City. While extreme weather events are indiscriminate, some residents have less capacity to prepare for, respond to, and recover from such events and their effects. For example, residents of mobile homes may be more vulnerable to property damage due to high winds than suburban and exurban homes, yet those suburban and exurban homes are at significantly greater risk of wildfires due to their location on or near rural, undeveloped land where fires can start and spread quickly.

Vulnerability is a concern because extreme and hazardous weather is almost a certainty. The City's Hazard Mitigation Plan identifies 12 natural hazards and calculates the probability of each occurring within Oklahoma City: extreme heat, flooding, hail, high winds, lightning, tornadoes, winter weather, drought, wildfire, earthquake, dam failure, and mosquito-borne disease. All but one - dam failure - are rated as "high." Before these hazards befall

> "Social vulnerability refers to the ability of people, organizations, and societies to withstand adverse impacts from multiple stressors to which they are exposed."
>
> - City of Oklahoma City Hazard Mitigation Plan, 2017

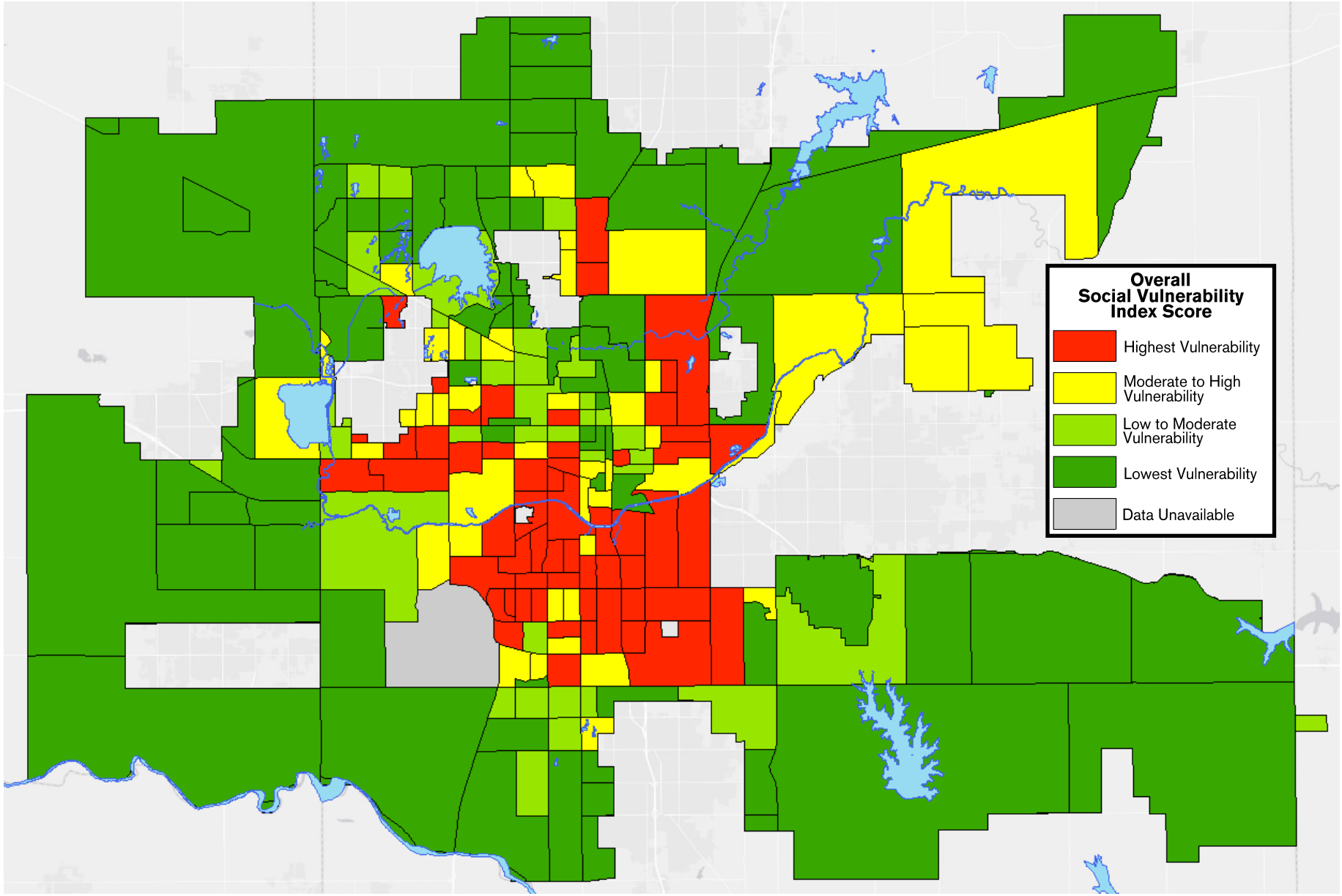
Oklahoma City and its residents, it is important to know and understand where populations of our most vulnerable reside so as to better strengthen our ability to respond and assist.

The U.S. Agency for Toxic Substances and Disease Registry created the Social Vulnerability Index (SVI) to identify and map communities most likely to need support before, during, and after a hazardous event. The SVI indicates the relative vulnerability of every U.S. Census tract, which are subdivisions of counties for which the Census collects statistical data. The SVI ranks tracts on 15 social factors, including unemployment, minority status, and disability, and further groups them into four related themes. Those rankings are on a scale from 0 to 1, with 0 meaning lowest vulnerability and 1 meaning highest vulnerability. Those tract rankings are illustrated in Oklahoma City via **Figure IF-2**. Broadly, many high vulnerability tracts are clustered in south-central Oklahoma City but include west-central and northeastern portions of the city.

A prime example of disproportionate vulnerability is linguistic isolation. American Community Survey (ACS) five-year estimates indicate more than 11,000 Oklahoma City households are linguistically isolated, meaning households where all adults speak a language other than English and none speak English well. Census tracts with high concentrations of linguistically isolated households are clustered south of the Oklahoma River. Many of these linguistically isolated tracts are within the 95th to 100th percentile in comparison to national data and are in similarly high percentiles for low income, less than high school educational attainment, and percentage of population under the age of five. While Spanish and Vietnamese are the predominant non-English languages in Oklahoma City households, ACS data identifies at least 36 other languages spoken in Oklahoma City households including German, Arabic, French, and Urdu.

Language barriers are just one complicating factor that, without preparation and planning, make public service delivery challenging, whether from a meter reader or a police officer. We can and should reflect the values, culture, and languages of our residents as a government and an ever-expanding effort towards inclusivity can do more than gird against calamitous hazards - they can help us create a more vibrant city that leaves no one behind, least of all the most vulnerable.

Figure IF-2, Oklahoma City Census Tracts by Social Vulnerability Index, 2016



Source: Centers for Disease Control and Prevention

The SVI synthesizes data including socioeconomic status (poverty, employment, income, educational attainment), household composition and disability, minority status and language spoken, and housing and transportation (vehicle ownership, multi-unit structures, mobile homes, etc.).

Issue Focus 8: Preparedness & Resilience

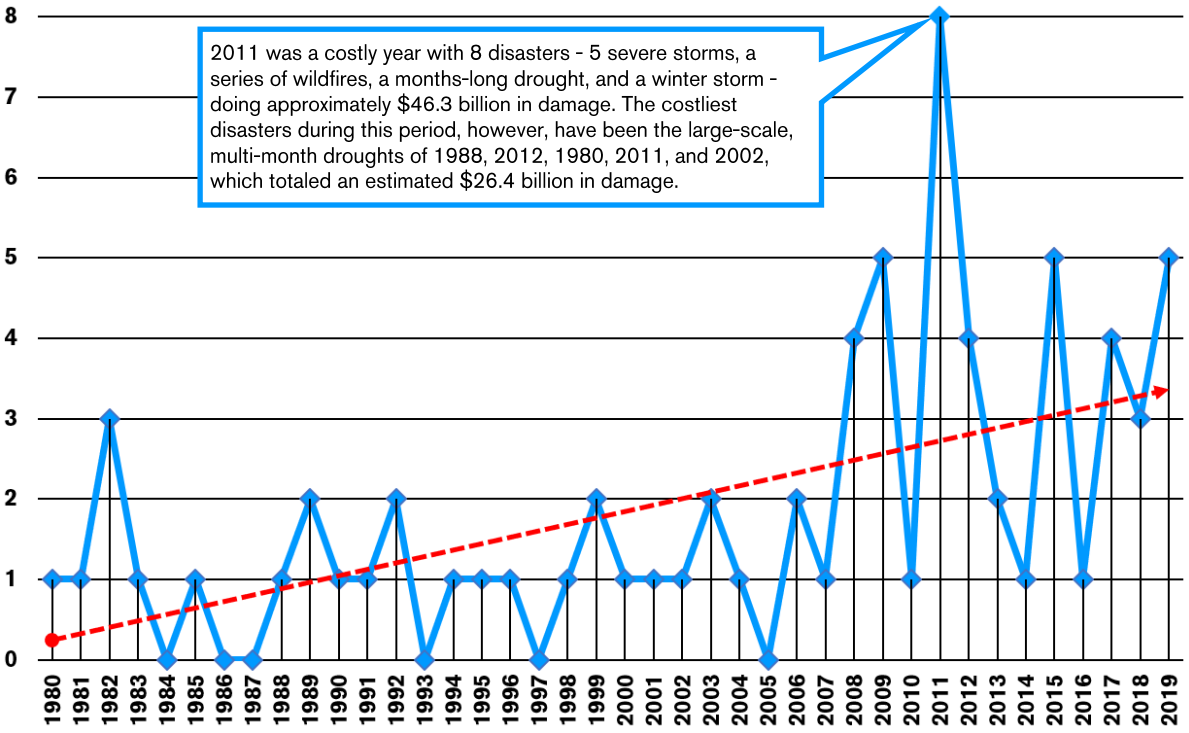
Oklahoma City is no stranger to severe and extreme weather events. The City's Hazard Mitigation Plan (HMP), updated and adopted by City Council in 2017, provides evaluations of natural hazards to which the City is most at risk and specifies actions to reduce the effects of those hazards. Projected changes to Oklahoma City's climate through 2080 indicate shifts germane to long-term hazard mitigation planning for enhancement of community preparedness as well as resilience during and after such extreme events.

The National Oceanic and Atmospheric Administration estimates since 1980, disasters have inflicted $1.7 trillion in damages across the U.S. FEMA data places Oklahoma third in the nation for number of federal major disaster declarations with 86, surpassed only by California (97) and Texas (99). These major disaster declarations include severe storms, severe winter storms, wildfires, flooding, tornadoes, and straight-line winds. The HMP identifies 35 mitigation actions to address hazards for which Oklahoma City is prone. These actions represent significant steps towards enhancing the preparedness and resilience of Oklahoma City and its residents. Better integration of the these concepts into the planning process across the City's functions could help growth occur in a more resilient way and assist residents in recovery when unavoidable extreme weather events occur.

Nationally, the number of major disaster declarations has increased since the inception of such declarations. Because these declarations can include federal assistance, they represent a growing burden not only on federal dollars but private insurance, states, localities, businesses, and residents. The figure opposite reflects the high percentage of supplemental, or ad hoc, funds Congress has provided to FEMA for the Disaster Relief Fund, the primary source of funding for the federal government's domestic general disaster relief programs pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act. This does not, however, reflect separate and distinct disaster relief programs funded and managed by other federal agencies including the Departments of Transportation, Agriculture, Housing and Urban Development, Small Business Administration and Defense. Planning for and mitigating the effects of disasters is thus critical to not only avoid local loss of life and property but to contain costs that could be distributed across society as a whole.

Billion-Dollar Climate Disasters Affecting Oklahoma, 1980 - 2019

In 2019 Dollars, Adjusted for Inflation



Source: NOAA

Both the costs and the frequency of billion-dollar climate disasters have and continue to increase. These disasters represent those that have affected some portion of Oklahoma and often include impacts on neighboring states or, in some large scale events such as multi-month droughts, significant portions of the U.S. The disasters depicted above have cumulatively cost approximately $372 billion and, more importantly, have cost 4,037 lives.

Federal Disaster Relief Fund Appropriations, FFY97 - 18

In 2018 Dollars, Adjusted for Inflation

Federal Fiscal Year	Annual Appropriation (Percentage Supplement or Contingency)	U.S. Major Disaster Declarations
1997	$6,989,480,000 (71%)	44
1998	$2,879,375,000 (83%)	65
1999	$3,129,984,000 (53%)	50
2000	$4,017,487,000 (89%)	45
2001	$2,251,693,000 (81%)	45
2002	$14,122,045,000 (93%)	49
2003	$2,995,856,000 (64%)	56
2004	$5,641,239,000 (58%)	68
2005	$86,921,490,000 (97%)	48
2006	$9,524,143,000 (77%)	52
2007	$6,699,654,000 (74%)	63
2008	$15,181,965,000 (89%)	75
2009	$1,612,240,000 (0%)	59
2010	$7,596,456,000 (76%)	81
2011	$2,935,777,000 (0%)	99
2012	$7,711,365,000 (90%)	47
2013	$19,832,033,000 (62%)	62
2014	$6,569,461,000 (0%)	45
2015	$7,382,189,000 (0%)	44
2016	$7,675,279,000 (0%)	46
2017	$15,040,665,000 (50%)	59
2018	$50,070,720,000 (84%)	59
Total	**$286,780,596,000**	**1,261**
Average	**$13,035,481,636**	**57**

Source: FEMA, Congressional Research Service

"Oklahoma County, Oklahoma, is one of the most disaster-prone counties in the United States. The county contains 14 municipalities and 22% of the state's population. It has experienced 23 declared disasters in the last decade and 42 since 1964—the year that the Federal Emergency Management Agency (FEMA) began collecting disaster declaration data at the county-level. The county has been hit by, and recovered from, almost every type of emergency and disaster situation … The county has experienced 14 severe storms, 13 fires, 7 severe ice storms, 4 floods, 2 tornadoes, 1 hurricane, 1 human-cased event - the Oklahoma City bombing - and has started to experience earthquakes, although not yet at a magnitude that has lead to disaster."

- The National Association of Counties, 2018

3.0 Planning Process

The genesis of adaptokc lies in planokc, the City's first wholly new comprehensive plan in more than twenty years. Adopted in 2015, planokc is a policy document that crafts a framework to guide decisions about future growth, development, policy, and capital improvements. Sustainability is in part defined by planokc as "the capacity to endure" and is discussed in economic, fiscal, and environmental terms.

Generally, these three notions address the necessity for greater economic diversity, the exponential costs of continued sprawl, and, via the greenokc element chapter, "understanding the relationship between how we develop land and the health of our environment." Moreover, 39 policies in planokc identify the Office of Sustainability as or among the responsible parties. Consideration of how to achieve the goals of each policy served as the foundation of adaptokc's scope. The policies included a wide combination of concerns and directions, some of which were collapsed into one another and others expanded to ensure adaptokc focuses on critical challenges and opportunities for Oklahoma City. It remains essential that adaptokc serves to implement the comprehensive plan while simultaneously identifying new methods to strengthen our city.

A second essential component of the planning process was the September 2015 report *Climate in the Heartland: Historical Data and Future Projections for the Heartland Regional Network*. The cities of Iowa City, Iowa; Columbia, Missouri; Lincoln, Nebraska; Lawrence, Kansas; and Oklahoma City cooperated on this regional study convened through an informal conclave of municipal and county sustainability officers throughout the Midwest.

With the expertise of state climatologists and the Iowa State University Climate Science Program, the report uses historical climate data to inform nine climate models in differing emissions scenarios to identify common factors across all models and downscale those to each locality. These downscaled results serve as estimates of changes to local climate in the period of 2021 to 2050 and 2051 to 2080, comparable to the thirty-year climate averages of the 1981 to 2010 period. While these projections are vital to understanding and planning for the challenges Oklahoma City will experience in the coming decades, we also know many of their effects are manifesting here and now. Given the time spans of many capital funding programs such as the decennial general obligation bonds or the irregular renewal of the penny sales tax, responses to these projections require both near-term and long-term solutions.

Projected Changes in Oklahoma City Climate, 1981 - 2080

Season	Metric	1981-2010	2021-2050	2051-2080
Annual	Average	60.7°F	▲ 63.2°F	▲ 66.0°F
	Minimum	49.8°F	▲ 52.4°F	▲ 55.3°F
	Maximum	71.5°F	▲ 74.0°F	▲ 76.8°F
	Precipitation	36.6"	▲ 38.0"	▲ 38.7"
Spring	Average	51.3°F	▲ 54.8°F	▲ 58.4°F
	Precipitation	10.7"	▲ 11.2"	= 11.2"
Summer	Average	77.1°F	▲ 79.8°F	▲ 82.5°F
	Minimum	66.8°F	▲ 69.6°F	▲ 72.3°F
	Maximum	87.4°F	▲ 90.1°F	▲ 92.7°F
	Precipitation	11.2"	▼ 11.0"	▼ 10.6"
Fall	Average	73.1°F	▲ 74.4°F	▲ 76.5°F
	Precipitation	9.8"	▲ 10.5"	▲ 11.5"
Winter	Average	39.8°F	▲ 42.5°F	▲ 45.4°F
	Minimum	29.6°F	▲ 32.2°F	▲ 34.8°F
	Maximum	50.0°F	▲ 52.8°F	▲ 56.1°F
	Precipitation	4.9"	▲ 5.3"	▲ 5.4"

Source: Climate in the Heartland

For the two 30-year periods of 2021 to 2050 and 2051 to 2080, Oklahoma City is projected to see only a slight decrease in summer precipitation and a leveling off of spring precipitation. All other metrics are projected to increase in comparison to what we experienced between 1981 and 2010.

Many of the primary authors of planokc helped to shape the scope of adaptokc. Given the years-long public process for and development of planokc, this informal committee helped to define and narrow adaptokc's reach. With their help, Office of Sustainability staff established topic areas, began research to establish baseline policies and data, and identified important voices whose expertise would be needed to provide practical, informed perspectives through direct focus group input.

Focus Groups

Staff recruited private and public sector subject matter experts as well as specialists within the City to each participate in one of six focus groups, each on a different topic: energy; water; natural assets; materials management; transportation; and preparedness and resilience. Over the course of structured meetings, each focus group discussed Oklahoma City's present situation including strengths, weaknesses, and opportunities, learned about successful programs developed and implemented in comparable cities, and responded to and refined prospective topic goals, objectives, and targets.

These subject matter experts and specialists brought diverse perspectives and proved invaluable in gaining a better understanding of the range of possibilities for both implementing and building upon plan**okc**'s policy recommendations. Their discussion with facilitators as well as each other provided staff with a preliminary assessment of needs, available data, and feasibility - both practical and political.

Additionally, surveys were provided to all participants following each focus group session. Each of these surveys was tailored in response to the topics, questions, and interactions of the session. These allowed for an anonymous means of input and feedback, recommendations for future session discussion, an opportunity to verify conclusions reached by staff, recommendation for additional participants, and general satisfaction with meeting organization and presentation.

Ultimately, the exceptional input and direction provided by our more than 90 expert participants across greater than 20 structured meetings and interviews helped us establish a sufficiently narrow scope. Changes were made on recommendations including the merging of water and natural assets into a combined natural and built environment topic; integration of preparedness and resilience into each topic rather than as a standalone focus; and concentrating the transportation topic on emissions and air quality rather than mode.

Office of Sustainability staff worked closely with partners to obtain data and conduct research. As the analysis and research revealed correlations and trends, the chapters of the plan evolved from the original workgroup focus areas to chapters that better communicate and more accurately align with findings.

ABOVE: NATURAL ASSETS FOCUS GROUP

Comprised of internal and external subject matter experts, the natural assets topic spanned impervious surfaces - particularly overabundant surface parking - and the urban heat island effect; access to food and food waste; and reforestation and the urban tree canopy.

Adoption and Implementation

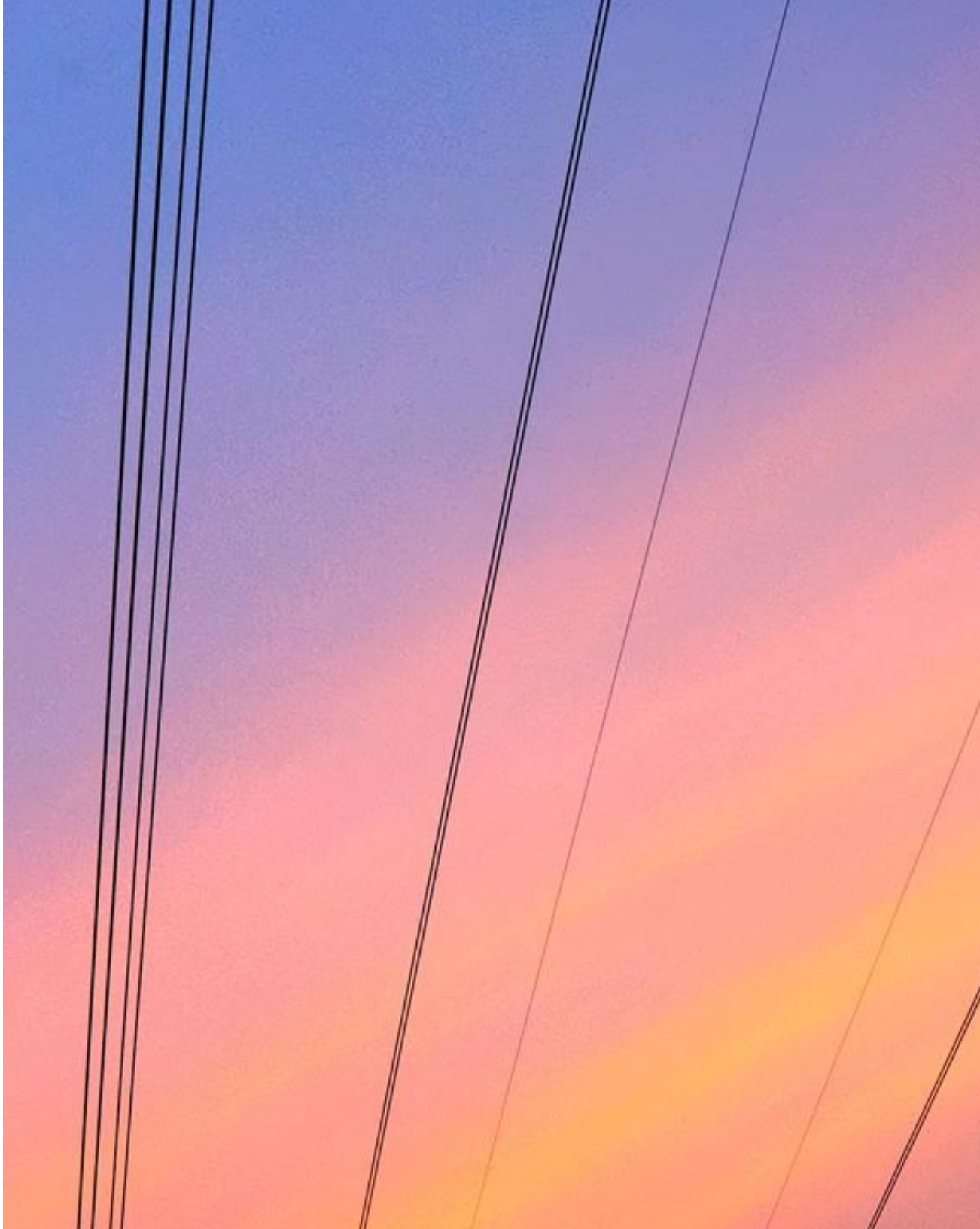
Nothing in adapt**okc** overrides or supersedes existing policies, ordinances, or Council resolutions, nor does it modify the purview, composition, or powers of decision-making bodies. This document does not create new programs nor impose new requirements. The proposed policies and recommendations herein will each require greater development and vetting, ultimately to be subject to review, recommendation, and/or approval by public bodies including but not limited to the Planning Commission and/or City Council - in addition to the ultimate arbiters of City policy, the public.

Under the quasi-judicial powers granted the Oklahoma City Planning Commission by state statute (§19-866.10), any amendment to the comprehensive plan must be adopted by the Planning Commission. As just such an amendment, adapt**okc** is ancillary to plan**okc** and extracts from it elements of long-range policy to inform policymakers, stakeholders, and the community at large; to articulate a vision and goals for the City and the community; to identify roles and responsibilities; and to recommend paths forward

chapter two

energy productivity

CHAPTER 2:
ENERGY PRODUCTIVITY



Our Situation

Energy is critical to our way of life. Without it, we could not fuel our homes, businesses, hospitals, or schools, and energy - oil and natural gas - has long been a pillar of our economy. Yet as Oklahoma City continues to grow, we cannot overlook the generation and use of our most fundamental form of energy: electricity.

In *Energy Productivity*, we examine our relationship with electricity and the economic and environmental implications of how it is used and generated. We propose both a vigorous commitment to renewable energy and a restored focus on energy efficiency. While the price of electricity may be low, we cannot afford to remain complacent about the costs of our consumption.

Oklahoma City's electricity generation needs are largely served by the investor-owned utility Oklahoma Gas and Electric (OG&E). While OG&E is a publicly traded company, it is not a unit of government or publicly-owned entity, which can limit the influence of municipalities on issues like renewable energy, energy efficiency, streetlights, and more.

Oklahoma City has immense potential to see economic and environmental benefits by embracing energy efficiency measures and implementing renewable energy. Those benefits can apply to both City operations and to the residents and businesses across the city. A current benefit is a relatively low price of electricity. Nationally, Oklahoma was ranked fourth lowest for average electricity price in 2017. Locally, OG&E was similarly found to have the fifth lowest average electricity price among all 49 electric utilities within Oklahoma.

What low price overshadows, however, is the quantity of consumption. While total residential sector electricity consumption is below the national median, per capita residential electricity consumption in Oklahoma is in the top third of all states. In 2017, homes statewide paid the 6th lowest average electricity price in the U.S. yet were 13th for average monthly electricity use. We surpass Maryland, Colorado, Massachusetts, and Oregon in total electricity use despite the larger population of all four of those states.

Consuming more creates demand for the fuels used to make electricity. In Oklahoma City that means greater than 90% of those fuels are non-renewable fossil fuels in the form of coal and natural gas. Reliance on coal can keep the direct cost of electricity low, but indirect costs, like health outcomes, increase total costs to residents. Coal combustion results in several emissions that are harmful to human and environmental health. These emissions contribute to climate change and cause respiratory illness and lung disease, as well as smog, haze, and acid rain.

Electricity use in Oklahoma City is highest in the three-month window of July, August, and September when regional temperatures peak. Oklahoma City's average annual temperature is projected to increase as much as 6°F with a decrease in precipitation through 2080. The number of days and nights of extreme heat will also continue to increase along with summertime electricity use and costs to residents.

Renewable energy such as solar and wind can insulate residents from volatile fossil fuel commodity values and negative health effects. Oklahoma is already a leader in wind energy production nationally, but has unrealized potential with solar and geothermal. As a recognized energy capital, we have the opportunity to embrace our most abundant and renewable energy assets.

We can harness these diverse resources to guarantee economic and environmental productivity, and we should do so now rather than await climbing costs that will hinder our ability to support the future of Oklahoma City and all its residents. We can work to increase the productivity of our energy use and align state law, municipal policies, and regulatory rules to support clean energy.

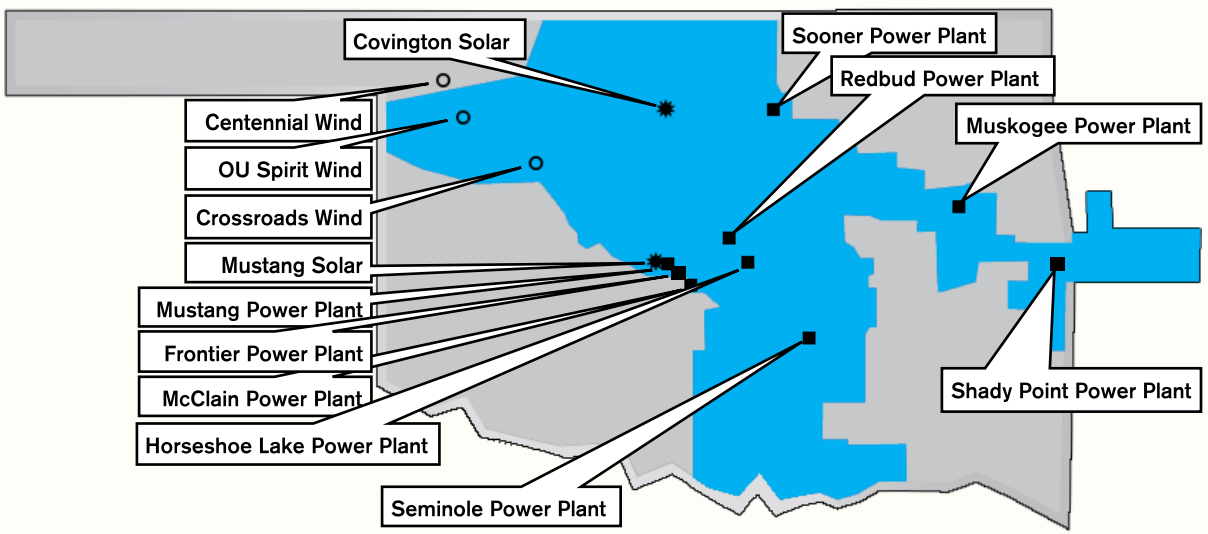
Electric Utilities

Oklahoma City is served primarily by OG&E, an investor-owned utility that generates, transmits, distributes, and sells electricity to 268 communities with a combined population of about two million across 30,000 square miles in Oklahoma and western Arkansas. Small portions of Oklahoma City's periphery are served by locally-owned electric cooperatives. There are also City facilities outside of our corporate limits, including Atoka pipeline booster pump stations and both the Deer Creek and Chisholm Creek wastewater treatment plants, who may be serviced by other electric utilities. None of these service territories overlap as Oklahoma law prohibits competition between utilities and instead grants exclusivity in service territories with regulation by the Oklahoma Corporation Commission (OCC) acting "as a surrogate for competition."

OG&E is not a government entity but a publicly traded corporation overseen by a board of directors and beholden to shareholders. OG&E is just one of the investor-owned utilities in Oklahoma. The other major utility - American Electric Power (AEP), which operates as Public Service Company of Oklahoma (PSO) - serves much of the northeastern, southeastern, and southwestern portions of the state including the Tulsa metro, McAlester, and Lawton. Many rural areas are served by one of 33 electric cooperatives, which are private, non-profit corporations owned by ratepayers themselves.

While OG&E serves most of Oklahoma City, its service territory spans well beyond our city limits. This means any and all growth in population or economy – including our own – within the service territory impacts the electricity on which we rely. The facilities depicted in **Figure EP-1** are those that generate electricity used throughout OG&E's service territory, meaning no facilities are dedicated to specific areas. Transmission infrastructure distributes the generated electricity throughout the service territory. Growth and development can require new transmission infrastructure and eventually the need for new generation facilities. These costly needs are paid for by all ratepayers within the service territory, meaning the price of Oklahoma City's electricity is tied to what occurs not just within our city limits but in the whole of the OG&E service territory.

Figure EP-1: OG&E Service Territory and Facilities, 2020



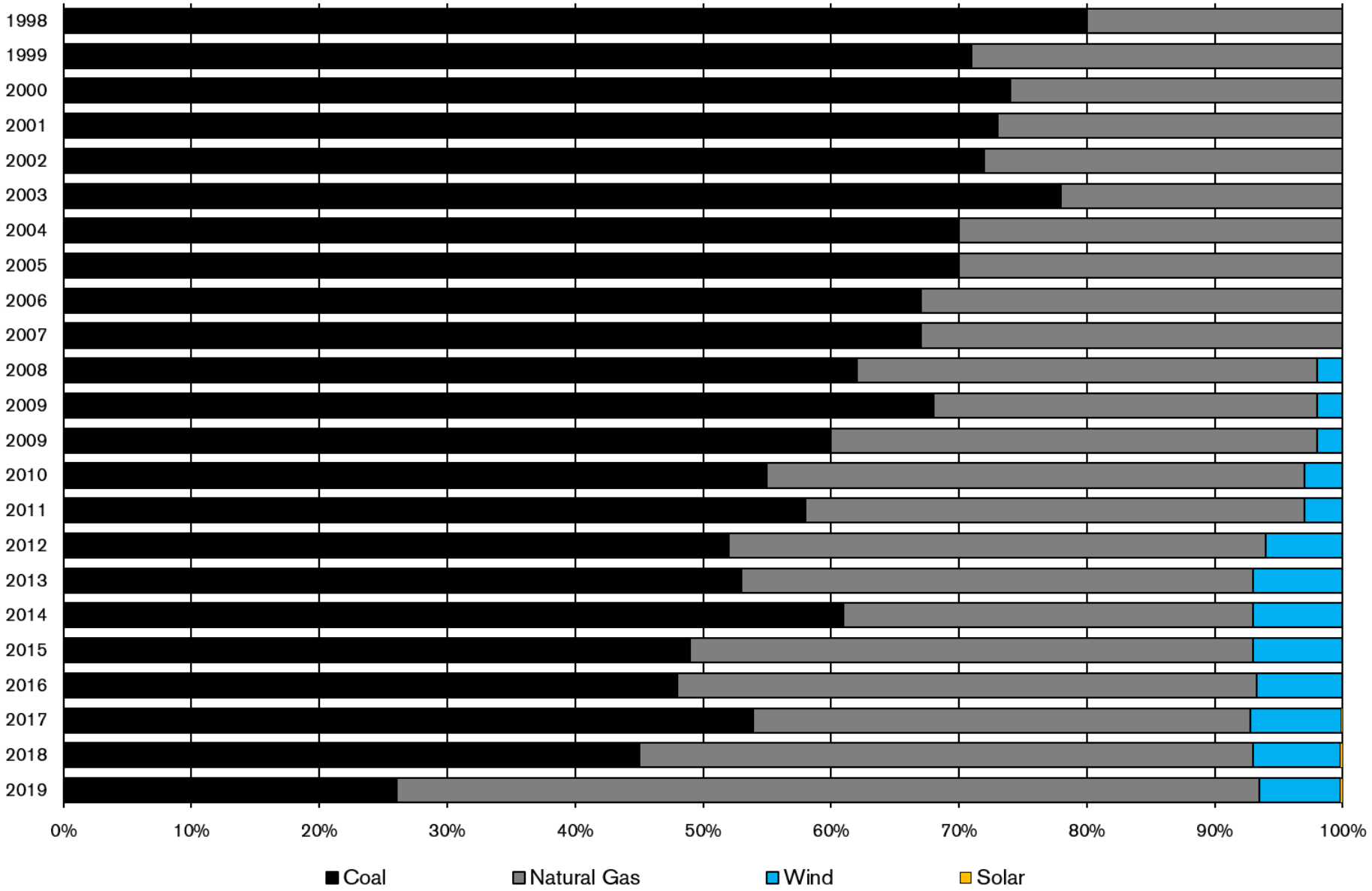
In 2019, OG&E purchased two additional power plants: the Shady Point plant near Poteau and the Oklahoma Cogeneration plant - renamed the Frontier plant - in western Oklahoma City.

How electricity is priced by OG&E varies due to tariffs. Utility tariffs are collections of rates and charges which can vary by season, time of use, sector, facility size, amount of electricity used, and more. For example, OG&E has four different tariffs that can apply to residential ratepayers, six tariffs for public schools, and three for oil and gas producers. All tariffs are submitted to, reviewed, and approved or denied by the OCC, whose responsibility it is to regulate "in the interests of the public."

OG&E is able to assess, adjust, and recover fuel costs based on commodity prices. Coal and natural gas are purchased as commodities, which are subject to price volatility. Renewable forms of energy are not subject to these variable fuel costs. OG&E publishes average price per kilowatt hour by generation fuel which illustrates the pass-through commodity cost on an annual basis. These costs are pass-through as they are recoverable through fuel adjustment clauses, which allow OG&E to adjust rates based on market commodity prices whether they increase or decrease. The annual price of natural gas especially demonstrates volatility, though OG&E does have ownership in publicly-traded natural gas midstream company, Enable Midstream, that operates across four states and three major shale developments.

While coal demonstrates more stable pricing, OG&E's supply of low-sulfur western coal is purchased from Wyoming suppliers. The volatility of commodity prices are a fundamental difference between fossil fuels and renewables: solar, wind, and geothermal tap into unlimited "fuel" with no price tag. As such, these sources of energy remove a significant cost that would otherwise be passed-through to ratepayers.

Figure EP-2: OG&E Electricity Generation Mix, 1998 - 2019



Source: OG&E

Though its use has declined over the past 30 years, coal remains a major component of OG&E's electricity generation fuel until falling sharply in 2019. The growth of renewable generation, primarily wind, can be seen slowly over the past decade and has yet to reach 10% of annual generation and solar generation was not added until the 2018 calendar year as 0.2% of overall generation.

Franchise Fees. Franchise fees are charged to public utilities for the use of public rights-of-way for their infrastructure. These fees, which differ from utility to utility, are the second largest contributor to the City's General Fund after sales tax.

OG&E pays an annual franchise fee of 3% of gross revenues on electricity sales within the corporate limits of Oklahoma City. The City is also provided a credit of up to 0.5% of kilowatt-hours sold to Oklahoma City ratepayers which can be applied to public assets including street lights, traffic signals, and City buildings. The terms of the current OG&E franchise agreement were approved by City Council on March 7, 2006, and approved in an election on May 9, 2006 with 3,905 voters. The franchise agreement's terms remain for a 25-year period, meaning a new franchise agreement will not be voted on until 2031.

The OG&E franchise agreement fundamentally compounds the financial contradiction of energy efficiency. The agreement ties franchise fees to gross revenue and because of this creates an incentive to maintain or increase electricity use in Oklahoma City. Similarly, sales tax levied on electricity bills is also one of the largest sources of revenue for the City. In other words, when electricity consumption in Oklahoma City is reduced, the City receives less revenue from two sources: franchise fees and sales tax.

Electricity Generation. How the electricity we use is generated connects directly to our local economy. The City of Oklahoma City itself is one of OG&E's largest customers but also represents more than 400,000 ratepayers within its corporate limits.

From 1998 to 2017, the fuel mix used by OG&E averaged about 64% coal, about 34% natural gas, and wind about 3%. Over this 19-year term, OG&E's reliance on imported coal decreased 32.5%, hitting a low of 48% in 2016; natural gas has expanded 95% with a high of 45.3% in 2016; and wind, not added to the generation mix until 2008, has grown 250% (**Figure EP-2**).

The volatility of commodity pricing is reflected in natural gas' 2016 peak share, as that year saw the prices of natural gas and crude oil fall to their lowest points in a decade. Illustrative of this, too, is the 41% decrease in kilowatt hours for OG&E oilfield accounts in Oklahoma from 2015 to 2016.

Photo by Trace Thomas

OG&E has two solar generation plants: a 2.5 MW, 10,000 panel plant at their Mustang facility and a 9.7 MW, 38,000 panel plant in rural Oklahoma near the town of Covington.

OG&E holds a 25.7% limited-partnership interest and 50% management interest in Enable Midstream alongside Houston-based CenterPoint Energy. Enable owns and operates natural gas and crude oil gathering and natural gas processing assets across five states that include the Anadarko Basin, the Arkoma Basin, the Ark-La-Tax Basin, and the Williston Basin.

Resident Savings

While critical to address how our electricity is generated, it is no less important to ensure energy consumption is as efficient and productive as possible. OG&E's customer numbers for 2018 show 849,372 accounts across their service territory. Of those, the vast majority - 725,440, or 85% - are residential. Those residential accounts use an average of 13,446 kWh annually at an average price per kWh of $0.926.

State data for 2017 published by the U.S. Energy Information Administration (EIA) found homes across Oklahoma have the sixth lowest average monthly price for electricity. Nonetheless, homes statewide were 13th for monthly electricity use, ranking 26th by average size of monthly electricity bills. Residences in Oklahoma are, on an average monthly basis, using more electricity and thus paying more for that electricity than residences in 24 states including California, New York, Colorado, Arkansas, and Michigan. Of those 24 states, 21 had a higher average electricity price than Oklahoma.

The Census Bureau's American Housing Survey five-year estimates for 2013 through 2017 includes housing costs for cities including Oklahoma City. Of an estimated 237,895 occupied housing units citywide, 29% are considered unaffordable. This is based on the definition of affordable housing used by the U.S. Department of Housing and Urban Development (HUD): households who pay more than 30% of income for housing, including utilities. It is also important to note the difference in housing costs between owner-occupied and renter-occupied. Based on the same 30% or more HUD threshold, 19.5% of owner-occupied housing is unaffordable while 42.8% of renter-occupied units are unaffordable.

LEFT: RESIDENTIAL LEED

This single-family home, built as part of Central Oklahoma Habitat for Humanity's 217-home Hope Crossing neighborhood in northeast Oklahoma City, earned silver LEED accreditation in 2009. Homes in this development were affordably priced around $85,000 and included geothermal HVAC systems.

The most recent American Housing Survey data includes housing-related costs for a sample of 25 U.S. cities. Per that data, the largest share of Oklahoma City households - about 30% - pay between $100 and $149 per month for electricity, followed by 20% of households who pay $150 or greater. Citywide, the median monthly cost of electricity per household is $104 for an annual median cost of $1,248.

OG&E forecasts electricity sales across their service territory will increase 6% between 2017 and 2024, an indicator of population and economic growth. Oklahoma City residential electricity use is driven heavily by cooling as evidenced by OG&E peak demand during hot summer months, especially June, July, and August. Nationally, the EIA projects future homes will use less energy, largely because appliances and consumer products will continue to become more efficient. However, those projections indicate an overall increase in energy for air conditioning and cooling.

While electricity prices are low compared to other regions of the U.S., Oklahoma tends to use more electricity than other states. The per capita electricity consumption is higher in Oklahoma than the national average and is greater than three-fourths of U.S. states. Utility bills, including electricity, are part of the overall cost of homeownership. To increase the energy efficiency of housing is to decrease those costs. Energy efficiency must be understood and treated not as a value-added luxury feature but a necessity for affordable housing.

One way to accomplish this is through a voluntary accreditation system like that of Leadership in Energy and Environmental Design (LEED). It and systems like it rely on receiving credits for specific items, projects, and additions to a home. We estimate 27 Oklahoma City residences have opted for LEED accreditation. These include a 2,000-square-foot single-family home in historic Mesta Park and numerous homes in Central Oklahoma Habitat for Humanity's Hope Crossing neighborhood in northeast Oklahoma City. However, LEED is just one example of certification and generally, the process is not just voluntary, but includes added costs.

Another, broader way of reducing electricity consumption is through the adoption of newer building codes. Updates and enforcement of newer iterations of each code would require increased efficiency in new developments. The International Code Council's codes serve as the base standards in the U.S. and are updated triennially. Currently, Oklahoma City's adopted codes including the 2015 International Building Code, the 2015 International Residential Code, the 2015 International Fire Code, and the 2009 International Energy Conservation Code.

The adoption of newer building codes is often met with opposition based on a perception of added cost to builders. Significant research demonstrates those initial costs are offset through savings generated by more efficient homes and businesses. For example the U.S. Department of Energy found regardless of climate zone, costs associated with the energy efficiency improvements required in the 2009 and 2012 codes have payback time periods between one and two years. Because these codes apply to new construction, the longer older codes are applied, the more building stock will assuredly be less efficient - and thus more costly than it could.

Ultimately, the inexorable rise of electricity costs will erode household disposable income and increase the price of property, be it residential or commercial. An expansion of distributed generation - where electricity generation is done nearer or at the site of use - as well as a look at our opportunities in newer codes can stave off these growing costs and contribute to maintained affordability for Oklahoma City residents.

City Savings

The City of Oklahoma City owns approximately $3 billion in property (**Figure EP-3**). Operating costs for all City facilities, from City Hall to the Chickasaw Bricktown Ballpark, are driven by electricity demand. The Cox Convention Center and the Chesapeake Energy Arena share a central plant to meet heating and cooling needs at both facilities. As such, these facilities combined accounted for $2.7 million in electricity bills in FY16 alone.

In FY17, the City of Oklahoma City spent $24.8 million on electricity representing approximately 6% of total General Fund expenditures. The combination of retrofit projects and strategic operational adjustments can enhance the efficiency of existing properties and protect against budgetary impacts of electricity price volatility. Reductions in electricity use at any City facility equate to a larger share of funds applicable to other programs or needs.

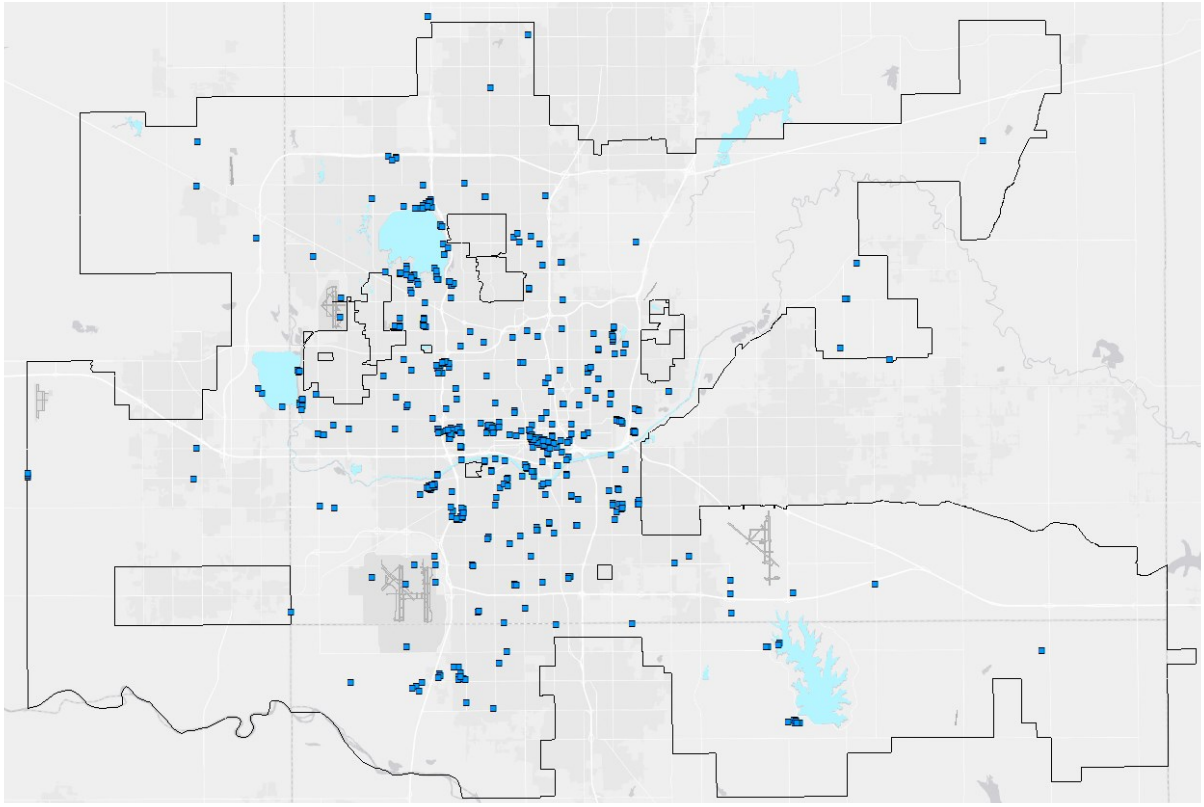
A comprehensive energy program should be established that targets strategic projects to yield returns on investment through cost reductions in existing facilities and ensures the design and construction of future City buildings to be as energy productive as possible. Electricity consumption at City facilities is driven by basic services from water treatment and pipeline booster stations, for example, to keeping the lights on at recreation centers and golf courses.

Additionally, while OG&E owns and maintains the majority of streetlights across Oklahoma City, the cumulative cost across 621 square miles - plus facilities like water pipeline booster stations outside of the city - is paid by the City.

$24.8 million

was the cost of electricity paid by the City for public facilities in FY17, an increase of about $2.7m from the year prior.

Figure EP-3: City-Owned Facilities, 2018



From parks to parking garages, water treatment plants to road salt storage facilities, the City of Oklahoma City has over 500 separate buildings, structures, and properties for which it is responsible for electricity consumption. Unconventional examples include the Chesapeake Energy Arena (bottom left) and all of the traffic signals throughout the city (bottom right).

Case Study: Tinker Air Force Base

The largest single-site employer in Oklahoma, Tinker Air Force Base (TAFB) has more than 26,000 military and civilian employees across approximately nine square miles with 15.2 million square feet of floor space in 760 buildings. According to the Oklahoma City Air Logistics Complex, TAFB is the largest user of energy in Oklahoma, the largest user of energy throughout the U.S. Air Force, and the largest user of energy in all of the U.S. Department of Defense.

Efficiency mandates, such as the Air Force's goal to reduce energy consumption 25% by 2025, have driven efficiency projects including steam decentralization that successfully reduced TAFB's natural gas consumption by 30% and a $19.1 million modernization project on the central utility plant to cut energy consumption 44% annually. Through the use of energy service contracts, TAFB is able to pay for projects with future energy savings generated by the improvements to be installed, provided and guaranteed by the contracting energy service company (or ESCo).

In 2017, TAFB announced the largest energy savings performance contract in the Air Force's history as a $243 million facility modernization project to reduce energy consumption by 23% and save $20.5 million annually. The energy savings performance contract with Honeywell guarantees annual energy and operational savings that will eliminate the need for TAFB to provide capital investment. Upon completion, improvements are anticipated to save more than $626 million in costs over the 21-year life of the project with energy expenses reduced by at least $6.7 million in the first year alone.

Elements of the project include manufacturing line modernization to eliminate wasted ventilation and increase work safety, updating wastewater treatment systems with equipment controls and alarm monitoring, installing two 2,000-ton chillers to increase cooling system reliability, installing efficient LED lighting with wireless controls, and installing smart meters to better monitor, track, and manage building energy consumption.

ABOVE: TAFB MANUFACTURING

A single wing of the Oklahoma City Air Logistics Complex is responsible for the maintenance and overhaul of more than 22,000 engines for a range of bomber, refueling cargo, and fighter aircraft.

Emissions

The process of generating electricity is incredibly resource-intensive. OG&E relies on two fuels for the majority of electricity generation: coal and natural gas. Both of these fuel sources result in emissions whose byproducts impose a range of risks from impacts to public health to contribution to climate change.

Oklahoma's electricity-generating power plants emit an estimated equivalent of 41 million tons of CO_2 annually, more than double those of all Oklahoma's passenger cars and trucks. These emissions are largely the result of imported coal, which remains the primary generation fuel for Oklahoma utilities including OG&E. An increase in electricity generation fueled by natural gas and renewables would not only reduce Oklahoma City's CO_2 output, but benefit our local economy.

Across OG&E's service area, CO_2 emissions have fallen since 2010 even as electricity generation at OG&E facilities has trended upwards. Much of this is due to the decrease in coal use while natural gas and wind have increased. Nonetheless, the Muskogee and Sooner power plants continue to produce the majority of OG&E's facility emissions. The former plant was outfitted with emissions-reducing scrubbers for $534 million, a cost that all ratepayers will see reflected in their monthly bills.

Economic Development

Oklahoma has a high concentration of energy sector employment - 5.8% of total state employment compared to 2.4% of national employment - and significant opportunity exists to expand and diversify Oklahoma City's energy industry jobs. The renewable energy sector can offer job growth as well as greater sales and use tax contributions to further displace Wyoming-imported coal as OG&E's primary generation fuel.

Both renewable energy jobs and energy efficiency jobs are valuable as they rely on geographically-constrained resources and as such are highly resistant to outsourcing. Oklahoma needs to strengthen both sectors in order to better insulate from out-of-state job displacement whereby demand is met by a supply of labor from nearby, more developed markets like Dallas or Denver.

Projections of sector employment changes in the Oklahoma City MSA between 2014 and 2024 find the largest increases in construction (15%), education and health services (14.1%), professional and business services (13.2%), and leisure and hospitality (21.1%). The construction industry job growth can benefit through energy efficiency practices as 70% of the 12,294 energy efficiency jobs presently in Oklahoma are in construction firms dealing with high efficiency and renewable heating and cooling. Nonetheless, state energy efficiency employment currently makes up just 0.6% of the national total and lags behind nearly all neighboring states. Energy efficiency jobs are projected to grow overall by about 9% with energy efficiency jobs within the construction industry increasing by 11%.

Renewables offer varying workforce benefits to Oklahoma City. In 2018, estimates from the American Wind Energy Association found between 7,000 and 8,000 wind industry jobs in Oklahoma including those at seven manufacturing facilities. Many of those opportunities, however, are found outside of Oklahoma City given the rural siting of Oklahoma's wind facilities.

A 2011 report from the office of Oklahoma Governor Mary Fallin found Oklahoma to be "the nation's leading geothermal" state given workforce proficiency in drilling, equipment manufacturing, and system engineering and design. Employment estimates were approximately 4,200 statewide with annual revenues more than $550 million. Oklahoma City is home to the headquarters of ClimateMaster, a recognized geothermal industry leader, which employs more than 600 and houses manufacturing, research and development, engineering, and marketing. The U.S. Bureau of Labor Statistics projects an estimated 63% increase in solar photovoltaic installer jobs between 2018 and 2028. That rate ranks it as the fastest-growing occupation in the U.S. during those ten years with the addition of approximately 6,100 jobs nationwide.

Solar is a significant job growth opportunity for Oklahoma City. While Oklahoma as a whole has seen remarkable solar sector job growth - 112% from 2015 to 2018 per the Solar Foundation's Solar Jobs Census - the state is 48th in the nation for solar jobs per capita. The primary barrier to growth has been state laws but, with the Attorney General's June 2018 opinion, the market is primed for expansion and growth. While those solar sector jobs had a 2018 median annual wage of $42,680, the second fastest-growing occupation, wind turbine service technician, is projected to see a 57% increase with a 2018 median annual wage of $54,370.

With the right strategic investments, Oklahoma City can add more quality jobs within the energy sector that not only build our local economy but enable residents and businesses to better meet their energy needs through the robust resources Oklahoma has to offer.

Property-Assessed Clean Energy (PACE). Under a PACE arrangement, private property owners evaluate measures that achieve energy savings and obtain financing, repaid as an assessment on the building. The assessment mechanism allows access to low-cost, long-term capital to finance improvements to the property. By eliminating upfront costs, extending financing, and simplifying the transfer of repayment obligations to new owners upon sale, PACE overcomes challenges that have hindered building energy efficiency and related projects.

More than 20 states are home to commercial PACE (C-PACE) programs and cover areas that include St. Louis, Dallas, Little Rock, Houston, Denver, Omaha, Washington D.C., Atlanta, Milwaukee, and many more. Market data estimates more than $521 million has been invested in C-PACE projects nationally. The Urban Land Institute reports commercial property owners across the country completed $222 million in PACE financing in 2017, up from the 2016 amount of $132 million. The largest share of C-PACE financing has gone towards office building projects followed by mixed use, retail, industrial, and healthcare.

Oklahoma is one of five states, alongside New Mexico, Wyoming, Alabama, and North Carolina, with PACE-enabling legislation but no PACE program or programs. Oklahoma has two statutes that authorize county governments to develop PACE financing to facilitate energy efficiency improvements for commercial property owners.

The Oklahoma Energy Independence Act, 19 O.S. § 460.1-460.7, authorizes counties to create "County District Energy Authorities" that can issue notes and bonds, seek out public and private lenders, and apply for grants and loans from other governmental entities to establish and fund PACE programs.

Once a county has established the Authority and PACE program, commercial property owners can receive a loan from the county for permanently-fixed renewable energy or energy efficiency improvements to their properties. These low-cost, long-term loans are then repaid through the owner's property taxes and constitute a lien on the property until paid in full.

The Energy Independence Act became law in 2009, but not a single county in Oklahoma had made use of PACE. After updates to the legislation in the 2019 legislative session, Tulsa County is working to establish a replicable program model that would streamline the effort in other counties.

From the perspective of regional competition, five states near Oklahoma - Texas, Colorado, Nebraska, Missouri, and Arkansas - all have active PACE programs, including programs specific to counties and municipalities like Frisco, Texas; Omaha, Nebraska; St. Louis, Missouri; and Pulaski County and Fayetteville in Arkansas. While Oklahoma City spans four counties, a program set-up in Oklahoma County alone could yield economic development dividends through supporting areas of intensive commercial development and redevelopment.

Example C-PACE Projects

1225 North Loop West
Houston, Texas

A 20-year fixed rate PACE loan of $1.3 million funded the cost of two new chillers, HVAC controls, and LED lights in this 200,000 square foot, 11-story multi-tenant office building.

D.C. United Audi Field
Washington, D.C.

With 500,000 square feet of mixed-use retail and residential on site, D.C. United Audi Field was the first use of PACE for a stadium project. $25 million of PACE financing was integrated into the project budget of $300 million.

Geothermal

Geothermal is a renewable source of energy as it relies on the Earth's constant and inexhaustible flow of heat. Geothermal can be used as both a source of electricity and directly for heating and cooling. The U.S. leads the world in installed geothermal capacity with more than 3.7 gigawatts and projections find geothermal alone could meet more than 10% of national electricity demand.

Because geothermal electricity generation requires water or steam at high temperatures (300°F to 700° F), it is best suited where hot springs or geothermal reservoirs are located within a mile or two of the Earth's surface. The hot water is pumped through a heat exchanger, which transfers the heat from the water into a building's heating system. The used water is injected back down a well into the reservoir to be reheated and used again, generating little to no waste and very few emissions of any kind.

Some may find geothermal to be a new or obscure method of electricity generation but Oklahoma is foremost in the nation for geothermal research and implementation. Oklahoma City-based ClimateMaster, for instance, is the world's largest manufacturer of water-source heat pumps used in geothermal installations, and has received Quality Jobs business incentive funds for job creation in 2016 and 2017.

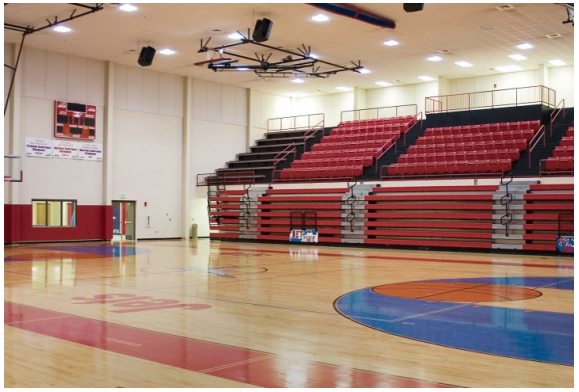
Geothermal is widely used in residential developments. Beginning in 2014, Oklahoma City-based Ideal Homes added geothermal heat pumps as an option for every Ideal Home residence and constructed two neighborhoods with geothermal heat pumps as a standard feature. An entire neighborhood of 1,600 to 2,500-square foot single-family homes in Moore began construction in 2015 with McAlister Construction and ClimateMaster including geothermal heating and cooling systems in each home. No doubt a significant contributor to this expansion is the federal tax credit for geothermal heat pumps last extended through the Bipartisan Budget Act of 2018.

While no comparable tax credit exists for public facilities, there are nonetheless a multitude of facilities with geothermal systems. Examples include the Lincoln Park Golf Course Clubhouse, the Northwest and Southwest libraries, Sooner Haven apartments, Myriad Gardens, Deer Creek Elementary School, John Glen Elementary School, and more.

Many other facilities in Oklahoma City and across the state house geothermal systems, as illustrated below, yet vast opportunity remains to expand deployment into both new and existing buildings, public and private, to reduce generation-related emissions and costs without curtailing electricity use. New or significantly expanded facilities should be subject to analysis to determine what if any cost savings could be achieved from the installation of a geothermal system to accommodate electricity use and reduce life-cycle maintenance costs.

Geothermal Facility Examples in Oklahoma City

The Metro Career Academy, a 54,000 square foot LEED-certified facility in Northeast Oklahoma City, was designed and constructed with a high-efficiency HVAC system powered by a 223-ton geothermal heat pump system.



Western Heights Middle School in Southwest Oklahoma City added a vertical ground-loop geothermal system of 200 wells to enhance the 144,000 square foot school's HVAC system.

The six-floor, 400,000 square foot Oklahoma State Capitol is one of the largest buildings in the world heated and cooled by geothermal. Installed in 1990, a 370-well system has provided a minimum 25% energy cost savings.

Wind

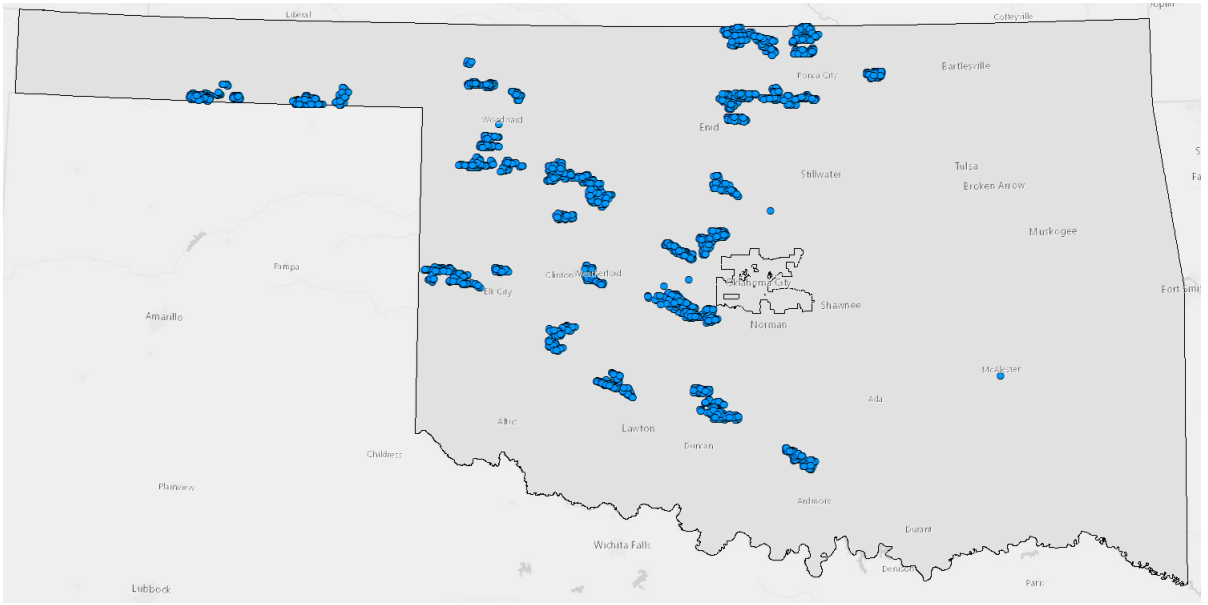
Oklahoma is third in the nation for installed wind capacity and second in wind energy generation behind only Texas and Iowa. As of late 2019, Oklahoma has 8,072 megawatts (MW) of installed wind capacity with another 1,015 MW of wind projects under construction. In 2010, Oklahoma adopted a voluntary goal to achieve 15% of electricity generation from renewable sources by 2015. That goal was not only achieved but surpassed with the 2015 renewable generation capacity reaching 25.9%.

In 2018, wind energy alone provided 31.7% of all in-state electricity production, making Oklahoma one of four states (Kansas, Iowa, and South Dakota) generating more than 30% of electricity from wind. The total capital investment into Oklahoma wind energy is estimated to be $14.7 billion through 2018 with between 7,000 and 9,000 direct jobs.

Alongside in-state use, Oklahoma wind energy developments export clean energy to multiple states, including Alabama, Nebraska, Arkansas, and Colorado. Oklahoma is considered a national example of the private sector owning, developing, or purchasing directly from wind projects. For example, when Google constructed a data center in rural Mayes County in 2011, the company agreed to purchase all energy generated from NextEra Energy Resources' Minco II wind facility for a 20-year period. The 100.8 megawatt Minco II facility was built as a direct result of Google's financial commitment.

This is an important mechanism for economic development as more and more companies, including Amazon, Target, and Walmart, adhere to corporate commitments to renewable energy. With wind estimated to be the cheapest new power source in 14 states including Oklahoma, it is in Oklahoma City's best interest to ensure wind development continues despite occurring outside our corporate limits. Research conducted by the State Chamber of Oklahoma Research Foundation underscores how sustained statewide wind energy development can contribute to growth and economic health of Oklahoma City.

Figure EP-4: Oklahoma Wind Turbines, 2019



Source: U.S. Geological Survey

There are currently more than 4,000 wind turbines across Oklahoma.

Based on tax records through 2015, the State Chamber found wind energy installations had increased county tax bases and property tax revenues in their respective counties through the installation of equipment appraised at $3.3 billion dollars. Counties home to wind energy projects see increases in the taxable property base which boosts revenue for county services and local school districts. This increased school district revenue benefits not only these rural districts but districts across the state.

The calculation of state aid to local school districts factors in the number of district revenue sources. If, after those sources are tallied, the district's projected per pupil revenue exceeds 150% of the projected state average per pupil revenue, the amount of state aid supplied to that district is proportionately reduced. This means more state funds are available for the support of all Oklahoma schools.

Simultaneously, wind development can directly reduce ratepayer energy prices. An annual analysis by the financial advisory and asset management firm Lazard found that in comparing electricity generation sources by unsubsidized levelized cost of energy - a metric of comparison that combines capital costs, operating and maintenance costs, performance costs, and fuel costs - the average cost of one megawatt hour (mWh) of wind-generated electricity has plummeted from $135 in 2009 to $45 in 2017. This is the lowest rate of any generation source, especially compared to coal ($102 per mWh). To that end, Oklahoma's two investor-owned utilities, OG&E and AEP-PSO, estimate wind energy projects will save ratepayers close to $2 billion.

While wind development has increasingly become a political target, its sustained development across Oklahoma has already afforded advantages to residents beyond rural counties. Recognition of and

The U.S. Bureau of Labor Statistics projects the second fastest-growing job in the U.S. between 2018 and 2028 will be that of wind turbine service technicians with a 57% growth rate. The top fastest-growing job? Solar photovoltaic installers.

support from Oklahoma City could see these advantages compounded.

Development of large-scale wind energy occurs outside of urban settings but manufacturing facilities are far more likely to be located within cities and towns. There are a few small turbines within Oklahoma City's corporate limits as code permits "private wind energy conversion systems" or PWECS. A prominent example is the OSU-OKC Engineering Technology Center, a LEED-certified facility with a geothermal HVAC system, solar panels, and wind turbine. 10-kW turbines are also located at a Department of Human Services facility near NW 23rd and I-235 and at the Governor's Mansion. The addition of PWECS is increasingly rare, but recent cost reductions could potentially signal a resurgence.

OG&E makes use of their wind-generated electricity through a specific sales program where a ratepayer can elect for a percentage of their annual use to be attributed among OG&E's seven wind farms statewide. Notably, OG&E prices this program at a higher cost, meaning a ratepayer using OG&E's general portfolio of electricity generation - again, chiefly coal and natural gas - would by design pay less than a ratepayer who elected 100% wind-generated electricity.

As an OG&E customer, the City could elect to enter into a power purchase agreement (PPA), the contractual mechanism for purchasing of large quantities of electricity, for wind-generated power. This could come at a higher cost, however, than is presently enjoyed by the City, despite the absence of fuel costs. While a preponderance of wind development would have numerous indirect benefits to Oklahoma City, what would ultimately be most beneficial is a shift to on-site distributed electricity generation, be it through geothermal means, photovoltaic solar arrays, or distributed wind systems.

$918m is the estimated amount of local school district funding projected to be paid out by wind energy projects statewide between 2003 and 2043.

Solar

Nationally, the solar industry is more diverse than comparable industries, thus providing more equitable job opportunities should the Oklahoma City market see greater development. The Solar Foundation's 2018 Solar Jobs Census found the solar workforce is comprised of approximately 26% women, 17% Latino/Hispanic, 10% Asian or Pacific Islander, 7.6% black or African-American, 10.5% age 55 or older, and 7.8% veterans. The importance of veteran participation in the solar workforce is critical given Tinker Air Force Base as a prime opportunity for veterans with highly desirable technical skills, especially given the deployment of solar by the U.S. military and the recognition that reliance on foreign fuel constitutes a threat to national security. The 7.8% cohort of U.S. Armed Forces veterans in the national solar workforce remains greater than the 7% overall participation of veterans in the national workforce, which underscores the opportunity Oklahoma City has to connect local veterans with job opportunities. In 2014, the Department of Energy launched Solar Ready Vets, a program developed on the specific needs of high-growth solar employers and tailored to build on the technical skills that veterans have acquired through their service. At 10 military installations across the U.S., roughly 20 soon-to-be inactive military personnel were trained for four to six weeks on skills vital for solar industry management, installation, sales, and other technical and non-technical positions, all with no out of pocket costs. While the program was effectively shuttered in 2017, it nonetheless graduated 526 students and remains indicative of how solar can provide opportunities for both military and non-military residents.

1:2,142 was the ratio of solar workers to the overall Oklahoma workforce in 2018 per the Solar Job Census. The majority of Oklahoma solar jobs were found to be concentrated in Oklahoma County (187), Tulsa County (162), and far south Jefferson County (122), but Oklahoma's statewide total of 838 ranks it 40th in the country for solar jobs overall, even with year-to-year solar job growth of 13% from 2017 to 2018.

The incongruity between Oklahoma City's solar potential and relatively low solar employment is indicative of unrealized job growth opportunity and the chilling effect of state legislation like SB 1456 (2014) allowing public utilities to surcharge rate payers who install solar or wind on their homes. Given projected increases of solar deployment and employment nationally, an important initiative to ensure we capitalize on the benefits offered by solar expansion in both the private and public sectors.

To that end in 2016, the City was selected to participate in the SolSmart initiative, a national program led by the International City/County Management Association and the Solar Foundation, funded by the U.S. Department of Energy, and supported by partners including the National League of Cities, the Solar Energy Industries Association, the Electric Power Research Institute, and the National Renewable Energy Laboratory.

A six-month period working with a SolSmart-provided consultant entailed outreach to solar experts and business owners, engagement with OG&E, and, most importantly, assessing existing Oklahoma City codes and ordinances to identify barriers to solar. Solar hard costs - inverters, modules, structural and electric components - have declined precipitously such that non-hardware costs or "soft costs" such as permitting and code requirements, zoning, financing, and interconnection policies now comprise the bulk of solar energy costs.

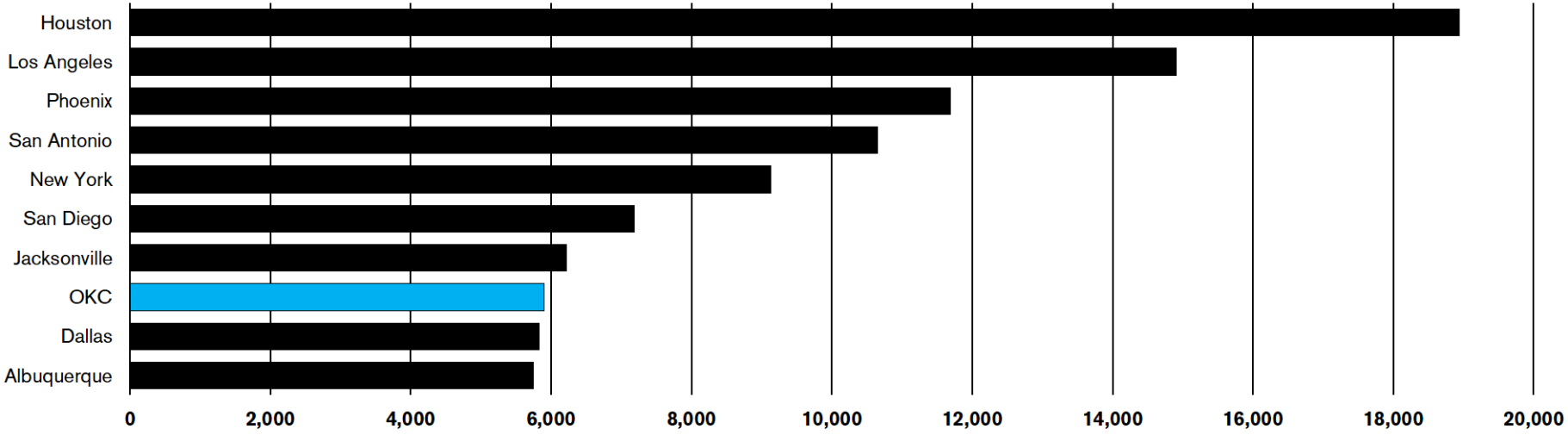
Though state utility policies are at the behest of the Oklahoma Corporation Commission and the Oklahoma Legislature, soft costs can be addressed at the local government level. City staff, the Solar Foundation, and the SolSmart consultant identified critical gaps that should be addressed to ensure residents, businesses, and institutions have clarity and stability should they pursue solar installations.

These and other important findings can be addressed through the City's development codes update process already underway, thereby ensuring Oklahoma City is a solar-ready community willing and able to capitalize on another significant resource within its energy portfolio.

Additionally, there has been a significant recent shift in state policy related to solar over the last year. In response to an inquiry from the Oklahoma Secretary of Energy and Environment, Oklahoma Attorney General Mike Hunter issued a formal opinion in June 2018 regarding distributed generation, which is

An Oklahoma City home outfitted with a photovoltaic solar array.

Figure EP-5: Top 10 U.S. Cities with Highest Solar Potential by Annual Gigawatt Hours



Source: Project Sunroof

Oklahoma City has enough solar-viable rooftops to generate an estimated 7.2 million MWh of solar electricity annually. Oklahoma City residents consume 3.7 million MWh of power each year. If all of the viable rooftops went solar, it would be enough to meet more than 100% of the city's residential power requirements. "Solar potential" can be understood as an area's propensity for sunny days.

broadly defined as electricity generation near or at the site where the electricity will be consumed by an end-user. Distributed generation can apply to a multitude of technologies including wind and geothermal but is especially important to solar.

A critical component of distributed generation is third-party financing, which allows a solar company to install solar on a customer's property, often with no upfront cost, and retain responsibility for system maintenance. Under a Power Purchase Agreement (PPA), the customer pays for the electricity generated by the installed solar at an agreed-upon rate. The customer leases the solar system and benefits from the electricity the system produces.

At the end of a PPA or lease term, the customer may be able to extend the term or purchase the system. The Attorney General's opinion finds third-party distributed generation financing through both leases and Power Purchase Agreements (PPAs) are lawful within incorporated areas, i.e. within Oklahoma cities and towns, under existing Oklahoma and federal laws and regulations. Systems must meet requirements set forth in the federal Public Utility Regulatory Policies Act (PURPA) of 1978 to qualify as a small power producer but, upon doing so, utilities are required to accept the excess power they generate. Lastly, the Attorney General found that third-parties with qualified small power producer systems would not be seen as a utility and are therefore excluded from utility regulation.

In addition to the Attorney General's 2018 opinion, the Oklahoma Corporation Commission in 2019 asked regulated utilities to submit tariffs enabling net-metering. Net-metering is the mechanism by which users and/or owners of distributed generation can receive compensation for any excess electricity their system generates and places onto the grid. This compensations represents "avoid energy cost," or the increment a utility - in this case, OG&E - avoids by having electricity generated elsewhere but seeing that electricity fed into the grid, thus circumventing the cost of generation. The majority of U.S. states have net-metering policies in place with 16 providing compensation at full retail price. Without an adopted net-metering policy, Oklahoma would be one of three states alongside South Dakota and Alabama with no net-metering policy. The actions of the Oklahoma Corporation Commission will help to bring much of Oklahoma's solar policies into the 21st century and provide a substantive opportunity to foment economic development and job growth.

Google's Project Sunroof estimates that maxing out rooftop solar on Oklahoma City buildings would reduce city-wide greenhouse gas emissions equivalent to taking 1,000,000 cars off the road over the life of the solar installations, which is typically 20 years or more. While this is a far-fetched idea, it illustrates what we can accomplish community-wide through expanded solar installation and warrants continued, proactive development.

Resilience

Overhead transmission lines are the most common electricity infrastructure across Oklahoma City, yet are a major liability during increasingly common extreme weather events. Ice storms, straight-line winds, flash flooding, and tornadoes frequently occur throughout the Oklahoma City metro, and cause both major and minor outages with adverse effects.

No type of electricity infrastructure is wholly invulnerable to the multitude of hazards to which Oklahoma City residents are exposed. In all cases, however, greater mitigation of the effects wrought by these hazards can limit their impact to people and property. As the variability of Oklahoma City's climate increases, diversifying and decentralizing our electricity infrastructure can ensure we are better able to adapt to shocks, natural or otherwise.

The City's Hazard Mitigation Plan identifies six electricity facilities throughout or extremely near Oklahoma City sited within 500-year floodplain, an exceptional degree of vulnerability for such vital infrastructure. Areas designated as 500-year floodplains are areas with a 0.2% chance of flooding in a given year. Such flooding in Oklahoma City would, per the U.S. Geological Survey, be based on the amount of rainfall in a given time period: 5.2 inches of rain in one hour, 12.5 inches of rain in 24 hours, 14.8 inches of rain in three days, or 15.5 inches of rain over seven days. Such floods have been experienced by Oklahoma City in June 2010 and May 2015. Projections of future inundation events underscores the physical vulnerability of our electrical infrastructure and the importance of secondary and tertiary options.

For a power system to be resilient, it must be capable of operating independently, or "islanding," from the grid during outages. Generally, outages in Oklahoma City are caused by damage to aforementioned transmission infrastructure but in a scenario where a major generation facility - OG&E's Mustang Power Plant, for example - is directly hit, overall grid reliability would be compromised.

Renewable forms of energy can offer redundancies suited to critical infrastructure including providing on-site power during or after an event. Systems such as solar microgrids can act self-sufficiently, generating energy and powering critical loads until utility services are restored. Diesel generators are often viewed as the default solution for providing resilient power and frequently the resource used at critical infrastructure sites from hospitals to public safety facilities, but they might not always be the most reliable or cost-effective solution. Reliance on traditional fuels such as diesel reduces an energy system's resilience because a disruption or contamination in the fuel supply can cause vulnerabilities.

ABOVE: OKLAHOMA CITY VETERANS AFFAIRS MEDICAL CENTER

In 2012, the Oklahoma City Veterans Affairs Medical Center (VAMC) installed a $4.6 million, one megawatt solar photovoltaic (PV) system to provide approximately 5.5% of the VAMC's annual electricity usage. Yearly savings were estimated to be about $110,000.

In addition to being resistant to sustained disruption, on-site renewable energy can also be scaled to provide electricity to a single site or several city blocks. As Oklahoma City's significant area includes many rural portions, solar in particular could be especially advantageous to residents and businesses that might see prolonged outages during and after events. These downscaled electricity grids can serve as redundancies regardless of geography or density.

With the Oklahoma Corporation Commission permitting third-party leasing as well as net-metering, the opportunities to invest in solar as a means of resilience can help such projects see a quicker return on investment. Nonetheless, a oft-voiced concern is whether or not solar modules can withstand hail. The U.S. Department of Energy and the National Renewable Energy Laboratory (NREL) collaborate on panel durability testing which includes firing ping-pong-ball-sized ice at different panel areas at approximately 70 miles per hour. After one severe hailstorm, NREL staff found only 1 of more than 3,000 panels was broken.

Oklahoma City's resilience can be strengthened through energy redundancies, resources, and flexibility so as to adapt to the challenges of today and those yet to come. Determining how to plan, finance, and implement strategies for greater energy resilience while simultaneously enhancing quality of life is not only possible but a necessity.

Photo by Steve Gooch, the Oklahoman, 2007

2007 Ice Storm

Between Saturday, December 8, and Tuesday, December 11, 2007, freezing rain fell across most of Oklahoma with between 1.5 to 3 inches accumulating in the Oklahoma City and Tulsa metros. 25 of Oklahoma's 77 counties were federally declared disasters including Oklahoma, Canadian, Cleveland, and Pottawatomie counties. At least 30 deaths were reported, many due to the hundreds of automobile crashes from dangerously icy roads and highways, and statewide as many as 640,000 homes and businesses lost power. OG&E said it was the largest outage in their 105-year history with an estimated 300,000 losing power in their service area. Damage to private property was estimated at more than $780 million.

Amid the widespread damage and outages, pictured above is an Oklahoma City resident casting her ballot on December 11, 2007, in the powerless St. David's Episcopal Church. The only citywide election that day was the 11 propositions making up Oklahoma City's $835.5 million general obligation bond. While every proposition passed, voter turnout for this critical decennial election responsible for major infrastructure maintenance dollars was estimated at fewer than 5% of registered voters with many polling places lacking light and heat. This is a stark reminder that the lingering effects of a single disaster could have long-term impacts on core tenets of local governance and finance; the continuity and stability of our most basic services and functions cannot and should not be taken for granted.

Our Plan

There is no foreseeable circumstance where the cost of electricity declines. Even less foreseeable is a circumstance where City operations, residents, businesses, and institutions see a reduced need for electricity. Right now, however, we cannot conflate low price point with low cost. Fossil fuel dependency guarantees exposure to commodity price volatility while shifting the burden of degraded environmental and public health to ratepayers. That same dependency bolsters barriers to renewable energy deployment, which compound costs by curtailing economic growth. We must work through every means possible to realize the full potential of a thriving renewable energy sector, especially our emerging solar market.

The energy efficiency of City operations should be a priority. Residents pay for electricity twice: once for their homes or businesses through monthly bills and again for the City's via taxes. Be it avoided costs in new facilities or return on investment in renovations and remodels, energy efficiency must be an inseparable and essential operating principle of City projects.

As the years grow increasingly hotter, we must be proactive with policies and programs to support affordability for residents, businesses, and institutions through efficiency, enforcement, and modern building requirements.

Our Goals

ATMOSPHERE AND CLIMATE

1. **Reduce emissions associated with energy consumption.**

ENERGY CHOICE

2. **Diversify local and state energy economies.**

RESILIENCE

3. **Reduce cost of municipal operations.**

Our Initiatives

Energy Productivity Initiatives	Goals 1	2	3
1. Reduce energy emissions.	■		■
2. Use and promote renewable energy sources.	■	■	■
3. Increase energy code compliance.	■		■
4. Enhance and promote energy efficiency programs.	■	■	■
5. Support renewable energy job sectors.	■	■	
6. Increase energy efficiency of City facilities.	■		■
7. Monetize carbon emission offsets.			■

"As we improve our energy efficiency, our emissions decline along with our costs."

- Devon Energy Corporation
Response to the Carbon Disclosure Project's
Climate Change 2016 Information Request

INITIATIVE 1

REDUCE ENERGY EMISSIONS

Establish a greenhouse gas emissions reduction target. Inventories are important tools to establish emissions quantities and sources. The City last published a greenhouse gas inventory in March 2010 that assessed emissions during FY09. Emissions for both City operations and the community were highest from energy consumption. An updated inventory would not only be instrumental in setting a greenhouse emissions reduction goal but to pinpoint sectors and City facilities where the greatest emissions reductions could be achieved through energy efficiency, renewable energy, and other methods to curtail costly wasted energy.

POLICIES

AQ-2: Conduct greenhouse gas emissions inventories every five years to capture both City operations and community-wide emissions.

AQ-3: Use emissions data to establish reduction targets.

AQ-4: Develop an emissions reductions strategy.

INITIATIVE 2

USE AND PROMOTE RENEWABLE ENERGY

Install solar on City property. New City facilities and those seeing significant renovation should be candidates for solar installations. These projects should be subject to a solar feasibility and cost-benefit analysis built into the required scope of architectural and engineering requests for bids.

Incorporate solar and wind best management practices into development regulations. Chapter 59 of the City's municipal code should be updated to explicitly allow photovoltaic solar panels as a permitted, or by right, use. This will ensure no barriers and, other than electric permit requirements, see no additional review procedures or permits are needed. Small wind systems are presently height-restricted and require a variance even in large acreages. Larger properties in conformance with planokc land use typologies could allow larger systems.

Consider geothermal technology to heat and cool City facilities. New City facilities and renovations to existing facilities should be candidates for geothermal installation. These projects should be subject to a geothermal feasibility and cost-benefit analysis built into the required scope of architectural and engineering requests for bids.

Provide renewable energy education opportunities for residents and businesses. Community workshops should be held to help residents and businesses navigate City and utility processes for solar, wind, and geothermal as well as existing programs for energy efficiency improvements. These should be conducted in collaboration with community partners including OG&E, neighborhood and homeowners' associations, and trade associations.

POLICIES

EP-1: Allow photovoltaic solar panels by right in all zoning districts.

EP-2: Increase renewable energy education opportunities and promote completed projects.

EP-3: Engage utilities to advance renewable energy use and identify partnership opportunities.

EP-4: Create solar-ready guidelines for builders in Oklahoma City.

EP-5: Develop criteria for using renewable energy in City projects and include in the City's Interdepartmental Guidelines on Coordination of Facility Projects.

EP-6: Perform cost-benefit analysis of including renewable energy on new or more than 50% renovated City facilities.

EP-7: Train appropriate staff to use cost-benefit tools to assess return on investment of renewable energy in new construction and major renovation (50% or more) projects.

EP-8: Require solar-ready construction for new City facilities that meet the criteria established in EP-5.

EP-9: Develop criteria for solar-ready construction requirements for developments seeking public financial assistance.

EP-10: Increase the number of Green Home Loan projects that include renewable energy.

EP-11: Identify opportunities and determine viability of solar energy generation on public property including, but not limited to, under-utilized land, brownfields, or Opportunity Zones.

INITIATIVE 3

INCREASE ENERGY CODE COMPLIANCE

Perform field inspections to verify compliance with adopted international energy code. City Council voted unanimously to adopt an amended form of the 2009 International Energy Conservation Code (IECC) in 2012. The City must target barriers to enforcement and integrate IECC into the plan review process to comply with both Council-approved policy and the terms of the American Recovery and Reinvestment Act. Enforcement would ensure new commercial construction is as efficient as possible to reduce overhead and limit energy cost pass-through to consumers.

The City is responsible for the cost of lighting, heating, and cooling more than one million square feet of public facilities. Data on facility energy use and costs is vital to reducing demand. New City facilities are built to adopted energy code standards and major facility renovations should also be opportunities to ensure energy code compliance.

One way to realize cost savings from outdated, inefficient public buildings is to ensure their future operations minimize costs. These renovations and improvements typically include public libraries, parks and recreation centers, maintenance facilities, and police and fire stations. Such facility renovations and improvements should require bringing facilities up to, at minimum, IECC 2009 to defray future energy costs as much as possible and remain consistent with the City's adopted codes.

POLICIES

EP-12: Provide energy code training for plan review, inspection, and code enforcement staff.

EP-13: Implement field inspections for energy code compliance.

EP-14: Perform energy code field inspections for municipal construction and major renovation (50% or more) projects.

INITIATIVE 4

ENHANCE AND PROMOTE ENERGY EFFICIENCY PROGRAMS

Expand the Green Home Loan program to offer more residents access to funding for energy efficient home upgrades. In 2010, the City created a revolving loan fund (RLF) with a portion of the $5.4 million formula grant from the Department of Energy's Energy Efficiency Conservation Block Grant program.

The Green Home Loan program is a proven success and efforts should be made to increase the RLF budget, expand the program's reach, and better integrate options for renewable energy systems into the program offerings and audits.

Provide information on the City's website about utilities, state, and federal energy efficiency programs available to property owners and residents. There is no cost to the City to promote existing energy efficiency opportunities. Examples include OG&E's free Home Energy Efficiency Program, Commercial and Industrial Energy Efficiency Program, or the federal tax credits for geothermal, residential wind turbines, and photovoltaic solar systems. Knowing about these opportunities - much less navigating them - can be a difficult feat but we can combine information on applicability and eligibility to help Oklahoma City residents make the most of these programs.

POLICIES

EP-15: Promote utility, state, and federal energy efficiency programs available to property owners and residents.

EP-16: Increase funding to expand the Green Home Loan program.

EP-17: Explore revising public financial assistance policies to include energy efficiency standards.

EP-18: Connect owners of multi-family properties to energy efficiency resources.

EP-19: Offer technical assistance and promote energy efficiency to businesses engaged in the Commercial District Revitalization Program.

INITIATIVE 5

SUPPORT RENEWABLE ENERGY JOB SECTORS

Collaborate on a Property Assessed Clean Energy (PACE) program. Already enabled by state legislation, working to establish a county PACE program would provide another economic development tool in addition to diminishing costly, wasted energy consumption. PACE could incentivize corporate redevelopment or relocation as well as stoke local energy efficiency and renewable energy economic expansion. Reductions in energy use at commercial buildings and offices not only lessen pass-through costs but provide capital assistance to businesses and developers.

Extend government relations efforts to the Oklahoma Corporation Commission. Responsible for the regulation of prices and service reliability for numerous industries, the Oklahoma Corporation Commission's oversight includes the three investor-owned utilities operating across much of Oklahoma. Rate changes and the introduction of new tariffs are set with the approval of the three elected Corporation Commissioners through administrative hearings, technical conferences, and rulemakings.

As the City contracts with lobbyists and drafts state and federal legislative agendas, a presence at the Corporation Commission is vital to ensure a voice in future rate cases. Changes in electricity regulation affect not just City operations but every resident, business, and institution within Oklahoma City.

Propose to include renewable energy in the City's Legislative Agenda. Each year, the Mayor, City Council, and City Manager work together to create a Legislative Agenda to establish priorities, initiatives, and positions in anticipation of the annual session of the Oklahoma State Legislature. State policy changes could create jobs, add manufacturing opportunities, expand finance and lending offerings, attract investment, and reduce both business overhead and resident utility costs.

These prospects should be explored in greater detail and articulated to City policymakers for consideration. Expansion of local opportunity for renewable power already aligns well with a federal legislative priority: to monitor enforcement and definitions of compliance with the Clean Air Act and EPA standards. Renewable energy sources emit no emissions and efficiently support reduced energy and water consumption. As result, fewer point sources contribute ozone precursors to the Oklahoma City metro's air.

"Oklahoma is an energy state. We are in the top three of oil and gas and wind, and we could be number six in solar energy, but we have some work to do."

- Lindsey Pever
Vice President, Oklahoma Solar Association

Work with local schools, colleges, and universities to establish solar training programs. Oklahoma City has the potential to be a major solar market. Key to ensuring that potential is realized is a trained, qualified workforce that can meet local demand. Programs and curricula to certify and train workers for solar occupations are needed to see local workers better positioned to occupy local jobs. Community colleges and technology centers are ideal starting points to develop and implement these programs.

Incorporate renewable energy into economic development programs. Oklahoma City and Oklahoma disproportionately rely on jobs related to oil and gas. The share of Oklahoma City's economy related to oil and gas is 6.65 times the national average and Oklahoma's oil and gas-related sectors are about 5.8% of total state employment, well above the national share of 2.4%. The renewable energy sector is a major employer nationally as the solar workforce increased by 25% in 2016 and wind employment increased by 32%. Oklahoma City has not been able to foster expansion due to barriers in state law.

The City, the Greater Oklahoma City Chamber of Commerce, and the Alliance for Economic Development of Oklahoma City work together on programs to provide performance-based incentives for qualifying employers in the renewable energy sector whenever possible.

POLICIES

EP-20: Establish a Commercial Property Assessed Clean Energy (C-PACE) financing program.

EP-21: Participate in Corporation Commission rulemaking and tariff processes.

EP-22: Build regional coalition of municipalities for representation at Corporation Commission.

EP-23: Partner with educational institutions, including colleges and metro technology centers, to develop renewable energy certificate programs.

EP-24: Support renewable energy and alternate energy sector businesses in pursuit of local and state job creation incentives.

INITIATIVE 6

INCREASE ENERGY EFFICIENCY OF CITY FACILITIES

Track and publish utility consumption data from City facilities. The importance of transparency in how public funds are spent cannot be understated. As with other public financial transactions, the City's energy consumption and costs are indicators to residents that we are continually striving to improve. We should work to publish the energy use and cost of Oklahoma City's operations to demonstrate how design, construction, and operations influence costs and how energy efficiency itself can be a source of savings.

Establish dedicated funding for ongoing energy efficiency improvements in municipal facilities. The City's Energy Management program requires funding to assess and implement efficiency measures. A dedicated operating budget is a necessity. Options should include savings generated by the City's opt-out of OG&E Demand Program Rider, savings generated by efficiency programs, or General Fund revenue. Regardless, dedicated operational funds are the best route to reducing long-term utility costs for the City.

Use third-party commissioning for municipal construction projects and major renovations. Third-party commissioning should be integrated into existing project management processes to verify building performance and functionality prior to final acceptance.

For retrofits and improvements of existing City facilities, energy service companies, or ESCos, can enter into an agreement with the City, called performance-based efficiency contracts, which include contractually-guaranteed annual energy cost savings.

Performance-based efficiency contracts are a means to incentivize energy efficiency by contractually tying ESCo profitability to performance, ensuring the City would see a return on investment, and assuring cost savings are persistent and consistent.

POLICIES

EP-25: Perform third-party commissioning for municipal construction projects or major renovations.

EP-26: Pursue dedicated funding source for on-going energy efficiency improvements in municipal facilities.

EP-27: Track municipal facilities in Energy Star Portfolio Manager.

EP-28: Publish municipal facilities' energy consumption and cost data to the public.

EP-29: Target cost reductions in City facilities with high energy demands by using performance-based energy efficiency contracts with guaranteed return on investment.

INITIATIVE 7

MONETIZE CARBON EMISSIONS OFFSETS

Define the City's opportunity to monetize carbon emission offsets. Multiple markets exist for the purchase of carbon offsets including one promulgated in Oklahoma via the Oklahoma Carbon Sequestration Enhancement Act. These markets require quantification and verification through a third party of projects before approval to be placed on a market. The calculated benefits from projects that offer some form of ecosystem services, such as trees that capture carbon, filter polluted water, or general biodiversity conservation, can be available for sale, trade, or transfer via payment for ecosystem services (PES) programs.

Private companies in Oklahoma, including Devon Energy and Chesapeake Energy, already make use of PES markets for carbon offsets and the research journal *Nature Sustainability* estimates more than $36 billion is exchanged each year in PES programs with the category of watershed services ($24.7 billion in 2015) leading the way.

Broadly, local projects could include transitioning vehicles to alternative fuels, tree plantings, or installing renewable energy systems on City land or facilities. Greater scrutiny of markets' required methodologies as well as the cost associated with quantifying and submitting projects should be assessed.

POLICIES

EP-30: Develop process to submit carbon emissions reductions from City projects for sale on market.

"Devon Energy has been undertaking a number of efforts to reduce its greenhouse gas (GHG) emissions throughout its operations in the United States and Canada. The company plans on greatly expanding these efforts because of the emergence of the market for generating and selling carbon offsets. Given the desire of many emission credit buyers to reduce their own carbon footprint – either for voluntary or potential compliance reasons – Devon has the opportunity to expand its GHG reduction initiatives, sell the resulting reductions as emission credits and earn additional revenues."

- Devon Energy,

chapter three

natural & built environment

CHAPTER 3:

NATURAL & BUILT ENVIRONMENT

Photo by the Office of James Burnett

Our Situation

Since Oklahoma City's founding, the built environment has blanketed one of our most important yet finite natural resources: land. The metro's sprawling urbanized area continues to expand the interface between the natural and built environment and contributes to extreme heat, flooding, and water quality issues.

In *Natural and Built Environment*, we propose actions that will enhance our continued growth with development that fosters healthy ecological relationships, better protects water resources, and preserves and expands vegetative cover.

As illustrated in **Figure NB-1**, Oklahoma City's population growth from 1891 to 1960 produced the most densely-populated environment the city has ever experienced with more people per square mile (8,396) in 1950 than 2016 Los Angeles (8,362). City leaders expanded the city limits by 125% (360 square miles) in the following five years to accommodate this rapid population growth and the mass production of automobiles.

This expansion of city boundaries set the scene for sprawling development patterns that gradually replaced our natural environment with the built environment and established a precedent for impervious infrastructure growth over the next several decades. Impervious elements of the built environment, like roadways, buildings, and parking lots, absorb the sun's thermal energy and affect how precipitation moves once it reaches the ground. This changes how the natural environment behaves during extreme heat and inundating rainfall that creates the conditions for flash flooding, degraded water quality, and the urban heat island (UHI) effect.

The UHI effect is a phenomenon where an "island" of ambient heat causes significantly higher temperatures in urban areas compared to nearby rural areas due to the vast amount of buildings, pavement, and infrastructure. This concentrated heat increases electricity consumption and associated costs, contributes to poor air quality, and creates dangerous conditions for sensitive populations like the elderly and those who suffer from respiratory illnesses.

In recent years, the trajectory of development continued to increase with more than 124 million square feet of newly developed and redeveloped building space constructed between 2012 and 2016. As of 2017, Oklahoma City's urbanized area spanned more than 234 square miles covering 38% of the city.

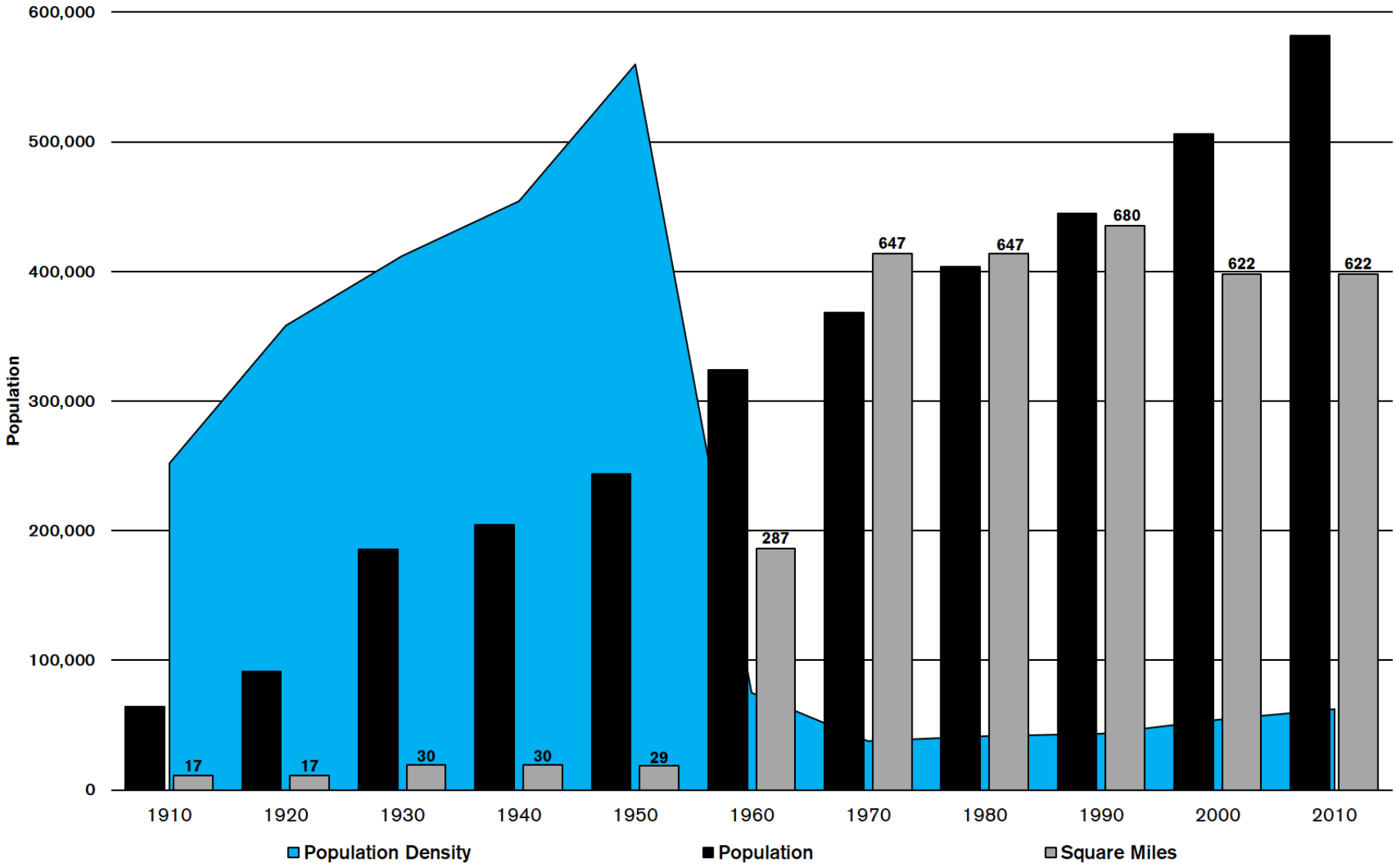
Boosted by code-required parking minimums, 11% of Oklahoma City's urbanized area is covered by the largest single type of impervious surface in the urban area: parking lots. Of Oklahoma City's entire 621 square mile area, four percent is parking lots – double the surface area covered by bodies of water.

Urbanization is synonymous with growth and growth is required to ensure our economic vitality. The question is not if we should grow, but how we grow. Sprawling development stretches demand and increases the cost of City services and, coupled with a changing natural environment and more severe extreme weather conditions, increases risk.

We must sustainably accommodate growth and maintain high-quality basic services while not degrading water resources or exacerbating the effects of extreme heat and associated costs. Development can merge form and function in a way that weaves the natural into the built environment, mitigating the negative impacts to water quality and public health by minimizing surfaces where heat is absorbed and water cannot infiltrate.

To this end, the City should institutionalize low-impact development (LID) techniques in capital improvement projects and allow and encourage LID best practices in private developments.

Figure NB-1: Oklahoma City Growth in Land Area, Population, and Density, 1910 - 2010



The chart above illustrates the dramatic rise and fall of Oklahoma City's population density. Since 1910, Oklahoma City's population has steadily increased, underscored by adding more than 80,000 people from 1950 to 1960. This influx of new residents into already tight confines caused city leaders to subsequently add nearly 400 square miles to the city's area in the 1960s to accommodate our rapid growth rate. After peaking in 1950 with more than 8,300 people per square mile (ppsm) and dropping to fewer than 600 ppsm in 1970, Oklahoma City's population density had only climbed to an estimated 1,036 ppsm in 2017.

Photo by Nick Oxford, Associated Press, 2013

LEFT: FLOODING IN MESTA PARK

The evening of May 31, 2013 saw approximately 8" of rainfall drench Oklahoma City in the span of about three hours, part of a severe storm that included an EF-5-rated tornado with a width of at least 2.6 miles. The torrential rain caused flash flooding and river flooding across the region with reports of at least one high water rescue performed at SW 86th Street and South Western Avenue. The flooding proved to be the deadliest on record for Oklahoma City. Lieutenant Jay Barnett of the Oklahoma City Police Department told *The Oklahoman* "Areas of the city that don't normally flood — we're seeing flooding."

Impervious Surfaces

A 2014 Climate Central report compared high temperatures in urban and rural environments to assess the impact of the built environment on heat levels. In Oklahoma City, we experience hotter temperatures by up to 15°F and approximately 22 more days above 90°F each year than nearby rural areas. The report attributes this heat disparity to urbanization that increases absorption of thermal energy. These extreme conditions can cause major issues for infrastructure, water quality, and public health.

Between July 1996 and September 2016, the National Centers for Environmental Information identified 32 extreme heat events that affected Oklahoma City resulting in 38 deaths and 326 injuries directly related to extreme heat. The fourth National Climate Assessment, released in November 2017, asserts the annual average temperature over the contiguous United States is projected to rise. The assessment also projects that a warming atmosphere will continue to increase extreme precipitation beyond observed increases across the country. Recent record-setting years may become the "new normal" in the next few decades with increases of about 2.5°F projected for the period of 2021 to 2050 relative to 1976 to 2005.

Localized projections from the *Climate in the Heartland* report project Oklahoma City's total annual precipitation will remain about the same over the next 30 years, but shorter, heavy rainfall events in the spring and summer are expected to increase. Oklahoma City residents can expect longer dry periods during hotter summers and shorter bursts of heavy rainfall and damaging flash flooding events.

A historic rain event in May 2013 that became the deadliest in Oklahoma City's history and the deadliest in the state since 1984 gave a glimpse of the dangers of increases in flash flooding severity and frequency. Over the course of a single day, 8" to 11" of rain fell on Oklahoma City. Emergency response personnel were dispatched on 114 separate calls of flood rescue and flood assistance. The storm ultimately resulted in an estimated $17 million in damage to Oklahoma City infrastructure and 13 fatalities.

Consistent, saturating precipitation can bring relief to drought-stricken areas, particularly those dependent on raising livestock and crops. Unfortunately, this type of weather pattern is expected to decrease. In its place, short windows of heavy rainfall will often provide more damage than benefit, and create hazardous conditions. If the ground is too dry, rainfall will move rapidly across the surface, washing away nutrients and evaporating before reaching deep plant roots. Excessive rainfall with saturated soil can remove oxygen from the soil. If the soil is too saturated before rainfall, runoff can cause roadways to flood and become impassable.

Drought conditions that drop reservoirs several feet below normal also cause higher concentrations of bacteria and organic matter that contribute to poor water quality. Warmer air temperatures, more days of extremely high temperatures, and longer periods without rainfall will decrease reservoir levels and increase water temperatures. Warm, stagnant, sunlit water with excessive nutrients like nitrogen and phosphorous – largely a result of over-fertilized lawns – are ideal conditions for the formation of blue-green algae (BGA), blooms of which produce toxins that pose health risks if consumed or inhaled by people, pets, or livestock. Outbreaks of BGA, like those in 2011 and 2016, can also threaten the Oklahoma City tourism industry, which generates $158 million annually in state tax revenue and $84 million annually in local tax receipts.

Projections of Oklahoma City's rainfall indicate a modest increase in annual precipitation. The average amount of rainfall per year in Oklahoma City will add 1.4" from 2021 to 2050 with a smaller increase of 0.7" from 2051 to 2080. While that equates to just a 5.7% increase across those three 30-year periods, the projections do indicate an important change in the distribution of precipitation based on seasonality. Oklahoma City summers are projected to see a reduction of 5.3% in precipitation in conjunction with a 7% increase in temperature. Our springs see a 4.6% increase in precipitation between the first two 30-year periods but remain flat thereafter, all while spring temperatures jump 13.8%.

These precipitation projections indicate our springs and summers are likely to be hotter and drier, but with a slight increase in annual precipitation, the rainfall will shift to the fall and winter. Fall will see the largest increase in seasonal precipitation with a 17% increase, from 9.8" to 11.5" with winter increasing 10%. While both will see average annual temperature increases, too - 4.6% for fall and 14% for winter - the likelihood of wetter, warmer winters could reduce the threat of damaging ice storms. These percentage changes are indicators of so-called "inundation events" where significant portions of precipitation fall over a brief period of time, triggering flash flooding as well as river flooding and overtax existing storm water and drainage systems.

Aside from risk to life and property, such massive flooding events can have lingering environmental effects due to the likely contamination of flood waters from a myriad of hazardous substances.

Water Quality

Maintaining clean water in reservoirs, lakes, and streams is a necessity that involves all levels of government. Municipalities like Oklahoma City with substantial amounts of impervious surfaces face a greater challenge of both increased storm water runoff volume and velocity as rainfall rushes from higher elevations through the network of storm water infrastructure and finally into water bodies. Roads, bridges, parking lots, buildings, and other impervious infrastructure are transformative changes which alter the functions of the natural environment thereby affecting the livability of our urban places and threatening the quality of our water.

Photo by Paul Hellstern, The Oklahoman, 2012

ABOVE: SE 125th STREET

More than three inches of rain fell in Oklahoma City on March 19, 2012, knocking out power to 1,500 businesses and households. Flash flooding washed out SE 125th Street, a privately-owned gravel road in far southeastern Oklahoma City and stranded households on the dead-end street by cutting off access to Dobbs Road. The washed out segment of SE 125th Street sits in a 100-year floodplain connected to the nearby Wes Watkins Lake reservoir.

Storm water runoff from impervious surfaces travels faster than natural conditions overburdening storm water infrastructure and resulting in more erosion, more flash flooding, more sediment and contaminants entering surface waterbodies, and less aquifer recharge. Soil erosion can cause significant damage to public facilities like parks and trails, while additional contaminants change the hydrologic conditions of the receiving waterbodies.

By disrupting the natural percolation of water into the landscape, the urban environment can exacerbate the physical hazards of inundating rainfall events by flushing a variety of contaminants down storm drains. Increases in the frequency and severity of flash flooding events also increase concentrations of sediment and pollutants swept from impervious surfaces into creeks, streams, and drinking water supplies.

Unlike pollution originating from one specific source, such as discharges from an industrial facility or sewage treatment plant, contaminants from several different sources that are carried into waterbodies by

rainfall or snowmelt are referred to as nonpoint source (NPS) pollution. NPS pollution is much more difficult to manage as both paved surfaces and manicured landscapes can increase contaminant levels.

As most of the impervious surfaces in Oklahoma City are used by automobiles, they are inherently dirty, covered in contaminants like oil, metals, grease, and sediment. The first five to eight minutes or first inch of rainfall is referred to as the "first flush," when the highest concentrations of contaminants are swept off our roads, parking lots, lawns, and rooftops directly into storm drains and deposited in local creeks, streams, or other waterbodies.

Runoff from landscaping and lawns can also degrade water quality when home or business owners apply excess fertilizers, herbicides, and pesticides. Bacteria and nutrients from livestock, pet waste, and faulty septic systems also contribute to NPS pollution.

As of 2016, 53% of the total area of Oklahoma City waterbodies was listed as impaired or threatened by at least one pollutant. The specific pollutants include high turbidity (a measure of total suspended solids or cloudiness of the water), dissolved oxygen, bacteria, oil and grease, nitrates, pathogens like enterococci and E. coli, selenium, mercury, chlorpyrifos, and chlorophyll-a.

A waterbody significantly impaired by a contaminant can trigger a time and resource intensive remediation planning process involving state and federal authorities. The Oklahoma Department of Environmental Quality (ODEQ) regulates point source discharges through review, permitting, licensing, and monitoring. If a waterbody is deemed threatened or impaired, ODEQ includes it in the state's list of impaired waterbodies, also referred to as the 303(d) list.

The 303(d) list is named for a section of the 1972 Clean Water Act which requires states identify waters that do not or are not expected to meet applicable Water Quality Standards with technology-based controls alone. States are required to establish a priority ranking for these waters, taking into account the pollution severity and designated uses of the waters. During this process, bodies designated Category Five are considered sufficiently impaired to warrant state development of a Total Maximum Daily Loads (TMDLs) which must document the nature of the water quality impairment, determine the maximum amount of a pollutant which can be discharged and still meet standards, and identify allowable loads from the contributing sources.

These TMDLs are calculations of the maximum amount of a pollutant allowed to enter a waterbody to meet water quality standards and are submitted to the EPA for approval and, if approved, state and local officials target reductions from point and nonpoint sources through an implementation plan.

Across Oklahoma, the most recent assessment based on 2016 data found 126 lakes and 550 rivers or streams were found to be classified as Category Five impaired: 520,967 acres of lakes and 8,747 miles of rivers and streams.

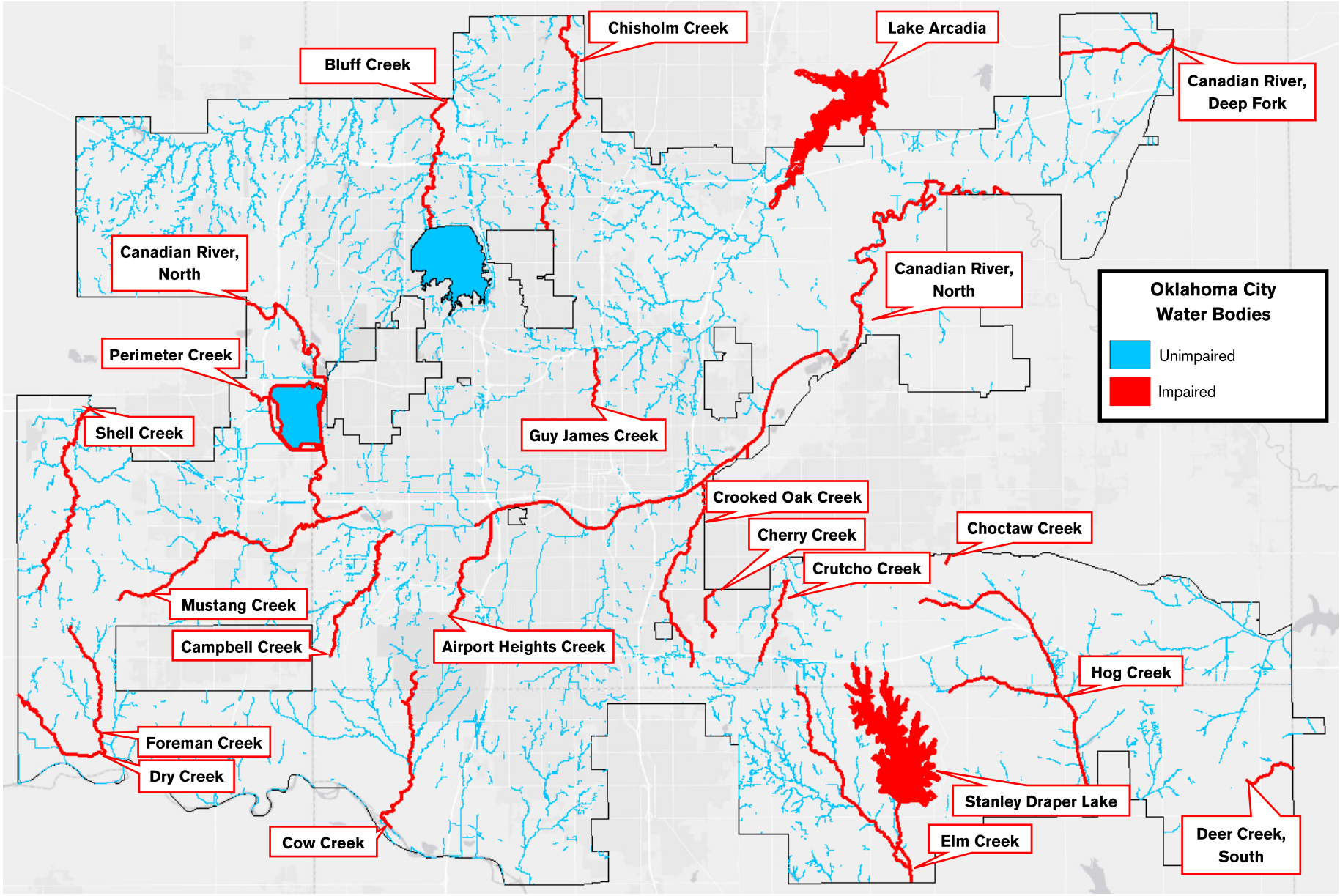
Impairment can lead communities to move towards higher stormwater utility costs to account for the greater capital needed to manage stormwater and this can include regulations on development within a watershed. Proactively seeking to limit stormwater runoff that contributes to impairment designation can be a strategic means of avoiding future costs that could hinder economic development or require greater fees.

Photo by Brent Fuchs, the Journal Record, 2016

ABOVE: LAKE STANLEY DRAPER WATER TREATMENT PLANT

Located in southeastern Oklahoma City, the Draper Plant has a water treatment capacity of 150 million gallons per day. Pollution from runoff can increase costs associated with treating drinking water.

Figure NB-2: EPA 303(d) Impaired Oklahoma City Bodies of Water, 2016



Source: U.S. EPA, Oklahoma Department of Environmental Quality

Urban Heat Island

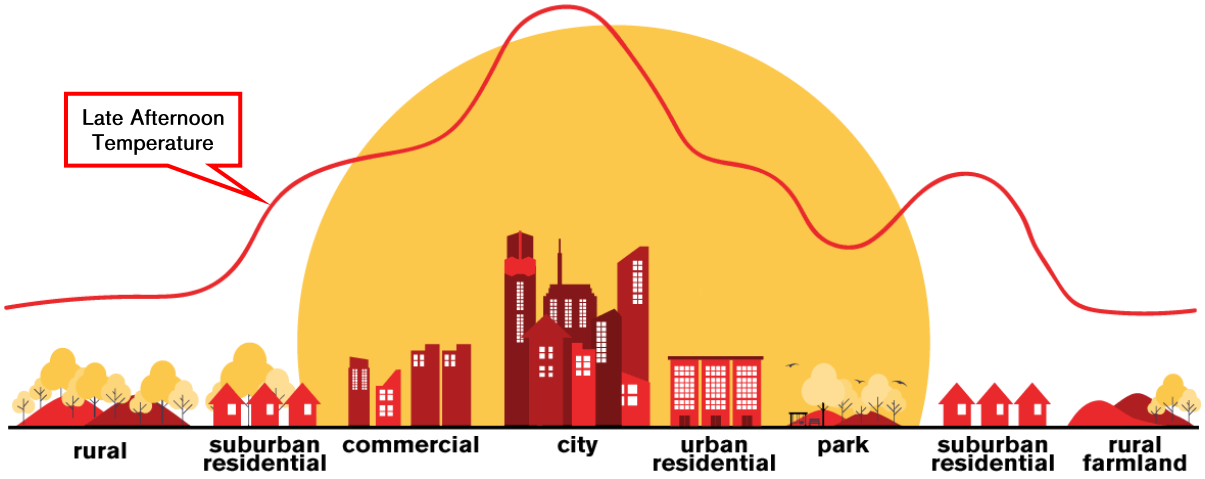
In addition to contributing to flash flooding and stream pollution, impervious surfaces such as streets, rooftops, and parking lots also absorb and store thermal energy as steel, stone, asphalt, and concrete reflect very little incoming solar radiation. These materials have very low albedo, or reflectance, and have a high heat storage capacity and are particularly common in densely-developed urban areas. This stored heat is retained in the material and gradually released, increasing ambient air temperatures and producing higher temperatures than those of less-dense, more vegetated rural areas (**Figure NB-3**).

This creates an urban heat island (UHI) effect where urbanized areas can store twice the heat of rural areas during the daytime, causing significantly higher temperatures, and creating "islands" of ambient heat over downtowns and suburban areas. A 2003 study comparing the UHI effect in Oklahoma City to Xi'an City, China concluded that population density, building density, and city size are important factors in UHI effect intensity. Additionally, less soil moisture and less vegetation cover over urban regions lead to surface warming since all absorbed solar radiation heats up the surface. Anthropogenic sources of heat such as energy consumption or vehicle exhaust contribute to the UHI effect as well.

A significant factor of the UHI effect is that it is not limited to daytime hours. Rather, materials radiate heat into the nighttime hours, ensuring that urbanized areas consistently sustain hotter temperatures. In Oklahoma City, there have been more frequent warm nights with five of the top 10 highest average minimum summer temperatures occurring in the last decade. Between 2004 and 2014, average summer overnight temperatures were more than 4°F hotter in cities than surrounding rural areas per a Climate Central research report.

There are multiple ways to capture and model the UHI effect. It is important we better understand Oklahoma City's UHI as we can deploy methods to combat its effects from an expanded urban tree canopy to requirements for high reflectivity on large urban and suburban roofs.

Figure NB-3: Urban Heat Island Effect



Increased daytime temperatures, reduced nighttime cooling, and higher air pollution levels associated with urban heat islands can affect human health by contributing to general discomfort, respiratory difficulties, heat cramps and exhaustion, non-fatal heat stroke, and heat-related mortality.

Health Impacts and Mortality. Extreme heat kills approximately 400 people each year and contributes to another 200 deaths in the U.S. The National Weather Service reports more deaths from heat in the past 30 years than any other type of weather including tornadoes, lightning, or floods.

The summer of 2011 was Oklahoma City's hottest summer on record with an average temperature of 87.5°F; the prolonged heat wave included a record of 43-consecutive days equal to or above 95°F as well as 21 non-consecutive days at or above 105°F. The Oklahoma Office of the Chief Medical Examiner identified 33 heat-related deaths in Oklahoma from May to September 2011 with the deceased ranging in age from 3 to 91 years and an average age of 52 years.

The UHI effect exacerbates respiratory sensitivities particularly for those with a higher risk of heat-related harm and death, including those over the age of 65, under the age of 4, in poverty, who are homeless, or who suffer from mental or physical disabilities. Additionally, the heat can increase air pollution as warmer ambient air temperatures during hot, windless days creates ideal conditions for the chemical reactions needed for the formation of ground-level ozone.

Formed when oxides of nitrogen (NOx) and volatile organic compounds (VOCs) chemically react in the presence of heat and sunlight, ground-level ozone is better known simply as smog. This is cause for concern given Oklahoma County's third-highest cause of death between 2011 and 2015 was bronchitis/emphysema/asthma, which the presence of ground-level ozone can exacerbate.

A 2014 report by Climate Central found a statistically significant correlation between higher daily summer temperatures and ground-level ozone concentrations in all 51 U.S. cities it studied. Urban areas are particularly susceptible to smog formation as there are typically higher concentrations of NOx and VOC emissions from personal vehicles and higher ambient air temperatures exacerbated by the UHI effect.

Photo by Paul Hellstern, The Oklahoman, 2012

LEFT: LINCOLN BOULEVARD HEAT DAMAGE

In July 2011, amid Oklahoma City's 28th day of 100-plus degree heat, the intersection of Lincoln Boulevard and NE 36th Street north of the Oklahoma State Capitol required repair after buckling. Lincoln Boulevard, a six-lane street, is more prone than streets of fewer lanes as the quantity of concrete increases the amount of thermal expansion.

Infrastructure. High temperatures, particularly long periods of extreme heat, can compromise the integrity of street, road, and highway pavements by softening asphalt and making it susceptible to rutting deformation. Concrete roads are also susceptible to buckling due to extreme heat as concrete panels absorb heat and expand, damaging the joints between panels and resulting in cracks.

Analysis conducted by the RAND Corporation in 2016 indicated Oklahoma is among the regions of the U.S. containing infrastructure projected to be disproportionately exposed to two or more weather hazards of higher intensity. While temperature impacts asphalt and concrete differently, climate factors such as precipitation, sunlight radiation, and freeze-thaw cycles affect the cost and efficiency of construction and maintenance as well as the useful life of the infrastructure itself.

As interstate highways have the most potential to be affected by drought, wildfire, and extreme temperatures, statewide cases of transportation infrastructure damage due to extreme heat are numerous.

Tree Canopy. Oklahoma City's tree canopy is a community asset that can help mitigate the urban heat island effect, reduce storm water drainage challenges, reduce heating and cooling costs, and improve air quality. Trees offer tremendous benefits for people and businesses in urban areas – shading hot parking lots and sidewalks, capturing storm water, capturing air pollution, and even providing a boost for business.

A human behavior study conducted by the University of Washington found shoppers were willing to pay 9% to 12% more for goods in tree-lined business districts than in shopping areas without trees.

The Oklahoma City Community Foundation (OCCF) and the Oklahoma Forestry Services (OFS) funded a tree inventory for the City of Oklahoma City Parks Department to translate into economic terms the environmental services provided by our trees and to support proactive tree care. The inventory project collected data from 19,632 trees that provide 310 acres of canopy cover in 134 City parks. The report calculated an estimated worth of $42.1 million, or $2,146 per tree, and provide more than $160,000 in air quality and storm water benefits annually. This project establishes baseline data to more efficiently plan for tree maintenance, plantings and replacements, and to protect tree canopy against potential threats like insects, disease, drought, ice and other severe weather.

In 2019, OCCF partnered with the Association of Central Oklahoma Governments (ACOG) and OFS to commission the Oklahoma City Metropolitan Area Tree Canopy Assessment over a 536-square-mile study area in the metro area. The assessment found nearly 65 million trees in the that are providing nearly $150 million in environmental benefits. The final report and accompanying geocoded maps illustrate how trees provide community-wide environmental, functional, and aesthetical benefits.

The data made available through these studies will shape our community's approach to air quality, extreme heat, and stormwater runoff planning, as well as inform optimal locations and tree types for future planting.

Flooding. Increases in heavy rainfall, flooding events, and population place greater emphasis on policy recommendations to reduce the amount of impervious surface required or allowed in development projects and determine what kind of water-conscious development options are possible. Oklahoma City has historically allowed development in the 100-year flood plain – the area with a 1% chance of flooding each year. Given projections of likelier inundation events in Oklahoma City, focusing resources on protecting assets in areas already prone to flooding will help avoid major losses and disruptions in the future.

Any development within a flood zone requires a permit. This includes, but is not limited to any and all new construction, filling, grading, and paving. Substantially damaged or improved structures, where the cost of repair or improvements equals or exceeds 50% of the building's market value, also requires building permits and elevation certificates, and are held to the same standards as new construction. Per FEMA, all new construction and substantially improved structures must be built at a minimum of one foot above the floodplain's base flood elevation. This standard provides added protection to structures but does not eliminate the flooding threat. Without these provisions, subsidized flood insurance through FEMA's National Flood Insurance Program would not be available to Oklahoma City property owners.

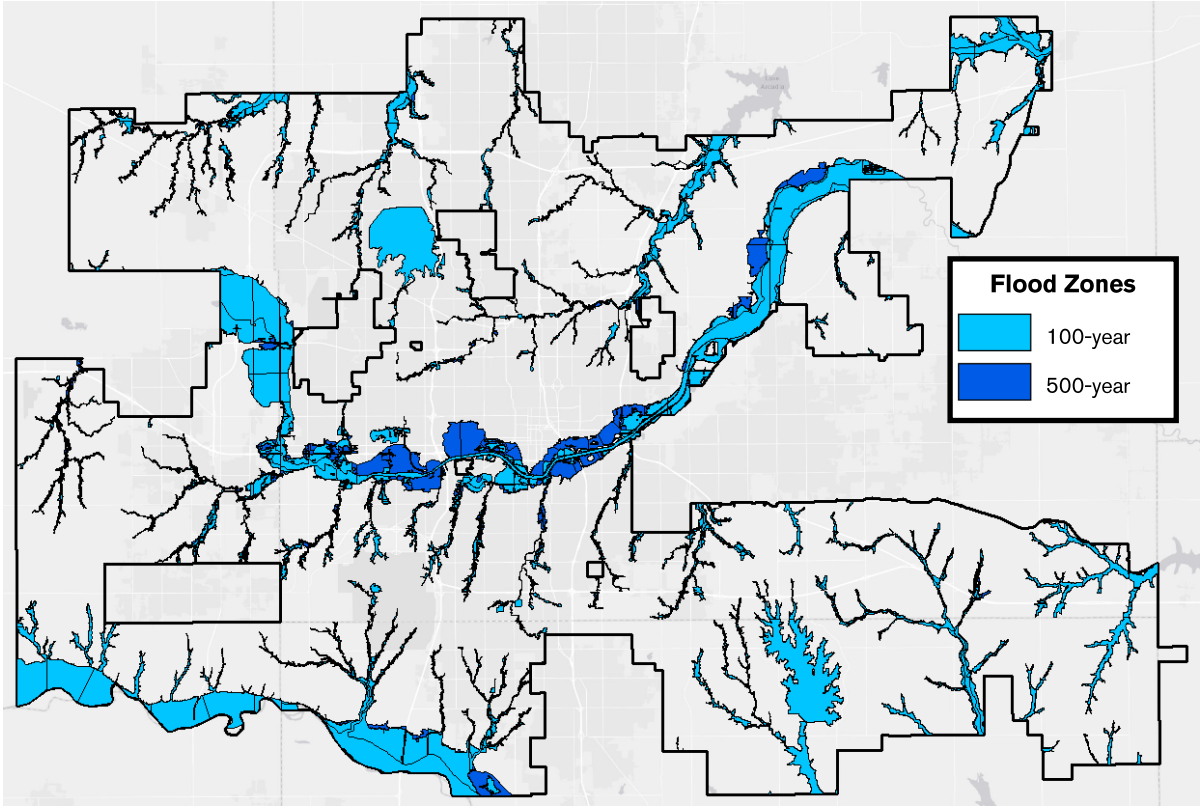
Currently, about 4,700 buildings are located within 100-year flood plains, occupied by more than 10,000 Oklahoma City residents. For perspective, a 500-year rainfall event in Oklahoma City would mean at least 5.2 inches of rain in the span of an hour, 12.5 inches of rain in 24 hours, 14.8 inches of rain in three days, or 15.5 inches of rain in seven days according to a report prepared by the U.S. Geological Survey. Oklahoma City residents have experienced several storms of that scale in recent history.

A 500-year storm event in June 2010 that brought more than 12" of rain in less than 24 hours damaged 209 structures in Oklahoma City and caused an estimated $5.5 million in damage in Oklahoma County. Three years later in May 2013, eleven people died in flood waters resulting from a heavy thunderstorm with tornadoes and large hail.

Flash flooding events also directly impact infrastructure even after the waters dissipate. Thirty days of rainfall in May and June of 2015, which included two 500-year flood events, resulted in Oklahoma City experiencing more than 24" of total precipitation, having a "significant impact on Oklahoma City roads." *The Oklahoman* reported rainfall on Saturday, May 23rd alone "caused evacuations, damage and severe flooding" that produced impassable intersections, multiple road closures, and even sinkholes.

Retrofits of and expansions to our existing drainage system are costly but no doubt necessary. Traditional storm water controls have focused almost exclusively on reducing pollution without addressing the increased volume of storm water discharged from urbanized areas. The benefits gained from removing pollutants are often overshadowed by the magnitude of the runoff volume. Even with storm water controls and high rates of pollutant removal, without volume reductions urban areas will contribute more pollution than pre-development conditions - thereby making it difficult to achieve important federal water quality standards.

Figure NB-4: Oklahoma City Flood Zones



ABOVE: Map of Oklahoma City's 100-year and 500-year flood zones. Approximately 111 square miles (18%) of Oklahoma City's land area is in a flood zone.

Low-Impact Development

Low-impact development (LID) is an approach to development that includes holistic site design utilizing green infrastructure treatments to divert storm water into natural areas on a site rather than directly into streets and storm drains. This approach allows design flexibility and can incorporate a variety of practices that ultimately prioritize rain water retention and groundwater recharge over runoff into storm drains or ditches which can cause or worsen urban flooding and pollution transmission.

Green infrastructure (GI) is an umbrella term for networks of natural ecosystem and greenway corridors as well as engineered-as-natural storm water management elements designed to blur the contrast between the natural and built environment. Incorporating both natural and engineered solutions, GI elements in storm water management seek to mimic the natural water cycle that protects and restores a variety of habitats. Green roofs, porous pavement, swales and rain gardens are examples of GI that are also LID practices; these treatments largely rely on using soil and vegetation to infiltrate, evapotranspirate, and/or capture storm water runoff and reduce flows to drainage collection systems.

By emphasizing infiltration, LID techniques allow rainwater to filter through soil before being slowly released to streams. This natural, but deliberate storm water management can help prevent negative impacts of flash flooding events, such as dispersing too much sediment into local creeks and stream habitats, road damage or closures, and/or loss of private property.

Incorporating LID features can increase property values and provide an opportunity to add an aesthetic local context to a community. What could have been a series of pipes, outfalls, concrete channels, and fenced basins plunging rainwater downstream is instead a thoughtfully-designed landscape of native plants and pollinator habitats holding and actively filtering storm water.

In Norman, the Trailwoods neighborhood was developed with an intent to study the effect LID treatments like green infrastructure can have on pollutant concentrations in storm water runoff that would ultimately end up in Lake Thunderbird. The neighborhood was designed with 17 homes that featured conventional "curb-and-gutter" storm water management practices and 17 homes designed with a variety of best management practices (BMPs) like porous concrete, rain gardens, rain barrels, and downspouts that divert and capture rainwater.

The EPA awarded a $500,000 monitoring grant to the University of Oklahoma and the results of the study highlighted a noticeable difference between the development approaches. The LID half of the development saw a nitrogen reduction of 30%, suspended sediment reduction of 32%, and a 152% reduction in phosphorous compared to the conventional side.

Example LID Projects

Blake-Service Soccer Complex
Edmond, Oklahoma

The City of Edmond installed a $38,000, 200-foot long rain garden to capture runoff from the complex's parking lot to filter stormwater before it is discharged into nearby Arcadia Lake.

Guthrie Green
Tulsa, Oklahoma

The 2.2 acre downtown green space, a remediated brownfield, includes bioswales to collect surface runoff and rooftop runoff and remove silt and small trash before it reaches the City's stormwater system.

Greening America's Communities

In 2016, Oklahoma City was awarded a technical assistance award from U.S. EPA under the Greening America's Communities Program to address flooding and connectivity issues for five key locations including the Paseo Arts District, Central Park, Jefferson Park, and Edgemere Park neighborhoods. City staff wanted design concepts that would capitalize on opportunities to integrate green storm water management with street and public space improvements that would support better environmental conditions downstream. EPA brought together a team of federal agency staff and design professionals to help the City create community-supported design solutions for each key area.

Engaging with neighbors and business owners from the project area offered the opportunity for the design team to learn the detailed history of flash flooding events and how residents' perception of and interaction with Guy James Creek has changed over time. Many residents expressed a desire for the design concepts to enhance quality of life, but in a way that preserves both historic character and natural spaces.

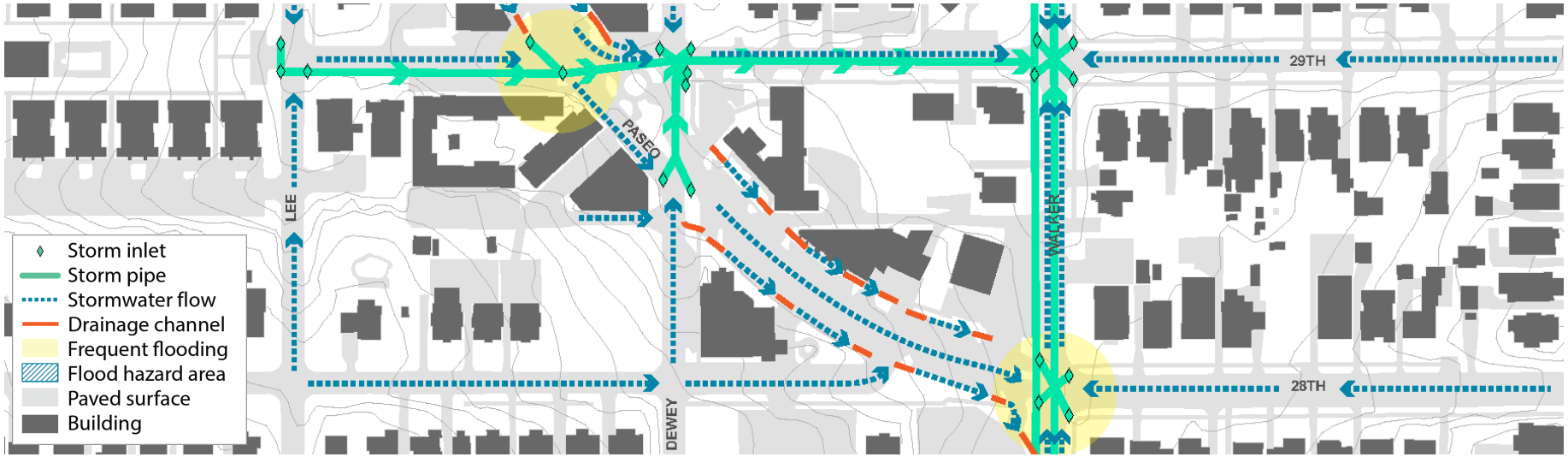
The resulting report provided community-driven concepts to the City that can serve as a starting point for potential future projects. The concepts incorporate a variety of green infrastructure tools to address storm water runoff with public amenities that improve connectivity and reduce pedestrian-cyclist conflicts with automobile traffic.

On Sept. 12, 2017, Oklahoma City voters approved 13 bond propositions and two sales tax initiatives known as the Better Streets, Safer City projects. Paseo Drive and Walker Avenue were included in the $240 million list of projects for new streetscapes which could include LID elements.

LEFT: EDGEMERE PARK

Edgemere Park Historic District, one of the first planned communities west of the Mississippi River, is characterized by mid-sized to large, well -maintained homes looking out toward Edgemere Park and Guy James Creek, a tributary of the Deep Fork River. Stream banks are highly eroded in some areas and the stream is deeply incised, creating steep drops from the surrounding park lawn.

The design concept for Guy James Creek, pictured left, increases the size of the creek to hold more storm water, and stabilizes the banks with plantings to reduce erosion; two outfalls shown in this illustration control water flow and a path connects visitors to the creek edge.



ABOVE: CONCEPTUAL PASEO DRIVE/NW 28th STREET AND WALKER AVENUE INTERSECTION ILLUSTRATIONS

The Greening America's Communities report identifies this wide intersection (above, left) as an important entry into the Paseo District, but notes frequent floods and north-south vehicles speeding on Walker Avenue. The intersection lacks pedestrian crossings, and the sidewalks are in disrepair. A proposed recessed roundabout (above, right) slows vehicles moving through the intersection and captures storm water during rain events. New sidewalks and street markings improve pedestrian safety, dedicated bike lane address cyclist safety, and planted bump-outs collect and infiltrate additional street runoff. The map (above, center) charts drainage infrastructure, topography, and areas of flooding from an aerial perspective.

Food Access

Across the country, the role of local government in the availability of and access to fresh, healthy food continues to gain prominence. One of the many factors contributing to this increased prominence is the importance of food to public health, especially as the adult obesity rate in the U.S. population exceeds 35%. Oklahoma is one of six states where 35% or more of the population is considered obese. The Oklahoma City metro saw a 20% increase in adult obesity between 2011 and 2017 according to the Center for Disease Control's Behavior Risk Factor Surveillance System.

Food access is just one determinant of health, however, as it also intersects with broader factors of both public and private influence, from land use and transportation to affordability and income. Access to and availability of healthy food is rooted in historical factors. Suburbanization, propped up by federal housing policies after World War II, caused significant population shifts from urban centers to sprawling new neighborhoods on the periphery - with grocery stores and supermarkets relocating accordingly. Today, revitalized urban centers are again hubs of population and commerce but struggle to attract those displaced supermarkets and grocery stores due in part to the cost and complexity of infill development in dense, historic downtowns.

Data from the Food Marketing Institute indicates grocery stores and supermarkets are trending smaller with a median square footage of 41,300 in 2016, down 15% from a peak of 48,750 square feet in 2006. While this gradual shift signals a broader move towards more dense grocery store and supermarket development, it also signals greater risk as the average supermarket in 2017 carried greater than 30,000 items. Research published in the *International Journal of Environmental Research and Public Health* that assessed grocery stores and supermarkets in Minnesota concluded "that smaller food stores have higher prices for most staple foods compared to their closest supermarket, regardless of proximity." Reductions in store square footage reduce inventory and can drive prices up, thereby contributing to low food access by limiting consumer buying power, particularly in low-income areas where access and/or inventory might already be constrained.

Retail food expenditures are the third largest U.S . consumer spending category at 12.6%, behind only housing and transportation. The U.S. Department of Agriculture's (USDA) most recent food expenditure data found in 2017 Americans spent an estimated $746 billion on food to be prepared and/or consumed at home. Almost 60% of this expenditure occurred at grocery stores followed by 22% at warehouse clubs and supercenters. Locally, food expenditures in FY19 generated an estimated $101 million in sales tax revenue for the City, with about $62 million of that generated from restaurants and about $22 million from supermarkets, grocery stores, and specialty food stores, followed by about $10 million from sales in gas stations and convenience stores. Total food expenditures for FY19 comprised approximately 22% of Oklahoma City's overall sales tax revenue.

Food Deserts. Census tracts where residents have limited access to affordable and nutritious food - usually understood to be fresh fruits, vegetables, and meats - are often described as food deserts. More specifically, the Food, Conservation, and Energy Act of 2008 defined food deserts as "an area in the United States with limited access to affordable and nutritious food, particularly such an area composed of predominantly lower-income neighborhoods and communities."

These areas are determined principally on proximity of households to supermarkets or grocery stores with additional variables of socioeconomic composition, vehicle ownership, and distance based on urban or rural development intensity. While USDA offers more than one food desert definition based on distance, the preferred approach to Oklahoma City food deserts identifies low-income census tracts where more than 100 housing units do not have a vehicle and are more than ½ mile from the nearest supermarket in an urban area. Inclusion of the vehicle ownership metric better reflects Oklahoma City's sprawl and development pattern.

The initial 2010 data found 27 Oklahoma City tracts were food deserts, representing a population of 92,633. By 2015, the number of food desert tracts increased to 31, affecting an estimated population of 98,591. Consistent with the body of literature on food access, in both 2010 and 2015 the residents of food desert tracts in Oklahoma City are overwhelmingly non-white - 52% and 56%, respectively. More specifically, the black and Native American populations in food desert tracts increased in those five years at a rate of about 21% and 17%. Those rates are even more highly disproportionate considering that from 2010 to 2015, the Black and Native American populations citywide increased just 7% and 3%. Research has consistently demonstrated how food deserts impact the health outcomes of low-income communities and have significant impact on communities of color. Between 2013 and 2017, the Kaiser Family Foundation analysis of the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System survey found that Black (74.7%), Hispanic (73.7%) and American Indian/ Alaska Native (77.3%) residents in Oklahoma have higher adult overweight and obesity rates than white residents (69.6%).

Food Swamps. An alternative but complementary perspective on food access emerged from 2009 research in post-Katrina New Orleans. The food desert concept stems from a perspective of undernutrition, as lack of access inhibits availability of fresh and healthy foods. The inverse is the "food swamp," as the researchers found areas of New Orleans where access to healthy foods was overwhelmed or "swamped out" by plentiful fast food restaurants and convenience stores.

Citywide parcel data from 2018 illustrates that of Oklahoma City's 290,318 residential units, greater than half (about 54%) are within a half-mile of a fast food restaurant alone. With at least 356 fast food restaurant parcels identified, that means each has an average of 443 residential units within a half-mile. Alternatively, only about 30% of residential units citywide are within a half-mile of a grocery store or supermarket. With such a saturation, determining what and how public policy could contend with consumer choices is daunting, even as Oklahoma City health outcomes grow increasingly poor.

Urban Agriculture. Another option to support access to healthy foods is to allow and encourage residents to grow, distribute, and sell their own, especially where public resources can be used to enhance self-sufficiency. A significant step to this end was taken by Oklahoma City in December 2013 with the adoption of the urban agriculture ordinance. This ordinance introduced to Oklahoma City's code legal definitions for aquaponics, hydroponics, and compost, and created new use units that enabled broader implementation of agriculture practices in urban settings including rainwater harvesting, roof gardens, urban farms, and community gardens. Perhaps most importantly, it codified the ability for residents to grow and maintain home gardens on the front, rear, and side yards of their property.

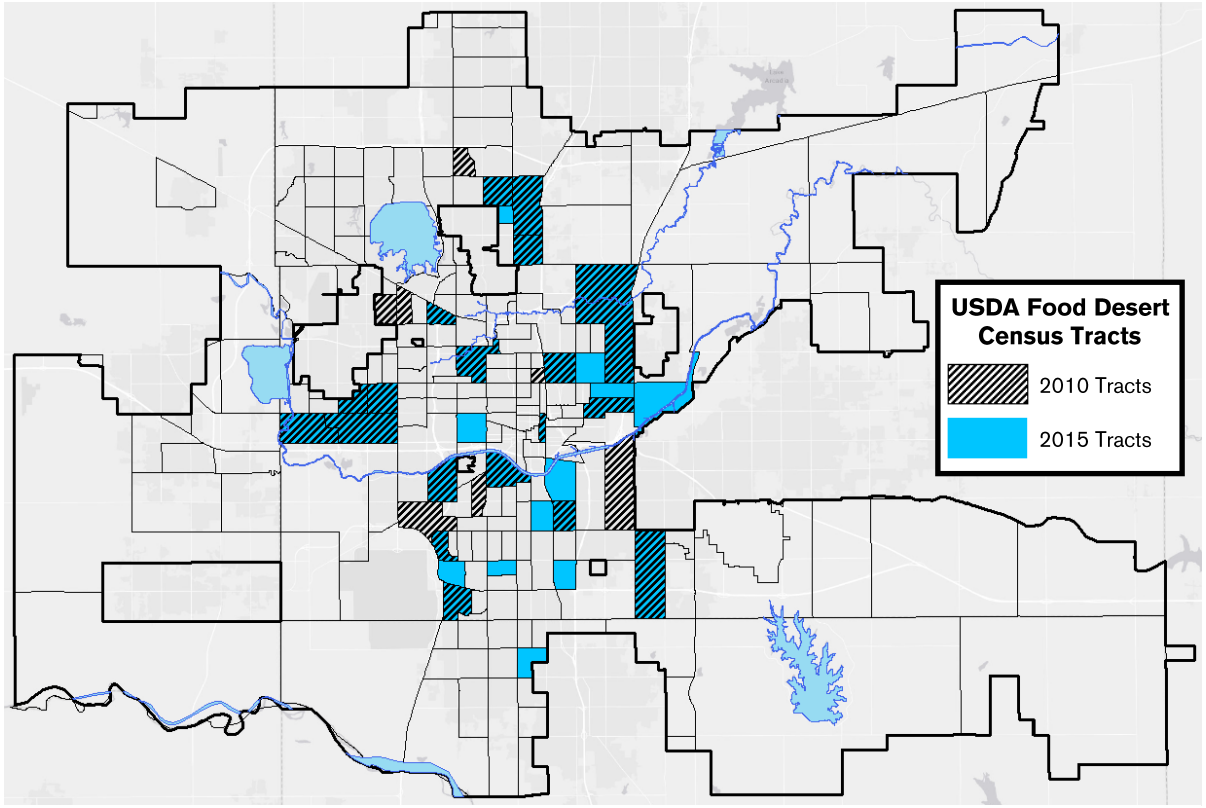
Sales of homegrown produce at or from a farm are exempt from sales tax per state law, but these sales are not permitted in residential areas by the ordinance. While the ordinance simply addressed what residents could or could not do on their property, urban agriculture program models elsewhere have leveraged public property to increase communitywide benefit and improve access to land, water, and tools necessary for vegetable growth.

In 2012, the City of Lawrence, Kansas launched a program called Common Ground which makes underutilized public property available to organizations for food production. These organizations must apply through the City of Lawrence and, if approved, become licensees who must follow policies and procedures that provide for safe and responsible use, similar to Oklahoma City's approach to maintenance agreements for medians with neighborhoods and private businesses.

At the close of 2018, the Common Ground program had nine program sites with 116 plots and four cooperative areas managed by 272 gardeners and volunteers, all of which resulted in more than 1,500 lbs. of produce donated in addition to two sites open to anyone in the community for harvest. Not only does this create space for community involvement, often set within pocket parks located inside neighborhoods, but it can reduce maintenance costs by using unoccupied space that might otherwise require mowing or the application of herbicide and pesticide.

There can be an economic component, too, to urban agriculture as locally-grown produce can be seen at any of the farmer's markets across the metro. Yet expanded opportunities for urban agriculture are still an interim step towards greater food access. More research and study is needed to determine what specific policy tools, from economic development to food cooperatives, could best work towards not only increasing food options, but also contributing to a healthier lifestyle that includes physical activity, a built environment conducive to aging-in-place, and fewer financial barriers. Many cities across the U.S. are struggling with how to resolve issues of food access but much of the results thus far indicate there is no panacea. Rather, there is a need for a holistic approach that more directly addresses root causes of food access and poverty.

Figure NB-5: Oklahoma City Food Desert Census Tracts, 2010 and 2015



Source: U.S. Department of Agriculture

Between 2010 and 2015, the number of food desert tracts increased by about 15% from 27 to 31 as well as the percentage of non-white residents in those areas (52% in 2010 to 56% in 2015).

Our Plan

For a modern city to remain globally competitive, it is critical to expand existing industries, attract new businesses, and accommodate more residents. Oklahoma City can distinguish itself by developing in a sustainable, efficient way as it grows that does not leave even greater challenges for future generations. Visitors and residents alike recognize the need to ensure local waterbodies are protected from contamination and vulnerable populations can find relief from the financial and physical effects of extreme heat.

Our plan seeks to ensure Oklahoma City realizes the benefits of the efficient growth pattern advanced by planokc, while encouraging proactive solutions to maintain a complimentary relationship between the natural and built environments. This complimentary relationship will strengthen the economy and sustain residents' high quality of life for many generations. Inaction addressing current and future vulnerabilities will affect our ability to deliver on existing commitments and lead to higher costs in the future.

By increasing tree and vegetation cover, making roofs and hardscapes cooler, and implementing the development and conservation strategies outlined in planokc, we can limit the negative impacts of urbanization on public health, local watersheds, and sustainable economic growth. Today's action (or inaction) will shape tomorrow's economic, social, and environmental vulnerabilities.

Our Goals

WATER QUALITY

1. **Protect water quality.**

FLOODING

2. **Prevent damage caused by flooding.**

URBAN HEAT ISLAND

3. **Mitigate effects of extreme heat.**

FOOD ACCESS

4. **Ensure residents have access to healthy food.**

Our Initiatives

	Natural & Built Environment Initiatives	Goals 1	2	3	4
1.	Use and promote low-impact development in City projects.	■		■	
2.	Codify low-impact development policies and promote best practices for private development.	■		■	
3.	Mitigate flooding vulnerabilities.		■		
4.	Mitigate areas of high heat exposure.			■	
5.	Support small-scale food production on vacant public land or underutilized park space.				■

"It should be indicated that urban development and environmental protection are not incompatible. With appropriate environmental criteria entering the land use management/ comprehensive planning process, there can be adequate quantities and rates of urban development as well as the preservation and protection of the natural environment."

- An Overview of the Natural Environment of Oklahoma City: Its Capacities and Limitations, 1976

INITIATIVE 1

STRATEGICALLY USE LOW-IMPACT DEVELOPMENT (LID) IN CITY PROJECTS

Develop a low-impact development implementation strategy for City projects. City-funded public projects are the most immediate opportunity to lead by example on LID. Be it through general obligation bond funds, an iteration of MAPS, or federally fund-supported programs and projects, the City can nurture and grow expertise in LID internally plus familiarize local and region architectural, engineering, and construction firms with LID practices.

POLICIES

NB-1: Provide LID training for City staff involved in design, review, inspection, and maintenance of LID systems.

NB-2: Initiate a multi-departmental process to develop an LID implementation strategy.

NB-3: Incorporate LID techniques developed in NB-2 in City projects and new facilities.

NB-4: Promote LID features at City facilities with signage and online map.

INITIATIVE 2

CODIFY LID POLICIES AND PROMOTE BEST PRACTICES FOR PRIVATE DEVELOPMENT

Establish design criteria for low-impact development techniques. While engineering standards and guidance are important, LID practices must be allowed to achieve drainage standards for development. The City should set standards for design and maintenance and encourage the use of LID by incorporating LID best practices.

Developers and property owners need clarity from the City to successfully implement LID practices. The City, too, needs to articulate standards to ensure, at minimum, LID is done correctly so as to ensure it functions successfully over time. This clarity must come in the form of formal policies such as new or updated ordinances as well as informal guidance to provide the greatest range of opportunity for those in the private sector to incorporate LID practices into their properties.

Create a low-impact development manual for architects, engineers, and developers. The Drainage Criteria Manual refers to a LID manual to guide landscape designers but one does not presently exist. Creating a LID manual would help remove perceived barriers to implementation of these practices.

Enhance the City's landscape ordinance. Developers and property owners are already bound to landscape requirements per the City's landscaping and screening regulations. The present landscape ordinance is a point-based system to afford flexibility to developers and property owners through a menu of options. Given the ordinance's purpose to "promote the enhancement of Oklahoma City's urban forest," expanding the ordinance's foundation and scope would be a strategic means both of improving development and mitigating heat.

Promote water quality programs, resources, and policies. The City's Storm Water Quality (SWQ) division of the Public Works department provides education and outreach about storm water quality and actively promotes programs like Curbs to Creek and concepts like LID. The Office of Sustainability can partner with SWQ to help boost the reach of water quality education.

Develop watershed master plans. LID practices often function to reduce runoff from localized impervious surfaces. Research has found LID planning on the scale of a watershed can identify high impact locations for LID intervention and, in doing so, inform cost-effective planning decisions for LID siting. A watershed-based planning approach could also help the City maximize use of public land such as parks, right-of-way, and City buildings to achieve water quality benefits.

POLICIES

NB-5: Create a low-impact development guide/manual for architects, engineers, developers, landscape architects, and planners.

NB-6: Increase promotion of water quality resources and programs, like Blue Thumb, on the City's website.

NB-7: Review and update list of nuisance vegetation and invasive species in municipal code.

NB-8: Inventory use of herbicides and pesticides in parks and other public properties, develop strategy, and establish targets to reduce use.

NB-9: Conduct ecological assessments and develop long-term management plans for watersheds.

Growth is inevitable and desirable, but destruction of community character is not. The question is not whether your part of the world is going to change. The question is how.

- Edward T. McMahon

INITIATIVE 3

MITIGATE FLOODING VULNERABILITIES

Collaborate to improve our Community Rating System (CRS) score. Under the National Flood Insurance Program's (NFIP's) CRS, flood insurance premium rates are discounted to reward community actions that reduce flood damage to insurable property, support the insurance aspects of the NFIP, and encourage a comprehensive approach to floodplain management. With approximately 112 sq. mi. of Oklahoma City (~18% of the city's area) designated as a floodplain or floodway, staff should collaborate between 5-year certifications to improve the city's CRS rating to increase affordability of flood insurance for residents.

Survey properties in vulnerable areas including flood plains. Identifying and receiving proper reimbursement for historic properties after severe weather events is challenging and sometimes impossible. Properties endangered by severe weather and flooding should be surveyed and documented prior to disaster events to better preserve our history and streamline the FEMA reimbursement process.

Discourage alterations to the 100-year flood plain. Alterations to flood plains can have negative effects on downstream, neighboring properties that can cause unexpected flooding. Enhancing requirements for developing in the 100-year flood plain – the area with a 1% chance of major flooding every year – will prevent loss of life and property and reduce the cost of recovery. FEMA's National Flood Insurance Program uses insurance discounts to incentivize specific flood plain management activities, such as preserving open space, discouraging development in certain areas, establishing clustering or setback rules, or encouraging green infrastructure or LID techniques in new development. Oklahoma City can pursue deeper insurance discounts for property owners by using projections rather than only historical data to inform regulatory maps.

Encourage resilient building practices in the 500 -year flood plain. Over time, flood risk shifts and changes, in part due to development, and maps are updated to reflect areas of high risk. As demonstrated by the three 500-year flood events Oklahoma City experienced over the course of five years, what was once a 100-year floodplain may turn into a 25-year floodplain due to increased frequency of inundating rainfall events or changes to nearby topography due to development.

Encouraging developers and property owners to plan for the life of the development will protect investments and prevent costly major losses from future catastrophic events.

POLICIES

NB-10: Work with Historic Preservation Office to map historic properties in areas vulnerable to flooding.

NB-11: Discourage alterations to the flood plain with 1% annual chance of flooding (100-year).

NB-12: Conduct historical flood damage assessment and inventory of properties in flood plains.

NB-13: Update municipal code to increase elevation requirements for new construction and substantially-improved structures in the 500-year floodplain.

INITIATIVE 4

MITIGATE AREAS OF HIGH HEAT EXPOSURE

Assess current tree canopy and set a coverage target. Tree inventories can be conducted in detail on the ground or at a high-level using aerial images and analysis software. Understanding first where the City's vegetative coverage gaps are, in addition to demographic data, will help prioritize mitigation activities to the most vulnerable areas.

Develop methods to measure, monitor, and report local urban heat island conditions. To develop the best efficacious and efficient mitigation policies, consistent and reliable data is a necessity.

ABOVE: KITCHEN LAKE

Part of the city's "Close to Home" fishing waters program, Kitchen Lake is a 33-acre lake stocked with largemouth bass, crappie, and three types of sunfish. Reducing pollution from stormwater runoff helps maintain healthy waters to benefit both aquatic life and casual anglers.

In the same way the quality of our water and air is monitored, we need a similar quantitative approach to our own urban heat island to understand and counteract its impacts.

Urban heat islands are multivariate and many factors, including seasonality, water usage, time of day, and climate influence their impacts. A robust incorporation of standard monitoring methodology should be the first step into integrating urban heat island effects into City decisions and, ultimately, policies.

Eliminate minimum parking requirements. Oklahoma City mandates the amount of surface parking required for new developments. This translates to added costs to developers, a reduction in developable land, and increased impervious surface that contributes to flooding and the urban heat island. The City should either default to parking maximums or, as has already been done with development in downtown, remove such requirements entirely and allow developers and their financiers to determine parking needs on a project-by-project basis.

Use highly reflective roofing materials when constructing new or replacing roofing on City facilities. Whether amidst a densely-developed area or surrounded by impervious surfaces, large roofs can be used to deter the intensity of urban heat islands. Whether new construction or retrofit, alternative roofs can reflect rather than absorb thermal radiation and thereby limit increases of ambient air temperature.

Such alternatives include light-colored, highly reflective materials or paint to boost albedo; vegetative or "living" roofs; planters to accommodate urban agriculture; or photovoltaic solar arrays.

Develop guidance for green roof installations. Green roofs provide both cooling and storm water benefits that will reduce pollution, electricity demand, and other effects of the urban heat island. Materials selection and proper installation is critical for a successful green roof. Standards and best management practices should be developed to maximize benefits, reduce maintenance costs, and streamline the review process.

Preserve trees and expand shade cover. Preserving mature trees is a vital step in realizing the ecological service and public health benefits now and in the future. Removing mature trees not only visibly alters the landscape, but can also drastically affect drainage and effects of the urban heat island. Activities on both public land should prohibit mature tree removal and private developments should be incentivized to preserve mature trees.

Vegetative cover and trees in particular will reduce the effects of the urban heat island and provide additional storm water and air quality benefits. Programs such as the Arbor Day Foundation's Energy-Saving Trees provide a platform for organizing tree-planting initiatives that assists property owners in siting prospective trees where they will block heat-gain from direct sunlight and maximize energy efficiency gains. Shade structures should be encouraged in areas where tree growth is not feasible.

POLICIES

NB-14: Determine methods to measure, monitor, and report local urban heat island conditions.

NB-15: Develop and adopt a tree preservation ordinance.

NB-16: Update municipal code to eliminate minimum parking requirement for new developments.

NB-17: Use highly reflective materials for new or replacement roofs on City facilities.

NB-18: Develop guidance for green roof installations in Oklahoma City.

NB-19: Develop a cooling plan for the Central Business District.

Photo by the Office of James Burnett

ABOVE: TREE-LINED STREETS

Expanding the urban canopy can not only provide temporary relief for pedestrians but help in maintaining a cooler ambient air temperature and absorb vehicular emissions as a sort of buffer between traffic and pedestrians.

INITIATIVE 5

SUPPORT SMALL-SCALE FOOD PRODUCTION ON VACANT PUBLIC LAND OR UNDERUTILIZED PARK SPACE

Develop a pilot leasing program for urban garden plots on public land. Several successful program examples exist in other cities that allow leasing of underutilized public space for the purpose of gardening. Program partner commitments, maintenance agreements, and routine renewal reviews can ensure the land is used for productive, community-building purposes.

POLICY

NB-20: Develop a pilot leasing program for urban garden plots on public land.

UPPER RIGHT: Swiss chard grows in Guilford Gardens urban farm in NW Oklahoma City. The gardens are an example of community-supported agriculture that connects producers directly with consumers.

RIGHT: Farmer's markets and community gardens represent a revived appetite for locally-grown food and fresh produce but also reflect gaps in Oklahoma City's dearth of grocery stores and supermarkets offering fresh fruits and vegetables.

Photo by Nate Billings, the Oklahoman, 2016

Photo by Paul Hellstern, the Oklahoman, 2013

chapter four

air quality

CHAPTER 4:
AIR QUALITY

Our Situation

The connection between land use and transportation is highly evident across Oklahoma City's 621 square miles. Our sprawl has a commensurate transportation system of approximately 4,930 miles of streets, roads, and highways, and Oklahoma City residents are estimated to drive about 36.7 miles daily. That ranks us fifth in the nation for daily vehicle miles traveled (VMT) per capita. In *Air Quality*, we focus on two byproducts of our automobile-oriented infrastructure: carbon dioxide (CO_2) and ground-level ozone.

In the past decade, Oklahoma City has made historic strides towards a more diverse transportation system: introduction of a downtown bike share; creation of a Regional Transit Authority; expansion of EMBARK night service and the addition of Sunday bus service; adoption of the city's first bicycle-pedestrian master plan, bikewalk**okc**; voter approval of the Better Streets, Safer City temporary sales tax; and a forthcoming bus rapid transit route along Classen and Northwest Expressway.

These advances are critical yet cars continue to dominate how we get around. Per five-year Census estimates, 82% of Oklahoma City commutes are single-occupant cars or trucks. By comparison, commutes made by walking, biking, or public transit represent a combined 2%. It is imperative the City continue to implement policies and design and build infrastructure to diversify Oklahoma City's modes of transportation, as greater use of so-called alternate modes of transportation is a key tactic to reduce emissions. Significant growth is projected for the region: between 2010 and 2040, the Oklahoma City metro is expected to increase 40% in population and 54% in vehicle miles traveled (VMT).

Our best approach to emissions reduction is two-fold: continue to enhance transit services and prioritize safe infrastructure for bicycle and pedestrian commutes; and accommodate remaining VMT through alternative fuels that generate few to no emissions. Those emissions - namely CO_2, and ground-level ozone precursors nitrous oxides (NOx) and volatile organic compounds (VOCs) - pose serious risks to the health, well-being, and economies of Oklahoma City.

Our primary sources of CO_2 emissions are personal vehicles, second only to electricity generation. The Supreme Court found in a 2007 case that the U.S. Environmental Protection Agency has the authority to regulate greenhouse gases including CO_2. While the likelihood of a federal mechanism to tax or assess a fee on CO_2 emissions appears high within the next ten to twenty years, it is CO_2 that is also a primary contributor to climate change. The concentration of CO_2 in the Earth's atmosphere is currently at the highest level in approximately three million years at 416 parts per million and the annual rate of CO_2 emissions is not only increasing in quantity but accelerating in growth. Between 1959 and 2018, the annual rate of global CO_2 emissions increased 204%, but nine of the ten years with the highest average CO_2 emissions have all occurred since 2000. Steps to reduce our CO_2 emissions now could not only help us avoid the brunt of a future regulatory update to the National Ambient Air Quality Standards (NAAQS) but help us reduce our contribution to climate change.

In 2002, the City was a signatory alongside the Association of Central Oklahoma Governments, the Oklahoma Department of Transportation, the Greater Oklahoma City Chamber of Commerce, the Oklahoma Department of Environmental Quality, and U.S. EPA Region 6 on the Early Action Compact (EAC). Submitted to U.S. EPA, the EAC was a memorandum of agreement among parties to develop and implement a plan to reduce emissions so as to avoid violation of federal air quality standards. City Council's federal legislative agenda currently includes monitoring, enforcement, and compliance of federal air quality standards, but the region is at immediate risk of violating those federal standards. Were the Oklahoma City metro to violate the ozone

standard, the subsequent requirements would reach into the daily lives of every resident, business, and institution across the region. Summer gas prices would increase as gas stations carry mandated reformulated gasoline to reduce vehicle emissions. Vehicle registration could see the addition of a Vehicle Inspection and Maintenance Program requirement that mandates emissions inspection and compliance to register or renew. Economic development would be hampered by more stringent requirements for facility construction and expansion.

One illustration of the relationship between CO_2 and ozone - and how that relationship has already affected us - occurred in April of 2018. Areas of Western Oklahoma were rated as in a condition of "exceptional drought," the highest category of drought per the National Oceanic and Atmospheric Administration's U.S. Drought Monitor; the addition of high winds and low humidity bore widespread wildfires with more acreage burnt statewide in April than all other months of the year combined. A single fire burning near the small town of Rhea consumed about the same square mileage as Oklahoma City which prompted mobilization of the Oklahoma National Guard. Those high winds ushered clouds of smoke and particulates hundreds of miles to Oklahoma City, degrading air quality and visibility.

Because of the accumulation of CO_2, conditions for more frequent and intense wildfires will increase as springs and summers grow drier and hotter. As these more frequent and intense fires burn, they emit pollutants - chiefly CO_2 but also ozone precursors - that accumulate in our atmosphere. This feedback loop - CO_2 accumulation causing more fires, and in turn causing more CO_2 accumulation - crystallizes how the content and quality of our air can impact us and our environment. And as for an effect on our economy, these fires warranted a FEMA major disaster declaration for five counties during a ten-day span and included more than $5.2 million in federal recovery funds.

The means and technology exist to help us improve the quality of our air and reduce wasteful and harmful emissions. Better we undertake these steps voluntarily than face a future of federal intervention that constrains our ability to perform and compete.

Smoke from a 120-acre wildfire 25 miles away blanketed downtown Oklahoma City the afternoon and evening of Friday, April 13, 2018.

Carbon Dioxide

When fossil fuels such as coal, petroleum, and natural gas are burnt, carbon dioxide (CO_2) emissions are a byproduct. While CO_2 is a common, naturally occurring gas, the amount of CO_2 within our atmosphere has increased drastically during modernity. As a greenhouse gas, CO_2 traps energy from the sun within our atmosphere and manifests as severe climatic instability worldwide. Some excess CO_2 can be absorbed by world oceans, but this reduces seawater pH which has widespread ecological impacts as reductions in pH mean increased acidity. While Oklahoma City is certainly no seaside municipality, the sheer scale of these changes would directly and indirectly affect us in multitudes. How we reduce our present contributions to atmospheric CO_2 as well as how we mitigate the impacts of present CO_2 levels are critical to long-term planning at every level.

Nationally, the CO_2 emissions of transportation surpass those of electricity generation. The latest Energy Information Administration (EIA) data for Oklahoma indicates the largest source of our CO_2 emissions is indeed transportation, mirroring national numbers. The most recent National Emissions Inventory (NEI) published by the EPA estimates Oklahoma's 2014 CO_2 transportation emissions as 31.2 million metric tons. 63% of those emissions – approximately 19.8 million metric tons – come from passenger cars and trucks. A forthcoming update to the NEI that reflects data gathered in 2017 should be available by the end of 2019 and provide a more current picture of Oklahoma City's CO_2 emissions.

The expanding use of wind and natural gas as electricity generation fuels continues to reduce the reliance on coal for electricity, in turn driving down CO_2 emissions in that sector from the 2008 peak of 51 million metric tons to 39.6 million metric tons in 2015. No such widespread fuel switch has occurred in the transportation sector, however, and when burned, a single gallon of gasoline produces approximately 20 pounds of CO_2. Our large land area is thus a contributing factor to our transportation and a major source of our CO_2 emissions.

Photo by Doug Hoke, the Oklahoman, 2011

Buildings near NW Expressway and N. May Avenue partially obscured by haze.

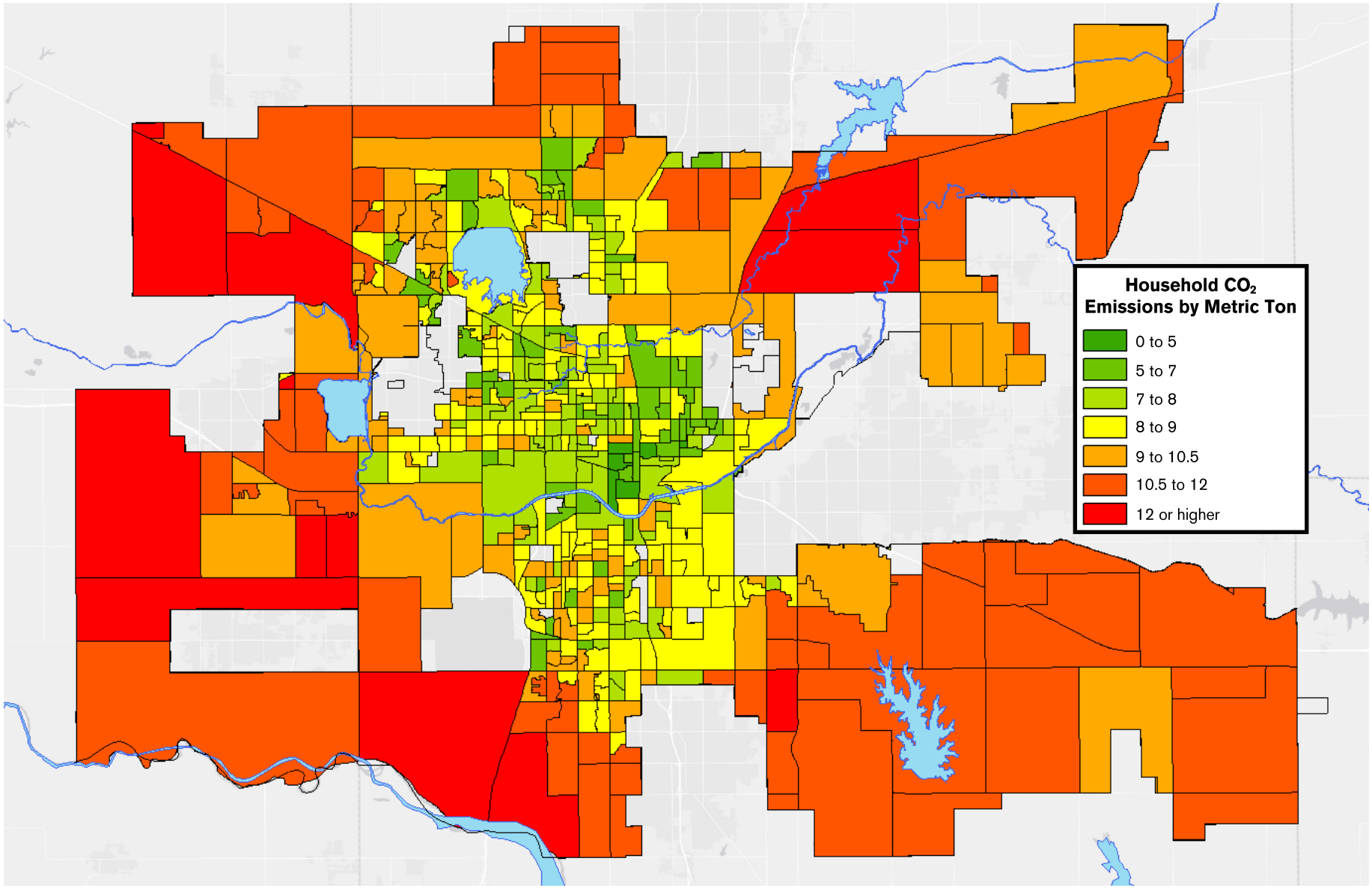
The EIA estimates CO_2 transportation emissions in Oklahoma have increased 52% from 1980 to 2016. The Oklahoma City region's estimated average CO_2 household contribution is 9.31 tons**.** Comparatively, this is a greater per household tonnage than the metros of Portland (8.20 tons), Denver (8.22 tons), Phoenix (8.27 tons), Pittsburgh (8.34 tons), Detroit (8.35 tons), Albuquerque (8.53 tons), Dallas-Fort Worth, (8.88 tons), Houston (8.96 tons), Omaha (8.98 tons), El Paso (9 tons), Madison (9 tons), Austin (9.03 tons), Jacksonville (9.03 tons), Kansas City (9.09 tons), Knoxville (9.23 tons), Des Moines (9.24 tons), Atlanta (9.28 tons), and many others.

Climate Change. CO_2 is currently at the highest atmospheric concentration ever in human history at approximately 416 parts per million. It is this atmospheric concentration that drives warmer conditions, glacial and ice melt, and ocean acidification. Often, the term "climate change" is seen as interchangeable with "weather." This is deeply inaccurate. A major difference between weather and climate is measure of time. Weather is what conditions of the atmosphere are over a short period, generally in a fixed location, whereas climate is how the atmosphere "behaves" over relatively long periods of time, often a minimum of 30 years.

Weather can change from minute-to-minute, hour-to-hour, day-to-day, and season-to-season. Climate, however, is the average of weather over time and space; its scope can span years, decades, or centuries. Anecdotes of a cold winter or mild summer are indicative of weather whereas climate is informed by long-term data about successive winters or summers.

Climate change is a global problem that has local consequences. Climate change projections downscaled to Oklahoma City compare the 30-year averages of 1981-2010 to those of 2021-2050 and 2051-2080. Those projections indicate a five degree Fahrenheit increase in Oklahoma City's annual

Figure AQ-1, Oklahoma City Annual CO_2 Emissions from Auto Use Per Household



Source: Center for Neighborhood Technology

Within Oklahoma City, the average annual amount of CO_2 emissions from transportation per household is estimated to be 8.78 metric tons. Block groups nearer to city center demonstrate a smaller per household emissions rate, anecdotally demonstrating the efficiency of dense development in emissions reduction and the role land use can play in diminishing emissions.

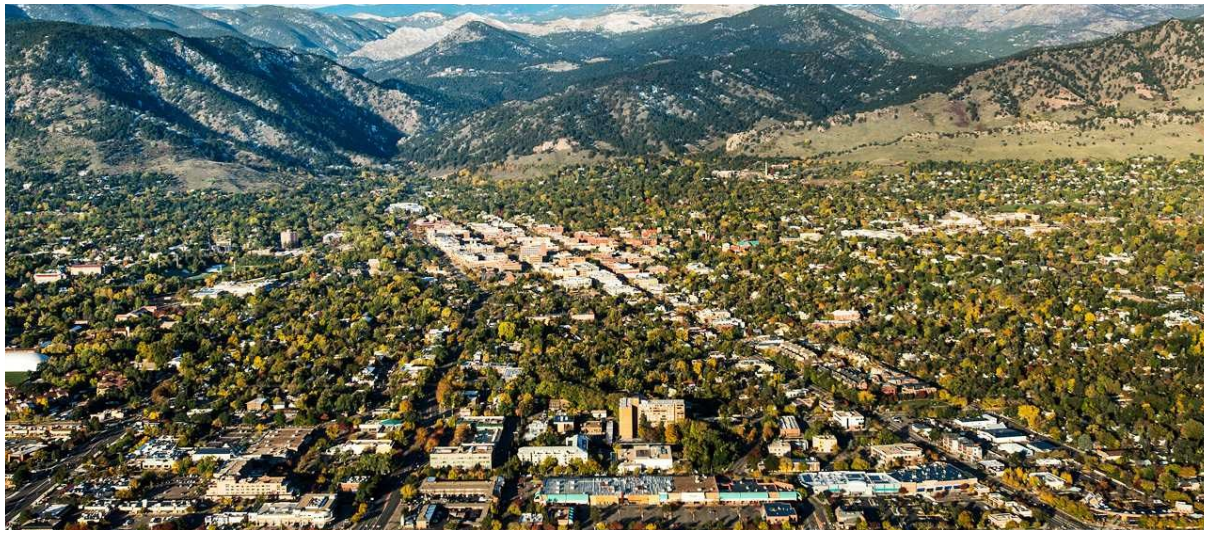
average temperature; significantly hotter, drier summers; warmer, wetter springs, falls, and winters; and fewer freeze-thaw cycles. The impacts of such changes would be sweeping and costly to residents, businesses, and the City itself, including heightened electricity demand, decreased agricultural yields, increased heat-related mortality, increased damage to all forms of infrastructure, increased smog, and even increased insurance deductibles for City-owned assets.

In Oklahoma City, the prospect of single-handedly halting the repercussions of climate change is impossible. Policies and initiatives on a much larger scale are needed to address the root causes of our changing climate. What we can and must do, however, is craft mitigation strategies to fortify our community and critical infrastructure from present day impacts and those yet to come.

Regulation and Taxation. A 2007 decision by the U.S. Supreme Court found the EPA has the authority under the Clean Air Act (CAA) to regulate greenhouse gases including CO_2. This allowed the EPA to include greenhouse gases in the two most recent iterations of the Corporate Average Fuel Economy (CAFE) standards for light-duty vehicles. These new standards, however, are part of a proposed rollback which could see CAFE standards frozen for vehicles produced between 2021 and 2026.

Despite uncertainty, future regulation, like the inclusion of CO_2 into the NAAQS or the creation of a national carbon tax, is worth consideration. A multitude of carbon tax proposals have emerged in recent years, from the cap-and-trade approach championed by former U.S. Secretary of State James Baker to the fee-and-dividend bill introduced in Congress in 2018. These efforts have been unsuccessful to date but a handful of U.S. cities and counties have structured their own carbon tax, including Boulder, Colorado (see inset) and Maryland's Montgomery County.

Many companies, including OG&E and ONG, use an internal price per metric ton of CO_2 equivalent as a tool in economic modeling and project forecasting. These valuations serve to demonstrate the monetization of carbon is neither improbable nor



Case Study: Boulder, Colorado Carbon Action Plan

The only functioning carbon tax in the U.S. is in Boulder, a city of just over 100,000 residents situated at the base of the Rocky Mountain foothills. In 2007, Boulder residents voted to levy a tax on residential, commercial, and industrial sector electricity customers to fund a Climate Action Plan (CAP). The City of Boulder works with the area's for-profit, investor-owned utility, Xcel Energy, to collect and remit CAP tax funds.

The CAP tax is the nation's first voter-approved tax dedicated to addressing climate change. The tax rate differs based on sector: $0.0022 per kWh for residential customers, $0.0004 per kWh for commercial customers, and $0.0002 per kWh for industrial customers. On average, these rates add $21 to residential customers, $94 dollars to commercial customers, and $9,600 to industrial customers. The CAP tax generates approximately $1.8 million each year.

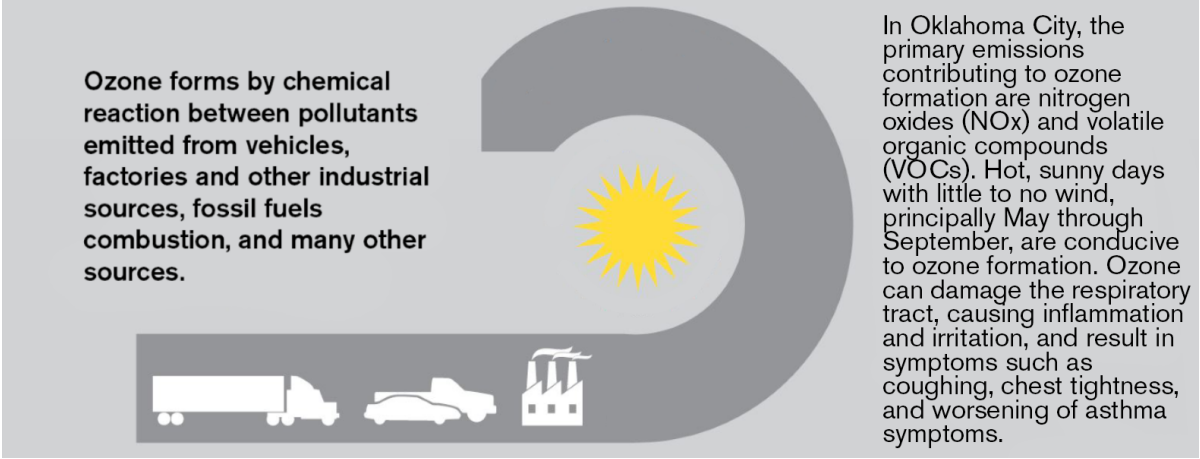
Funds generated by the CAP tax go exclusively towards programs intended to reduce greenhouse gas emissions. These programs have included a city-wide greenhouse gas inventory, significant energy efficiency programs specific to the commercial and residential sectors, renewable energy, water conservation, urban forestry, and alternate fuels and modes of transportation. The City of Boulder estimates CAP-funded programs helped to avoid more than 50,000 metric tons of emissions between 2007 and 2015, maintaining emissions rates as Boulder saw growth in population, jobs and economic activity.

In 2015, Boulder voters approved a continuation of the CAP tax through March 31, 2023.

distant. Hypothetically, carbon regulation or taxation would factor in real costs not presently captured in the market price; by making consumption costlier, consumption would be reduced. This would likely translate to higher prices for fossil fuel-generated electricity and heat as well as motor vehicle fuels.

What the future holds with regard to a national carbon tax is not clear. However, what is clear is that there is an associated price with carbon, albeit one that differs from organization to organization. For example, the City's Water Utilities Trust purchases CO_2 via contract at a cost of $100 per ton; this is a higher rate than used by many other companies including OG&E ($15 to $20 per ton), Devon Energy ($16 to $24 per ton), ConocoPhillips ($9 to $43 per ton), and General Motors ($5 to $20 per ton). Markets that trade in carbon via offsets have emerged in recent years and cities have begun capturing, packaging, and monetizing local CO_2 reductions. For example: the cities of Austin and Pittsburgh along with King County, Washington, and Clackamas County, Oregon, are all in varying stages of CO_2 credit projects for tree plantings and reforestation. Other forms of projects are eligible, however, including energy efficiency, renewable energy, and transportation/fleet efficiency. While no single authoritative body regulates carbon standards, there are required protocols and formulations to quantify and verify project offset amounts and payments. These protocols, and the IRS credit valuation of $35-50 per megaton can vary, especially based on the type of offset project.

The Oklahoma Carbon Sequestration Enhancement Act (§27A-3-4-101) authorized the Oklahoma Conservation Commission to establish and administer a carbon sequestration certification program. With this in mind, the City should explore opportunities to quantify, verify, and monetize carbon offsets as part of existing projects and programs. This can be especially effective by including prospective partners such as the Oklahoma City Community Foundation or local companies already engaged in carbon offsets like Chesapeake Energy and Devon Energy, who have generated a combined 547,428 credits via two projects through the American Carbon Registry.



Source: California Air Resources Board

Ozone

Within the stratosphere – the second major layer of the atmosphere between approximately 6 and 31 miles above Earth's surface – a shield of ozone absorbs 97% to 99% of incoming solar ultraviolet radiation. That shield, the ozone layer, is how most are familiar with the gaseous chemical ozone, particularly through efforts to reduce its depletion. However, ozone can form in the layer of the atmosphere closest to the planet's surface, the troposphere, where this ground-level ozone can go by a different but familiar name: smog.

As with any chemical reaction, the formation of ground-level ozone cannot occur without the proper ingredients and conditions. Those ingredients, or precursors, include nitrogen oxides (NOx) and volatile organic compounds (VOCs), typically byproducts produced from the burning of fossil fuels by industrial facilities and internal combustion engines. The required conditions, common in Oklahoma City throughout the spring and summer, are hot, sunny days with little to no wind. Stagnant air allows concentrations of NOx and VOCs to chemically react in sunlight and create ground-level ozone. In Oklahoma County, the greatest annual share of NOx comes from non-diesel passenger vehicles and diesel-powered heavy-duty vehicles – 7,024 tons and 6,527 tons respectively. Whereas oil and gas production is the largest NOx source statewide, it is only the sixth greatest source in Oklahoma County, where it also comprises just 1% of those statewide oil and gas NOx emissions. As for VOC emissions across the four metro counties, non-diesel passenger vehicles are within the top four emissions sources in each county: fourth in Canadian, second in Cleveland and Oklahoma, and third in Pottawatomie. Even with both statewide and county emissions reductions, passenger vehicles continue to be a primary source of ground-level ozone precursors.

As ground-level ozone is a pollutant with adverse effects on human health, it is subject to regulation by the EPA. Regulatory authority of air pollutants was vested in the EPA by the Clean Air Act (CAA), first passed by Congress in 1963 and subsequently strengthened in 1965, 1967, 1970, 1977, and 1990 by Congressional amendments. The 1970 amendments established the National Ambient Air Quality Standards (NAAQS), a series of regulatory limits on six types of air pollution – including ozone – periodically reviewed and revised by the EPA. If an area exceeds the pollution limit, the EPA could designate it as a nonattainment area. This formal designation entails considerable regulatory changes at the federal, state, and local levels.

The U.S. overall has shown improved air quality

RIGHT: OUHSC CAMPUS

In a nonattainment scenario, the University of Oklahoma Health Sciences Center (OUHSC) campus' 450,000-square foot, 144-bed patient tower would see construction complications and costly delays due to its potential to emit.

since 1990 based on the pollutants regulated by the EPA. While this is true too of the Oklahoma City metro, ozone has seen the smallest reduction of those pollutants at just 14%, compared to the national average reduction of 21%. Future revisions to the NAAQS that lower the allowable pollutant threshold further expose Oklahoma City and the metro to greater risk of a federal nonattainment designation, especially as average annual temperatures continue to increase. The consequences of such a federal designation would be significant, far-reaching, and long-lasting.

A study conducted for CAPCOG, the Central Texas metropolitan planning agency (MPO), found a nonattainment designation could cost the Austin metro between $24 and $41 billion total from 2018 to 2046. In 2011, the City of Wichita estimated a vehicle inspection and maintenance program required with a nonattainment designation would cost more than $13.7 million annually. The MPO for the San Antonio metro area estimated costs could range from $3.2 billion to $36.2 billion based on the severity of the designation and ensuing time frame. Locally, ACOG, with support from nine organizations including the City of Oklahoma City, used federal transportation funding to release a Cost of Nonattainment Analysis Scoping Report for the Central Oklahoma area in February 2020 to better understand the regulatory risks of a nonattainment designation. However significant the economic losses, however, the purpose of nonattainment designation is to safeguard the health of the public.

For the sake of our residents' well-being, our regional prosperity, and our city's economic growth, proactive efforts to reduce ground-level ozone and its precursors is, while no small feat, an absolute necessity for the City and the region.

Economic Expansion. Businesses seeking to construct, modify, or expand a major plant or facility could face costly restrictions under a nonattainment designation, thereby reducing Oklahoma City's competitiveness and the efficacy of economic development programs. The increased costs, delays, and uncertainties would not only discourage investment in Oklahoma City but also could erode the economy of the entire Oklahoma City metro.

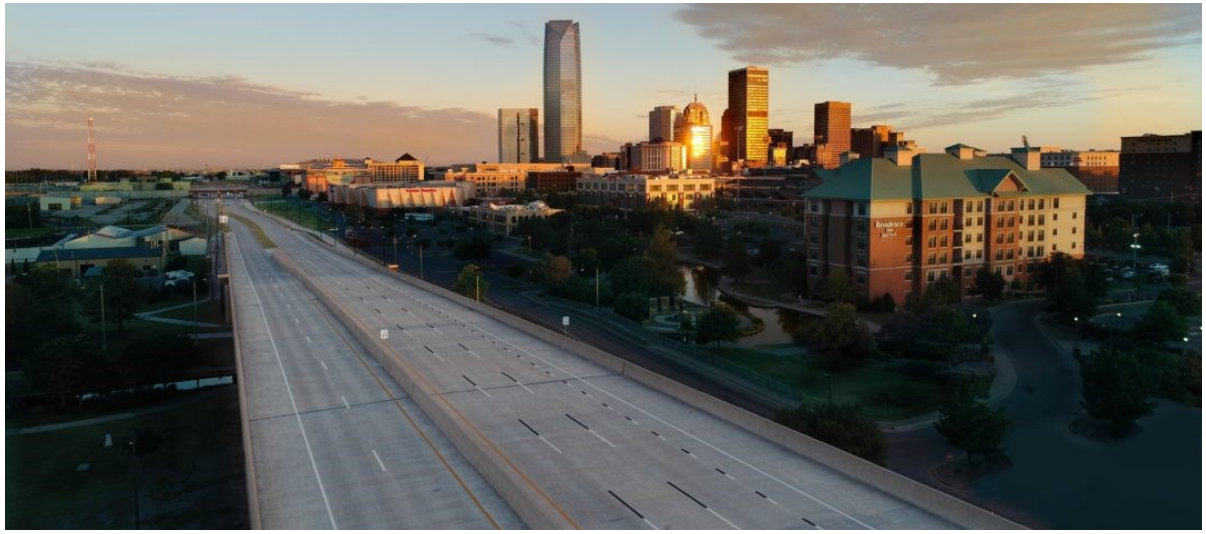
Air quality permits, issued after review and analyses by the Oklahoma Department of Environmental Quality (ODEQ) as set forth in the 1990 amendments to the CAA, are documents issued to a specific site with legally enforceable requirements regarding on-site emissions-generating equipment, air pollution control equipment, monitoring requirements, and any specific rules that apply to that facility.

Nonattainment compounds the permitting process through Nonattainment New Source Review (NNSR), requiring technical assessments to quantify a facility's emissions potential, prescribe technology to reduce or control pollutants with consideration of cost, and/or require a company to either reduce their proposed facility's emissions or identify, negotiate, and purchase emissions offsets. In addition to direct costs, NNSR assessments can protract the permitting process to last beyond a year, adding uncertainty and delay. In some conditions, inability to demonstrate emissions reductions at a facility may effectively prohibit construction, expansion, or modification.

Examples of facilities likely to be subject to NNSR include publicly-owned treatment plants, petroleum refineries, landfills, cement plants, paper mills, hot mix asphalt facilities, natural gas transmission and storage facilities, and many others as NNSR is based upon potential to emit rather than strictly defined categories of facility types.

CAPCOG's nonattainment analysis included specific financial estimates due to loss of economic activity. The loss of expansion at an Austin semiconductor manufacturing facility was projected to cost between $21 billion and $33 billion in gross regional product (GRP) between 2018 and 2046. Another projected loss, the prospective construction of a new cement plant, was estimated to cost between $1.8 billion and $3.7 billion in GRP. Costs of reducing NOx emissions to existing Austin metro facilities would total approximately $463 million between 2022 and 2046.

The Alamo Area Council of Governments also conducted a nonattainment study and estimated the



LEFT: OKC BOULEVARD

In a nonattainment scenario, the Boulevard would require detailed analyses and emissions modeling in order to gain funding and approval from the Federal Highway Administration.

cost of each NNSR to illustrate the possible severity of the San Antonio MSA's nonattainment designation. Each NNSR permit could entail a cost of $100,000 to $250,000 each, totaling between $24.2 million and $67.3 million. Project delays due to the permitting process were estimated to total between $1.4 billion and $1.6 billion in lost GRP. A nonattainment designation's chilling effect on expansion or relocation within regional manufacturing was estimated to range from $699 million and about 5,000 jobs to $27 billion and more than 140,000 jobs.

The fewer the barriers to Oklahoma City's growth and prosperity the better. The functions of entities like the Alliance for Economic Development of Oklahoma City, the Oklahoma Department of Commerce, the Greater Oklahoma City Chamber, the Oklahoma State Chamber of Commerce, and the City itself are predicated on working directly with new and existing businesses for job growth. Competition between other urban centers, including those within the region, is already significant.

A nonattainment designation would greatly impede economic development efforts and seriously impair Oklahoma City's ability to attract new businesses and foster growth and expansion for companies already at home in this market.

Streets and Roads. Federal dollars play a crucial role in Oklahoma City's transportation infrastructure. Between FFY13 and FFY17, approximately $45 million in federal funds were awarded to Oklahoma City for transportation projects including road widenings, street resurfacings, and traffic signal upgrades. Typically, federal dollars fund 80% of the total project cost with Oklahoma City providing the remaining 20%. A requirement of nonattainment called transportation conformity would severely limit the City's flexibility in using federal funds for transportation infrastructure. These effects would extend to the Oklahoma Department of Transportation (ODOT) and other metro area cities, towns, and counties as well.

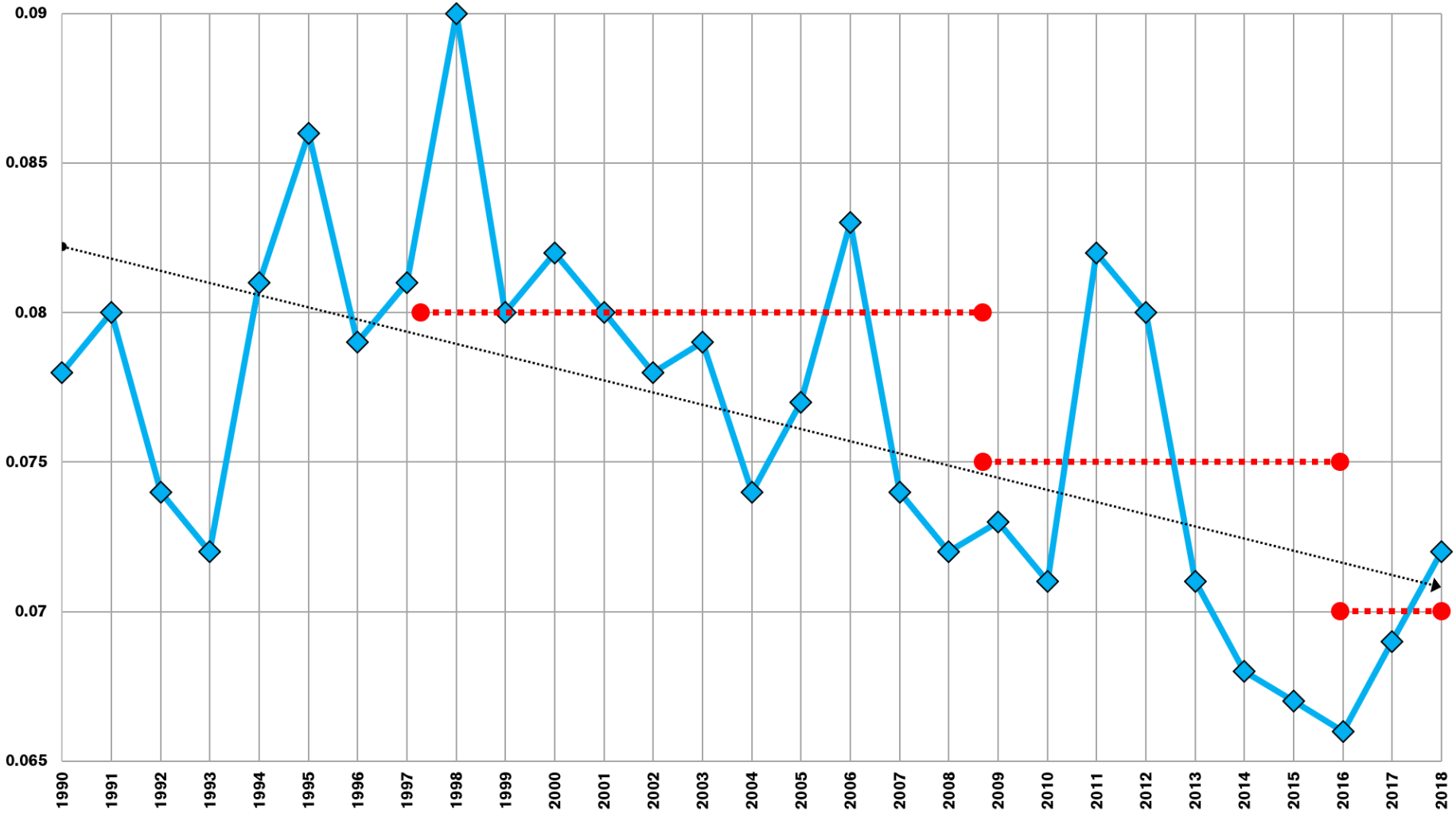
Transportation conformity requires any federally-supported transportation project, whether supported through federal funds or through federal approval, to demonstrate it would not negatively impact the area's air quality or exceed the area's motor vehicle emissions budget. The term is rooted in the requirement that projects conform to an approved plan to reduce emissions, called a State Implementation Plan, in both the planning and coordination stage at the regional level (e.g. through the Association of Central Oklahoma Governments) and at the local, project level. Such a demonstration of conformity is produced through emissions analyses, including inventorying and modeling, the findings of which are subject to review and approval by regional interagency bodies, the EPA, the U.S. Department of Transportation, and the Federal Highway Administration as well as public notice, public comment, and public hearing procedures. In many areas of the U.S., the local process of conformity determination has been the target of lawsuits from advocacy groups, which only compounds project delays.

The full repercussions are difficult to project but both the aforementioned CAPCOG study and the Alamo Area Council of Governments study sought to quantify their regional transportation conformity impacts and can help to demonstrate the scale of this facet of nonattainment. The CAPCOG study estimated the costs generated by transportation conformity to be in the range of $72 million to $216 million including lost federal funds, project delays, and required project analyses. The Alamo Area Council of Governments study estimated road construction delays would cost between $571 million and $855 million in lost GRP.

Oklahoma City's transportation infrastructure has required our most consistent public investment. While transportation conformity would not entirely eliminate Oklahoma City's capacity to conduct and fund local street and road projects, it would unreservedly constrain how we could both access federal transportation dollars and the types of projects eligible for those dollars.

Historically, with designation comes additional federal transportation dollars to assist with emissions reductions, specifically Congestion Mitigation and Air Quality (CMAQ) funds. The current federal transportation bill, the Fixing America's Surface

Figure AQ-2: Oklahoma City MSA Annual 4th Highest Ozone Values in Parts Per Million, 1990 - 2018



OKC MSA Design Value

The design value is a number based on the annual fourth-highest daily maximum 8 -hour concentration of ozone taken from ODEQ's monitoring system averaged over three years. The design value is the regional number assessed by the EPA for the purpose of designation.

EPA 8-Hour Ozone Standard

In 1979, an ozone standard of 0.12 ppm on a 1-hour basis was established. That changed in 1997 when the standard was not only lowered to 0.08 ppm but shifted to an 8-hour standard. That 8-hour standard was lowered in 2008 to 0.075 ppm and again in 2015 to 0.07 ppm.

The chart above shows a general improvement in air quality from 1990 to 2018 in the Oklahoma City metropolitan statistical area, but the standard established by the EPA has also decreased the allowable pollution levels, most recently in late 2015.

Several factors contribute to improving air quality, but more stringent fuel efficiency standards for automobiles made a significant contribution to the pollution reduction during this timeframe. Growth in vehicle miles traveled combined with hotter, drier summers could increase conditions for ozone formation, however.

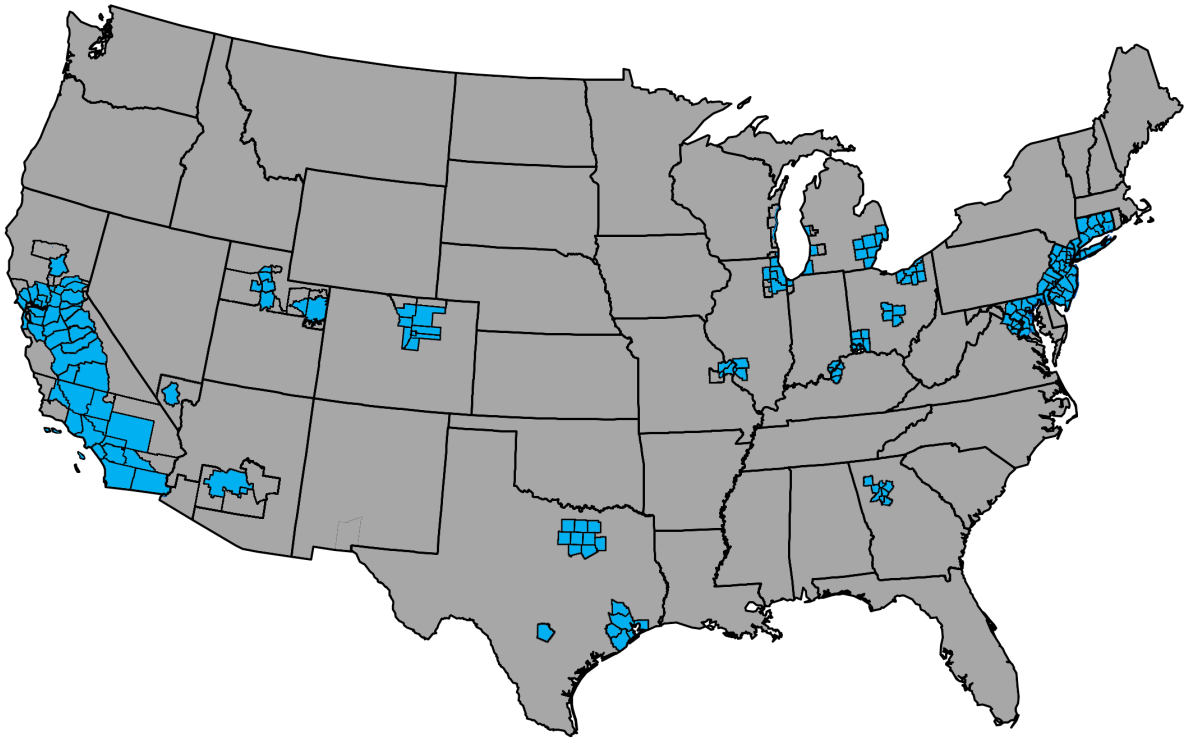
Transportation (or FAST) Act, authorized about $2 billion annually from 2016 to 2020 in CMAQ funds. These are, however, subject to the constraints of transportation conformity.

There are project types exempt from transportation conformity per Title 40 of the Code of Federal Regulations (§ 93.126). It is perhaps most important to underscore that bicycle and pedestrian projects are wholly exempt from conformity alongside many transit project types. Functionally, this could translate to more dollars available for bicycle, pedestrian, and transit projects which could circumnavigate the costly and time-consuming delays faced by many other types of street and road projects. Broadly, safety projects such as resurfacing, the addition of medians, lighting improvements, and traffic control/ signalization are exempt, and exempt transit options include shelters, fleet replacement, fleet vehicle rehabilitation, operating assistance, and more. While there is a degree of flexibility when it comes to project type exemptions during development of a State Implementation Plan, it is highly unlikely any project that widens or adds lane capacity to a road or highway would be allowed given the induced demand and subsequent contribution to congestion they cause.

Nonattainment would affect our ability to finance, construct, and maintain projects on one of our most vital public assets, rendering some projects ineligible while multiplying costs and timelines, and ultimately rendering it more difficult to provide the quality of infrastructure residents expect. For a region such as ours that has an overwhelming reliance on our transportation infrastructure, conformity would provide additional funds while significantly constraining our ability to take a business-as-usual approach to our transportation infrastructure.

While ozone and its precursors are less present in Oklahoma City's air, the lowering of the NAAQS continues to apply pressure to our ability to escape a nonattainment designation. Proactive steps now to further diversify regional mode share and replace emissions-generating VMT with alternative fuels that reduce or eliminate tailpipe emissions could not only generate dividends but prove vital to avoiding the high cost of nonattainment.

Figure AQ-3: Areas Designated Nonattainment of 2015 8-Hour Ozone Standard



Source: U.S. EPA

Above are the 51 areas consisting of 197 counties currently designated with some degree of nonattainment under the 2015 8-hour standard as of late 2019.

"The City works with ACOG and state agencies to monitor the metropolitan area's [Clean Air Act] compliance. The Central Oklahoma region has remained in compliance, though we had a challenging summer in 2018, and came within one failed pollution reading to be out of compliance."

- Oklahoma City 2019 Federal Legislative Guide

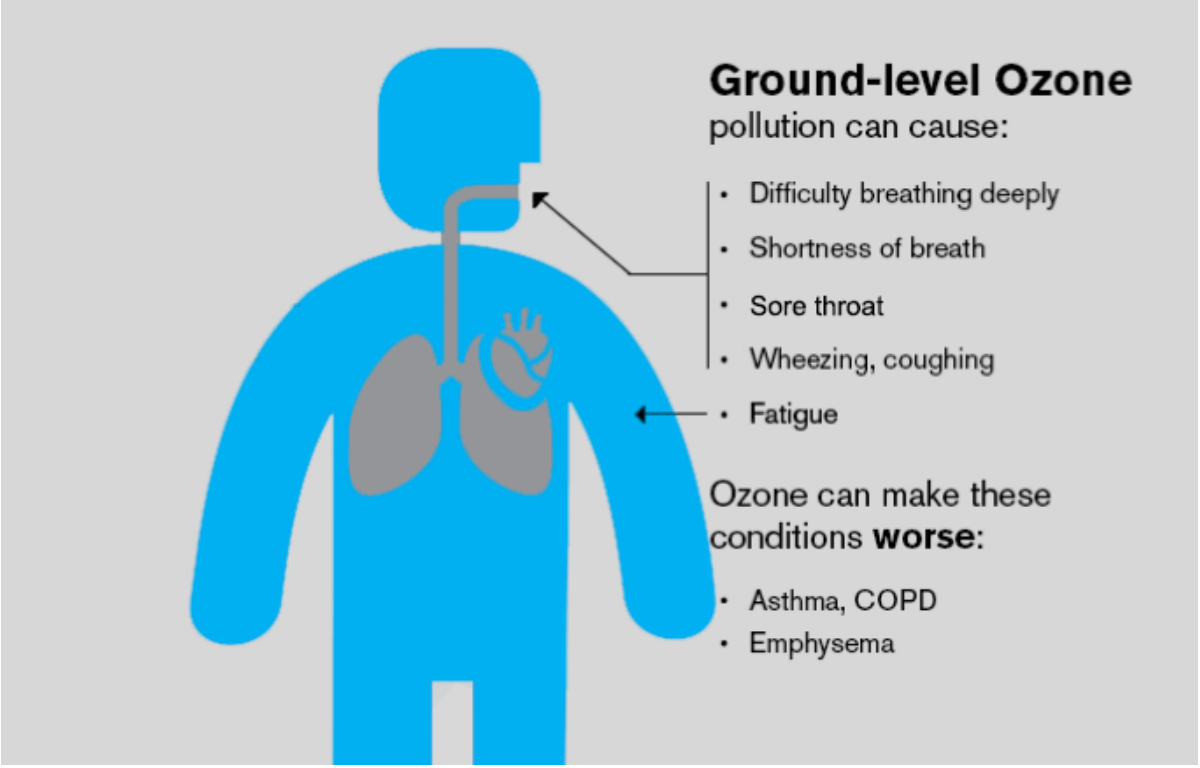
Public Health. The regulation of ground-level ozone was federally established because it presents a direct threat to public health. Inhalation of ground-level ozone can induce respiratory symptoms including coughing, irritation of the throat, shortness of breath, and pain, burning, or discomfort when taking deep breaths. Higher daily concentrations of ozone are associated with increased asthma attacks, hospital admissions, and daily mortality.

The Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System (BRFSS) indicates Oklahoma's adult asthma rate as 10%, well above the U.S. median of 9.3% and the 16th highest adult asthma rate among all U.S. states. Oklahoma's 10% rate is a marked increase from the state's 2000 rate of 6.3%. Most Oklahomans with asthma experience persistent severity, meaning 68.3% of adults in Oklahoma diagnosed with asthma are on long-term medication or have uncontrolled or poorly controlled asthma without medication.

The most recent asthma mortality data ties Oklahoma and Indiana at fifth in the nation with 12,900 asthma-related deaths per million residents. The prevalence of asthma and other chronic respiratory conditions has other implications for health and wellness. For example, 40.8% of Oklahomans with asthma report their health as "fair" or "poor" whereas Oklahomans without asthma report their health as "fair" or "poor" at a significantly lower rate of 19.5%. The share of obese Oklahomans without asthma is 30.2%, more than ten points below the share of obese Oklahomans with asthma: 41.3%.

Locally, the EPA tool EJSCREEN places Oklahoma City in the 91st percentile nationally for ground-level ozone, meaning the average person in an Oklahoma City Census block group has a chance of exposure greater than or equal to 91% of the U.S. Oklahoma County has the highest adult asthma rate of all 77 counties at 11.4%.

The Oklahoma City-County Health Department reports chronic lower respiratory diseases (CLRD) were the third leading cause of death for residents of all ages in Oklahoma County, and disproportionately for residents age 55 or over, between 2011 and 2015.



When all 56 ZIP codes within Oklahoma County are ranked by CLRD mortality rates per 100,000 residents between 2013 and 2015, the top nine are all either wholly or partially within Oklahoma City. Those nine ZIP codes have an average mortality rate of 131.8 whereas the full list of 56 ZIP codes averages 67.9.

Our built environment can directly influence exposure to traffic-related pollutants like NOx based on land uses near highways as well as busy streets and roads. Research indicates populations living close to roads are more likely to experience adverse health outcomes including breathing problems, heart disease, cancer, and premature death.

Populations with increased vulnerability to these impacts include children, the elderly, and people with certain pre-existing medical conditions including CLRD. The Oklahoma City planokc Health Impact Assessment includes an analysis of major Oklahoma City highways with sensitive land uses nearby. The analysis estimates greater than 50,000 Oklahoma City residents live within 500 feet of a major highway; additionally, within that same 500 feet buffer, there are eight schools, seven of which include elementary students.

Ultimately, supporting an expansion of transportation modes through service and infrastructure is the primary way to reduce ozone-forming emissions. We can design and construct our built environment, through the siting of sensitive land uses and the placement of vegetative buffers and tree canopies, as a tool to mitigate the impacts of existing emissions on residents.

Case Study: San Antonio, Texas

After the EPA's revision of the NAAQS in October 2015 lowered the 8-hour threshold for ground-level ozone from 0.075 to 0.070 ppm, the San Antonio metropolitan statistical area's MPO, the Alamo Area Council of Governments, published a study projecting the potential economic costs of a regional nonattainment designation. The study focused on potential loss of gross regional product, as well as the impact on employment, incomes, and output within major industries under both a marginal and a moderate nonattainment designation.

Researchers estimated costs could range from $3.2 billion to $27.5 billion under marginal nonattainment and could increase from $7.1 billion to $36.2 billion if the San Antonio region is given a moderate nonattainment classification. The region's transportation infrastructure would suffer a loss of between $23.7 million and $74.6 million in federal funds while transportation conformity would impose costs between $48 million and $141 million. These costs include project delays and required analyses of air quality impacts by each prospective project.

These analyses would critically limit the types of transportation projects that could receive federal funding and could even affect locally-funded projects should federal approval be required. Expansion of rail systems and aviation services would also see delays, costing as much as a combined $2 billion.

The private sector, particularly manufacturing, construction, large businesses, and the Department of Defense's Joint Base San Antonio would be significantly affected by nonattainment. Designation would trigger new requirements for permits and infrastructure development and additional regulations on business emissions are now required in an effort to get the region back in compliance with air quality standards.

Companies planning expansion or seeking to relocate could incur losses ranging from $699 million to $24 billion. Permits needed to adhere to new regulations could cost between $24 million and $60 million. Researchers found nonattainment could discourage two major companies from expanding in the region, costing as much as a combined $37.5 billion in lost gross regional product.

On Wednesday, July 18, 2018, the EPA announced of the eight counties in the San Antonio metropolitan area, all were designated as in attainment with the new 2015 ozone standard - with the exception of Bexar County. Home to approximately 1.7 million, Bexar County is the fourth-most populated county in Texas and the location of the city of San Antonio. Bexar County has until 2021 to meet the 0.070 ppm threshold for ground-level ozone.

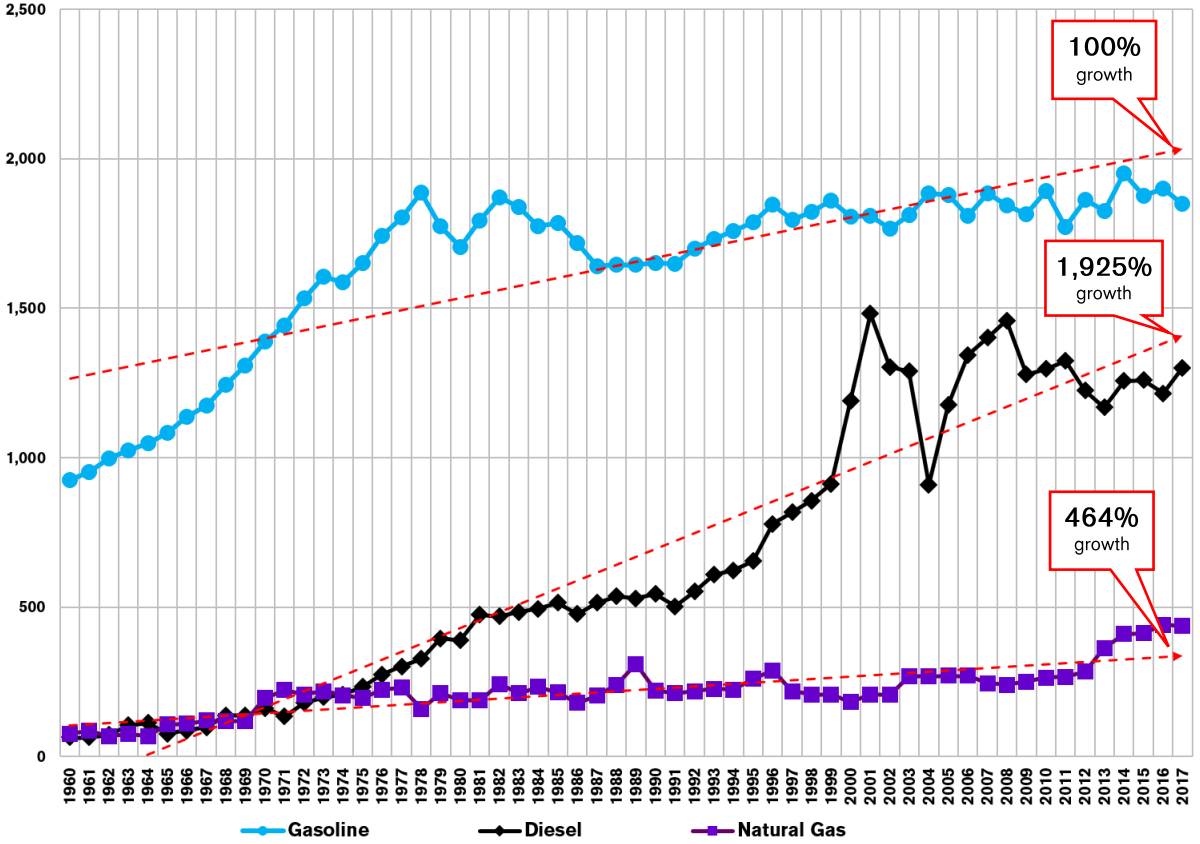
Between 2015 and 2017, the period of record for the EPA's decision, San Antonio's average ozone levels were calculated at 0.074 ppm. The new standard as of October 2015 is 0.070 ppm.

Alternative Fuels

The term alternative fuels refers to a broad range of fuels derived from sources other than petroleum. Per the Energy Policy Act of 1992, these are defined as "pure methanol, ethanol, and other alcohols; blends of 85% or more of alcohol with gasoline; natural gas and liquid fuels domestically produced from natural gas; propane; coal-derived liquid fuels; hydrogen; electricity; pure biodiesel (B100); fuels, other than alcohol, derived from biological materials; and P-Series fuels." The U.S. Department of Energy can designate other fuels as alternative if the fuel is substantially non-petroleum and yields significant energy security and environmental benefits. As many alternative fuels are produced domestically, they contribute to energy security insofar as reducing reliance on foreign oil imports, a pillar of national energy policy since the embargos of the 1973 oil crisis. Alternative fuels also consistently emit fewer pollutants than petroleum-based fuels, an important tool to stave off future contributions to climate change as well as the possibility of a nonattainment designation.

Critically, alternative fuel adoption is fundamentally market-driven. Variables such as public and private sector commitments, sufficient fueling infrastructure, sufficient vehicle market demand and availability, and pricing competitive with petroleum-based fuels are key to advancing fuel switching on an effective scale. For Oklahoma City, alternative fuels offer a way to accommodate high vehicle miles traveled during gradual reduction through multimodal strategies while simultaneously diminishing emissions and reinvesting money into domestic, if not local, fuel processors and manufacturers. The City must determine how best to navigate its role in advancing the deployment of alternative fuels beyond its existing commitment to the municipal fleet. Without strategic action, not only could the benefits of alternative fuels decline but prove disruptive to our infrastructure and economy. Long-term consumption of diesel and natural gas as transportation fuels has grown markedly even though the quantities consumed remain well below those of gasoline.

Figure AQ-4: Oklahoma Transportation Fuel Consumption in Millions of Gallons or Gallon Equivalent, 1960 - 2017

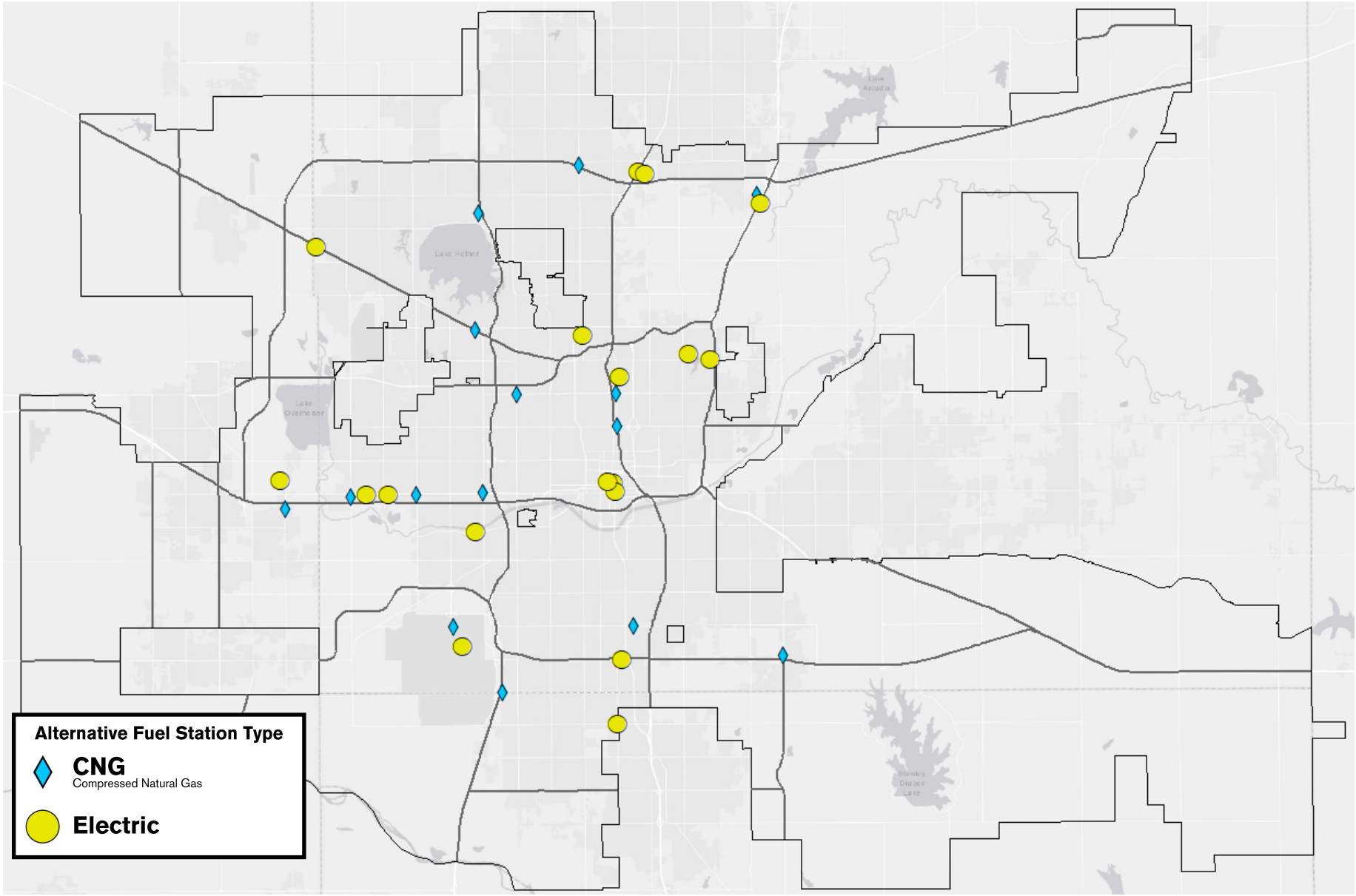


Source: U.S. Department of Energy

The significant growth of diesel consumption statewide indicates the growing demands of shipping and freight on our transportation infrastructure.

Consider, however, that as the existing apportionment formulas for the dedicated diesel and natural gas fuel taxes do not include remittances to Oklahoma cities and towns, those marked increases illustrate lost revenue to local governments - including Oklahoma City. The existing diesel fuel apportionment formula, for example, produced an annual remittance of $2.1 million to Oklahoma County during FY18; about $107,000, or 5%, of that amount was deposited in the County Bridge and Road Improvement Fund, which can be used to jointly fund construction and maintenance of roads with the state and/or cities. Oklahoma County is responsible for approximately 549 miles of roads, the ninth fewest miles of roads among all 77 counties. The portion of Oklahoma City within Oklahoma County alone is comprised of approximately 3,622 miles of road, more than six times that of Oklahoma County.

Figure AQ-5: Publicly-Available CNG and Electric Vehicle Fuel Stations in Oklahoma City, 2020



Source: U.S. Department of Energy

As of early 2020, Oklahoma City has 15 CNG stations and 18 stations equipped with 44 electric vehicle charging ports. Compare to nearby cities such as Dallas (9 CNG, 199 EV stations with 326 ports); Tulsa (11 CNG, 29 EV stations with 78 ports), Wichita (1 CNG, 8 EV stations with 52 ports), and Little Rock (1 CNG, 25 EV stations with 91 ports).

Fuel Taxes. Petroleum-based fuels have long dominated as the primary fuel of the transportation sector, so much so that from the national level all the way down to municipalities, taxes on fuel purchases have generated revenue for governments. Oklahoma levies a tax of 20¢ per gallon on both gasoline and diesel fuel, the collections of which are apportioned by the state to a variety of entities including state, county, and local governments based on separate apportionment formulas codified in law. These 20¢ per gallon taxes are in lieu of sales tax, meaning the amounts afforded governments represents the total financial contribution of fuel purchases to every level of government in Oklahoma.

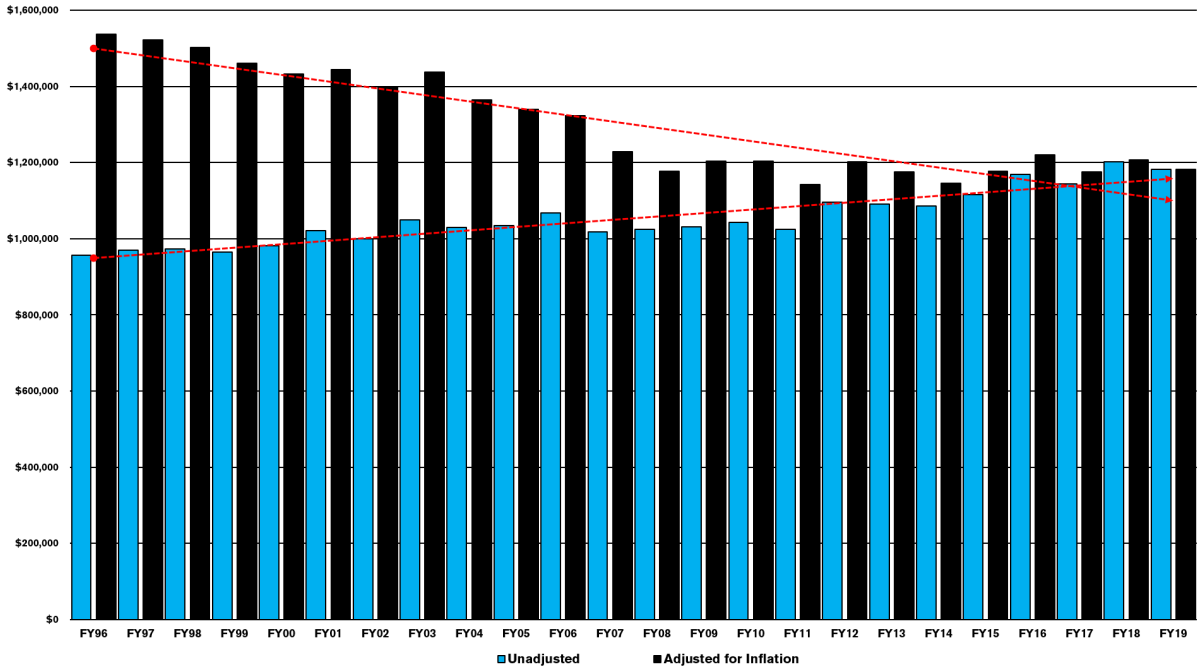
The amounts remitted to county and local governments are strictly required, per the Oklahoma Constitution, to be spent on the construction, repair, and maintenance of streets and roads. The Oklahoma fuel taxes are in addition to a federally-levied tax of 18.4¢ on gas and 24.4¢ on diesel, respectively, the revenue of which the U.S. Department of Transportation's Highway Trust Fund uses to finance transportation projects.

The gas tax apportionment formula's 1.875% remittance to cities and towns is distributed monthly based on gas sales within an entity's corporate limits. Given Oklahoma City's size and share of state population (approximately 16%), we receive the largest monthly apportionment of all Oklahoma cities and towns. However, in the 21 years between FY96 and FY19, the average annual remittance amount has been approximately $1 million.

That apportionment alone is far from able to fully fund municipal transportation expenditures, so those funds are placed in the City's General Fund and bundled with general purpose tax dollars to form the budget of the Public Works Department's Streets program, which is responsible for road repair and reconstruction. Based on Streets program budget actuals from FY13 to FY18, gas tax funds comprise an average of about 8.9%.

As for Oklahoma's diesel tax of 20¢ per gallon, it is now tied with Texas as the fifth lowest in the U.S. However, no portion of diesel tax collections are remitted to cities and towns, even as annual freight

Figure AQ-6: Gas Excise Tax Remittances to Oklahoma City, FY96 - FY19



Source: Oklahoma Tax Commission, U.S. Bureau of Labor Statistics

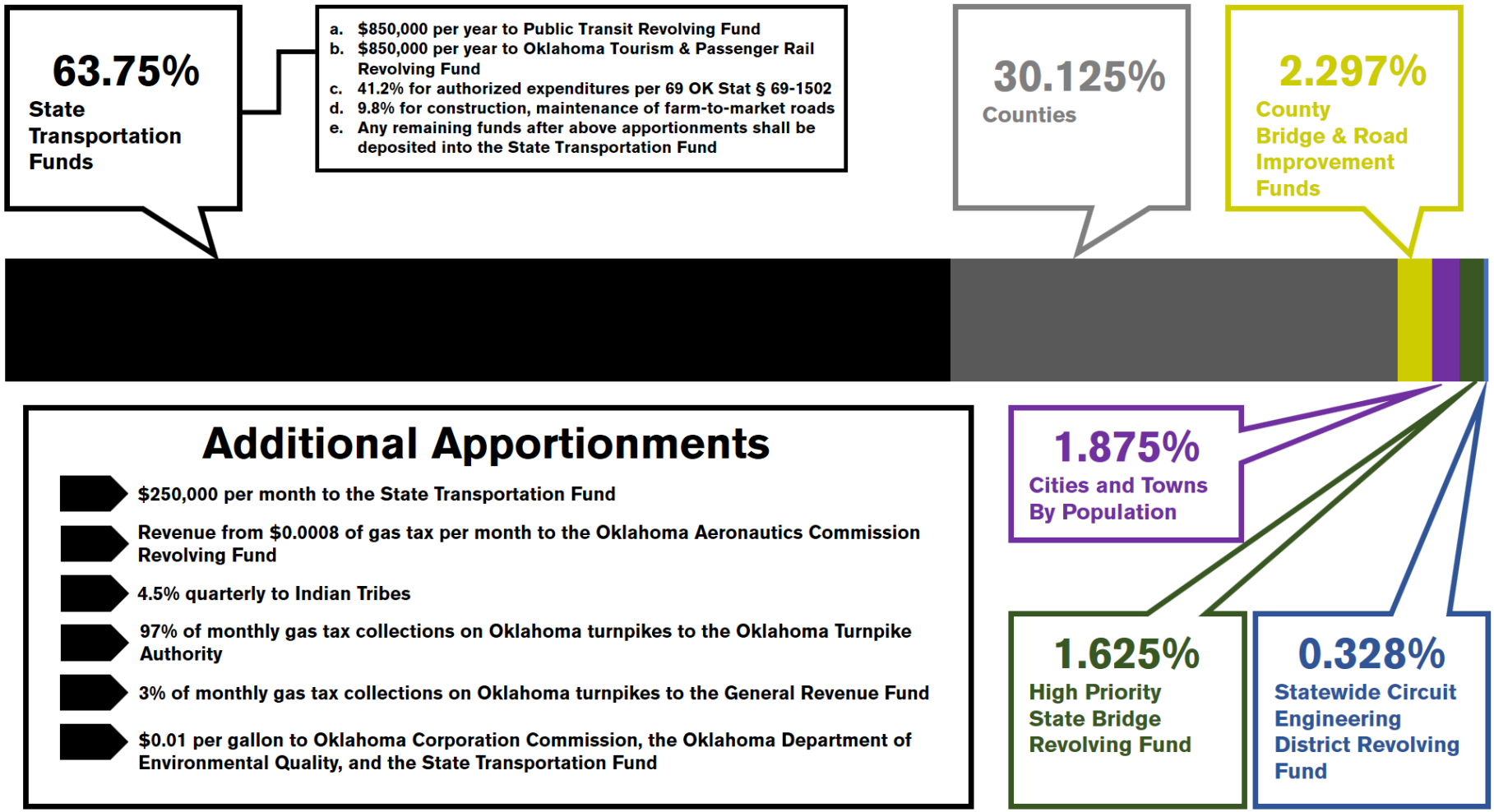
tonnage on Oklahoma City metro roads and highways is projected to increase 35% between 2010 and 2040. Oklahoma City is at the intersection of two interstate highways of the U.S. – I-40 and I-35 – making it a major crossroads for freight in North America.

The U.S. Department of Transportation valued 2013 statewide freight flow via all modes at $327.1 billion, and the highest value commodities shipped from Oklahoma, to Oklahoma, and all within Oklahoma are energy-related: coal, crude petroleum, and fuel oils. More than half of all statewide freight flow – approximately 65% – is by diesel truck. As a result, the Oklahoma City metro is one of 49 U.S. metros with highway freight truck volumes greater than 8,500 per day. The continuing growth of e-commerce is a leading contributor to freight growth and, while the Supreme Court's 2018 decision in South Dakota v. Wayfair Inc. closed the tax-free loophole for online sales, it is state law that ensures the growth of diesel-fueled freight traffic will afford no return to Oklahoma City by way of diesel fuel tax.

Oklahoma City residents consistently express dissatisfaction with the conditions of local streets and roads via the annual Oklahoma City Citizen Survey. Since 2005, satisfaction with the condition of Oklahoma City streets among residents has averaged just 18.3%, reaching its lowest point in 2016 at 9%. In all annual Citizen Surveys conducted, the City service residents identified as most important was the condition and maintenance of streets and roads. Thus, fuel tax collections are an essential component of meeting what residents have consistently articulated as their most pressing concern.

Part of the challenge is that gasoline consumption in Oklahoma has remained relatively flat for decades, which clearly has repercussions on gas tax revenue. While there have been year-to-year increases and decreases, in the 33 years between 1982 and 2016,

Figure AQ-7: Oklahoma Statutory Apportionments of Gasoline Excise Tax



The Oklahoma FY17 revenue and apportionment data from the Oklahoma Tax Commission can help illustrate the practical application of the above formula. Overall, the gas excise tax took in $308,079,273.04 between July 2016 and June 2017. The largest share of that amount, about $137 million, went to the State Transportation Fund. Cumulatively, counties received about $94 million between direct remittances as well as payments to the county bridge and road improvement funds and circuit engineering district revolving funds. Tribes received about $13.7 million and the state's General Revenue Fund saw about $1.4 million. The Turnpike Authority kept about $46 million while about $6.4 million went to the specific funds that include Tourism and Passenger Rail, the Oklahoma Aeronautics Commission, High Priority State Bridges, and Public Transit. Approximately $5.4 million was split between 584 cities and towns.

changes have shifted between the 2014 height of about 1.9 billion gallons to a low of 1.6 billion gallons in 1987, all within a range of about 310 million gallons. In 1987, Oklahoma gasoline sales totaled 5.7 million gallons per day and by 2014 those sales decreased slightly to 5.6 million gallons per day. Oklahoma was one of only 10 states to see a reduction in gasoline sales during that period, even if less than approximately 2%. This exposes the two serious flaws of Oklahoma's fuel taxes which, incidentally, are mirrored in the national fuel taxes: vulnerability to inflation and commodity price volatility as well as unresponsiveness to ever-increasing fuel efficiency.

Oklahoma's fuel taxes are fixed at a cents per gallon rate. Those fixed amounts mean diminished returns over time due to inflation. The Bureau of Labor Statistics' Consumer Price Index (CPI) Inflation Calculator estimates $1 in 1987, when the state gas tax was last increased prior to 2018, has the same buying power as $2.27 today. More specifically, what was 16¢ in 1987 was the equivalent of 36¢ today. In contrast to Oklahoma's fixed rate fuel taxes, 21 states have some form of variable-rate gas tax to capture sufficient transportation revenue. For instance, Florida, Maryland, North Carolina, and Rhode Island adjust their gas tax based on the CPI. Georgia adjusts their tax based on vehicle fuel efficiency standards; and Hawaii, Illinois, and Indiana all apply their general states sales tax to gasoline. While fuel tax rates are the purview of the Oklahoma Legislature, it is unavoidable that the current approach guarantees only inadequate transportation funding in perpetuity at the local, state, and national levels.

Corporate Average Fuel Economy (CAFE) standards, mandated by Congress after the 1973 oil crisis, are one of the principal catalysts – if not the principal catalyst – for the increases in miles per gallon of cars and light duty trucks. The CAFE standards are fleet-wide averages that must be achieved by each automaker for its car and truck fleet, each year, since 1978. When these standards are raised, automakers respond by creating a more fuel-efficient fleet, which is intended to improve national energy security and save consumers money while also reducing emissions.

ABOVE: MUNICIPAL FLEET CNG

A City employee refills a CNG-powered fleet vehicle at the $1.28 million fast-fill CNG fueling station at the City's Central Maintenance Facility site. The station was added through federal funds from the Energy Efficiency & Conservation Block Grant through the U.S. Department of Energy.

Since the standards went into effect for passenger cars in 1978, the requirements have ratcheted up from 18 miles per gallon to about 40 miles per gallon in 2017, a 122% increase in efficiency that translates to fewer gallons of gas required to travel further in U.S. cars. Light duty trucks, whose CAFE standards were introduced in 1982, have jumped from 17.5 miles per gallon that model year to about 29 miles per gallon in 2017, an increase of about 65%.

These standards are in direct contrast to the nature of fuel taxes, however: whereas federal, state, county, and local taxes rely on fuel purchases, CAFE standards effectively mandate reductions in fuel purchases. While the CAFE standards do diminish said tax revenue, they can also be interpreted as incentivising research, development, and adoption of alternative fuels.

There are two well-developed alternative fuels already present in Oklahoma City that afford economic and environmental benefits: CNG and electricity. Both fuels have already had an impact on Oklahoma City and, due in no small part to private sector support, shall undoubtedly continue to do so.

CNG. Oklahoma's most prominent alternative fuel is CNG, hardly surprising as Oklahoma is the third largest natural gas producer in the U.S. CNG fuel consumption in Oklahoma continues to trend upward as consumption reached an all-time high in 2016, the most recent year data is available, with 440 million gallons of gas equivalents (GGEs) consumed – a growth of 469% from 1960 to 2016. The Department of Energy's Alternative Fuel Data Center identifies 103 public CNG stations statewide with 16 of those within Oklahoma City's corporate

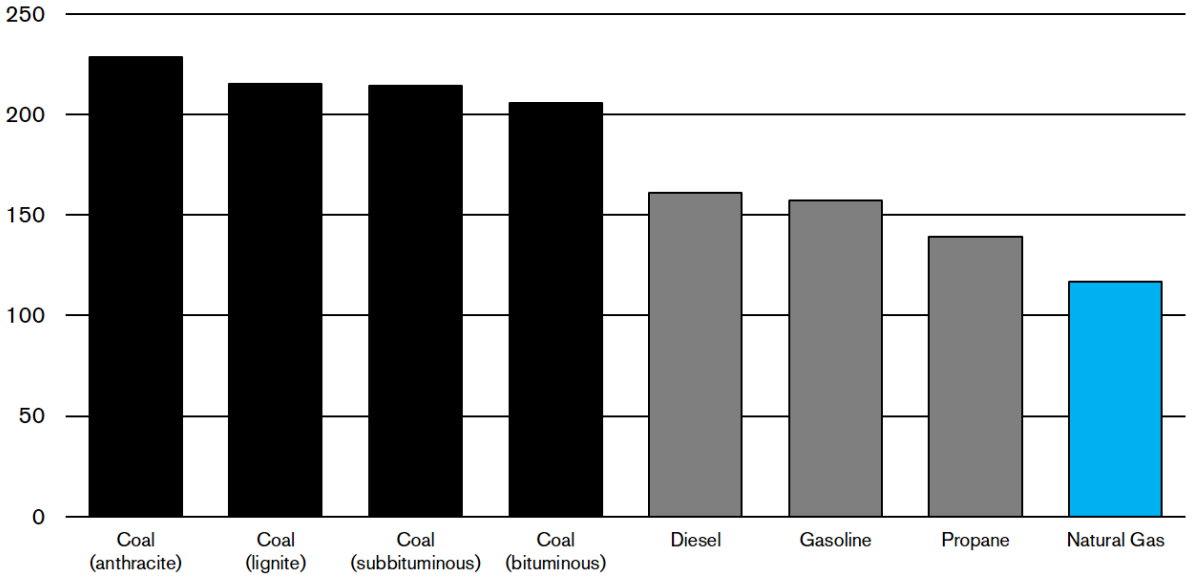
limits. Oklahoma leads the nation in CNG fueling stations per capita thanks in part to a statewide corridor with public CNG stations every 100 miles.

At a state level, Oklahoma has supported CNG fuel adoption via a suite of incentives and tax credits. For instance, the Alternative Fuel Vehicle (AFV) Tax Credit. This served as a one-time tax credit of 45% towards the incremental cost of either converting a vehicle to run on an alternative fuel or the purchase of a new alternative fuel vehicle. Eligible alternative fuels, however, were limited to CNG, liquefied natural gas (LNG), and liquefied petroleum gas (LPG). Another tax credit also allows for up to 75% of the cost and installation of commercial alternative fuel infrastructure for natural gas, propane, and electricity, with a 50% credit for residential CNG refueling system. A reduced fuel tax on CNG of 0.05¢ per gas gallon equivalent (GGE) is also tied to the expiration of the AFV tax credit, after which the excise tax will increase to be equal to the tax rate imposed on diesel fuel. The AFV credit was scheduled to sunset at the end of calendar year 2019, but was extended in 2019 through December 31, 2027.

While this subsidized fuel excise tax rate has not yielded a remittance to Oklahoma City, Argonne National Laboratory's GREET model estimates the life cycle petroleum use and emissions of light-duty vehicles running on CNG emit approximately 6%-11% fewer pollutants than gasoline, meaning Oklahoma City has benefited from fewer tailpipe emissions even while it reduces fuel excise tax revenue. The City has supported CNG through the addition of CNG vehicles to its fleet, including 80 light-duty CNG vehicles, heavy-duty CNG refuse haulers, five CNG sedans, and an ever-growing fleet of CNG-powered transit buses. A federally-funded $1.28 million fast-fill CNG pumping station was installed at the City's Central Maintenance Facility. The most recent fiscal year City fuel usage reports indicate that, by annual average price per gallon (or equivalent), CNG was the cheapest fuel by both bulk purchase ($1.11 per GGE) and at the pump ($1.08). In contrast, conventional unleaded gasoline was the most expensive at $1.63 per gallon in bulk and $1.71 per gallon at the pump. A downside of CNG, however, is that while it emits far fewer emissions than conventional petroleum fuels, the extraction process itself generates emissions of a highly potent greenhouse gas. Natural gas itself is largely methane and leakage from wells, storage tanks, pipelines, and processing plants account for a significant portion (32%) of U.S methane emissions and about 4% of total U.S. greenhouse gas emissions per the EIA. While methane is a short-lived pollutant, lingering in the atmosphere for approximately twenty years in contrast to the centuries or millennia for which CO_2 can persist, the Intergovernmental Panel on Climate Change estimates methane's potency as a heat-trapping gas is 86 times greater than that of CO_2. Furthermore, when methane does decay after a few decades, it simply becomes CO_2.

Figure AQ-8: Pounds of CO_2 Produced By Fuel Type

Per Million British Thermal Units of Energy



Source: U.S. Energy Information Administration

The amount of CO_2 produced when a fuel is burned is a function of the carbon content of the fuel. The heat content, or the amount of energy produced when a fuel is burned, is mainly determined by the carbon (C) and hydrogen (H) content of the fuel. Natural gas is primarily methane, which has a higher energy content relative to other fuels, and thus has a relatively lower CO_2-to-energy content.

Natural gas is an important part of the economies of both Oklahoma City and Oklahoma and, while a significant improvement over petroleum fuels, it nonetheless poses environmental risks for which there are better long-term options.

Electric Vehicles. An emissions-free form of transportation, electric vehicle (EV) motors are becoming increasingly common in the 21st century despite development dating back to the early 19th century. Adoption of EVs in Oklahoma appears more gradual than elsewhere in the country. Across the state there are 234 public stations with 622 electric vehicle charging outlets. Oklahoma City is home to 28 of those locations with 15 fast-charging stations, surpassed only by Tulsa (37 total with 12

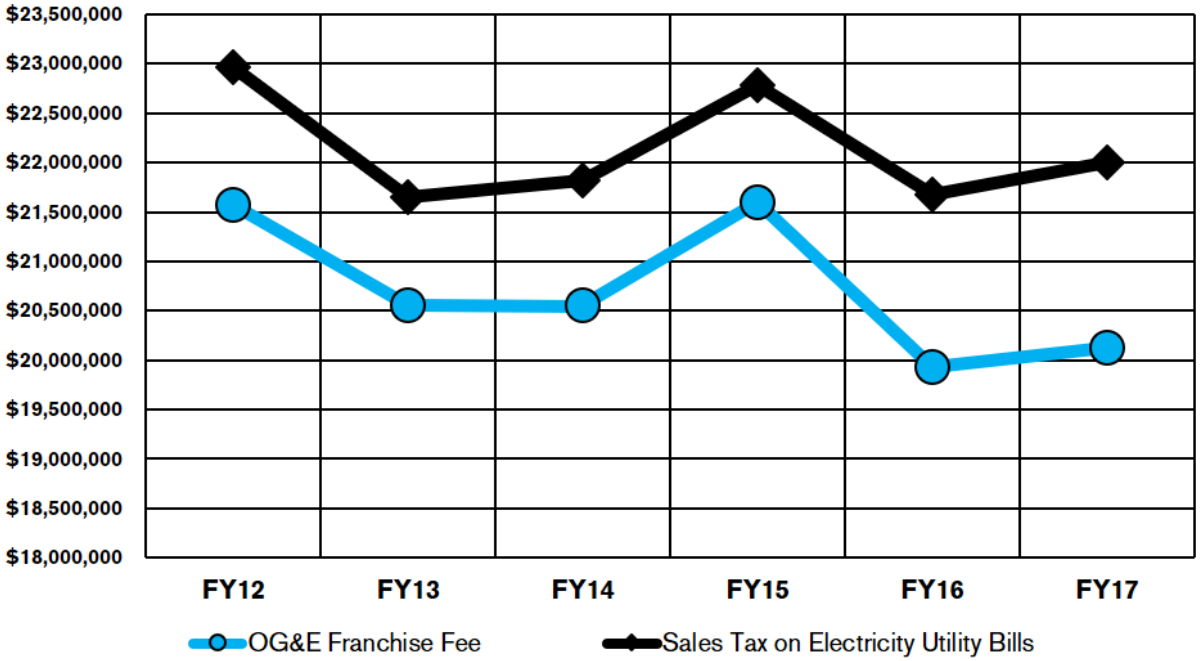
fast-charging) for the largest share of stations. Current locations include the Zoo, Skirvin Hilton Hotel, Whole Foods, Leadership Square parking garage, and OKC Outlets shopping center. Nationally, there are more than 30,000 public EV charging stations with more than 90,000 charging outlets, which means Oklahoma's share is less than 1% of both U.S. charging stations and charging outlets. Oklahoma is well below the U.S. average of about 461 charging stations per state, putting an unquestionable damper on EV adoption.

The state's two Clean Cities Coalitions (ACOG's Central Oklahoma coalition and INCOG's Tulsa Area coalition) formed the Oklahoma Electric Vehicle Coalition, a working group with more than 30 private sector, non-profit, and government representatives, including both City of Oklahoma City and OG&E seeking to increase EV use and facilitate the deployment of EVSE (electric vehicle equipment).

OG&E has made an effort to bolster EV adoption in Oklahoma in the recognition that the transportation sector is a new market segment for the investor-owned utility. In 2017, OG&E struck a promotional agreement with two regional car dealerships, Fenton Nissan and Bob Howard Nissan, to provide a $10,000 rebate on the purchase price of a 2017 Nissan Leaf EV. This rebate, in conjunction with the existing federal tax credit for the purchase of an electric vehicle, equated to a potential $17,500 reduction of a Leaf's sticker price, which ranged from $30,000 to $38,000.

The scenario OG&E finds itself in is not unlike that of the City. Clearly, OG&E would benefit from greater adoption of EVs but OG&E itself cannot single-handedly install the needed infrastructure in both residential and commercial sectors. Yet the charging infrastructure is arguably the critical component to greater momentum behind EV adoption. The Department of Energy's Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite estimates at the end of 2016, the Oklahoma City metro had 985,500 light duty vehicles with 520 of those being EVs. If that number were to double to 1,040, the region would need an additional 49

Figure AQ-9: Comparison of Electricity Consumption Revenue, FY12 - FY17



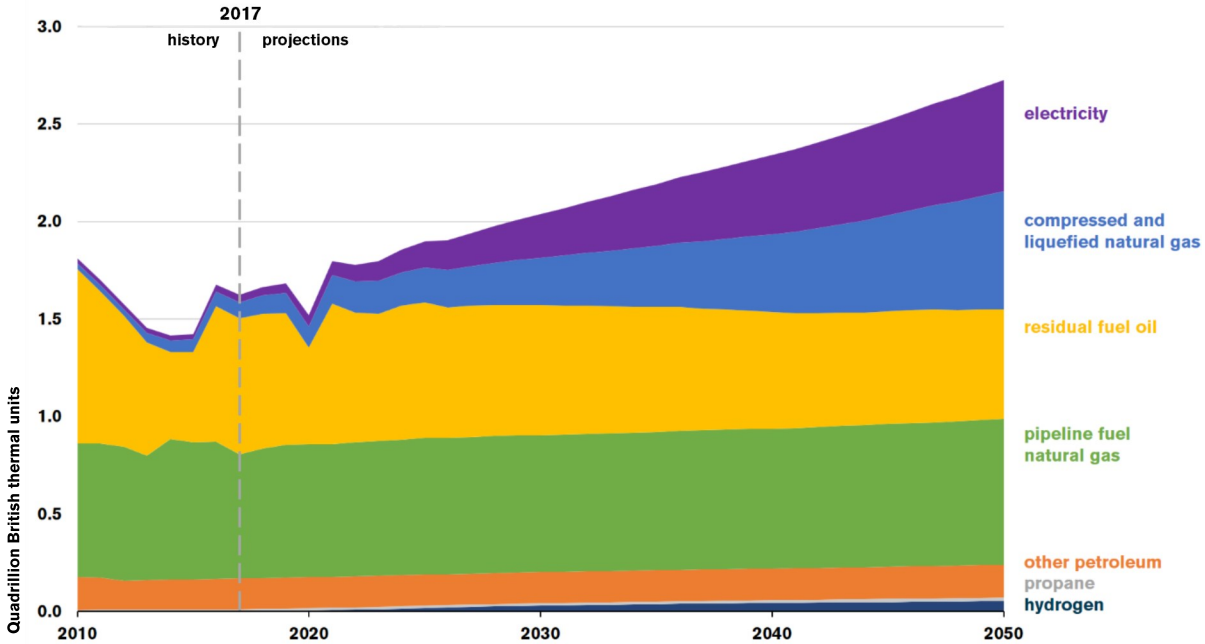
Electrification could generate more revenue for the City twice-over: once through sales tax levied on increased electricity bills - a higher tax rate than that of the gasoline excise tax - and again as part of the contractual 3% return on gross receipts provided by OG&E as part of the franchise agreement.

charging outlets capable of Level 2 chargers of 240-volt output or more. This assumes, however, every EV driver has residential charging and a mix of plug-in hybrids and all-electric vehicles with differing ranges. This underscores the chicken and the egg conundrum of EVs: consumers are unlikely to invest in an EV without plentiful, visible EVSE, yet investment in EVSE is unlikely until more consumers invest in EVs. OG&E, like the City, must determine how to best navigate the market-driven factors to reach the opportunities in wider EV adoption.

One of the major opportunities is distinctly economic. Electricity utility bills are subject to Oklahoma City's local sales tax, a substantially higher taxation rate when compared to the sliver of gas tax revenue remitted to the City. Increases in electricity consumption within Oklahoma City boosts OG&E's annual revenue, of which 3% is returned to Oklahoma City per the 25-year franchise agreement. Practically, the expansion of electricity as a transportation fuel would be financially beneficial to Oklahoma City, both in terms of revenue and the achieved emissions reductions.

Electricity costs are also substantially lower than that of gasoline. The Department of Energy estimates a statewide average of $2.69 per gallon of gas in Oklahoma. By comparison, they use residential energy prices to determine the cost of an "eGallon," or the electrical charge of an EV equivalent to a gallon of gasoline in a conventional vehicle. An Oklahoma eGallon is 94¢, meaning a resident could save $1.75 per gallon of gas. While this can differ

AQ-10: U.S. Transportation Sector Consumption of Alternative Fuels, 2010 - 2050



Source: U.S. Energy Information Administration

Electricity and natural gas are projected to see the greatest growth through midcentury. Electricity use as fuel is projected to increase sharply after 2020 due to a projected rise in new light-duty vehicles sales that are electric and/or plug-in hybrid-electric. Natural gas consumption increases over the entire projection period due to growing use in heavy-duty vehicles and freight rail. Nationally, both passenger travel and total freight movement are projected to increase including 18% growth in light-duty vehicle VMT and truck freight VMT by 27%.

based on vehicle type and the specific tariff a residence or business might be on - think about a SmartHours participant charging their vehicle during peak hours versus charging overnight - it nonetheless demonstrates the significant cost savings to consumers electric vehicles can provide.

The average Oklahoma City household, per the Center for Neighborhood Technology, sees an average annual expenditure of 26% of household income on housing and 25% on transportation. While Oklahoma City's housing costs are far below the national average, our transportation costs are higher due in part to the significant average household VMT (21,327 per year). Changes to household expenditure on fuel could help reduce those household transportation costs given the price difference of gasoline and electricity. While in-home vehicle charging would increase housing costs, consumers would still lower overall costs. The City has already taken steps to light the path for wider EV adoption. The municipal fleet includes several partially-electric and fully-electric vehicles for employee use, ensuring short trips are made without an emissions impact. With the addition of those vehicles comes EVSE at the Civic Center and within the Arts District Garage, though neither are open to the public. The City has recently added two EVSE and EV-dedicated parking spots to the remodeled Santa Fe Intermodal Hub as well as the Oklahoma City Zoo. While these are policies internal to the City and City assets, an ordinance adopted in 2017 has created a mechanism for property owners to better accommodate EVs and EVSE.

Adopted in August 2017, City Council approved ordinance 25,709, which, in § 32-625, establishes a process whereby property owners can apply to the City's Traffic and Transportation Commission to designate and dedicate parking spaces for electric vehicles. This ordinance not only creates the ability to dedicate parking spaces upon approval of the Commission but allows for enforcement via parking citations for non-electric vehicles or non-charging electric vehicles found to be occupying spaces reserved for electric vehicles. The ordinance requires these reserved spaces are connected to EV charging infrastructure and are clearly marked by signage. This important tool provides not only the opportunity for property owners to reserve parking stalls but also to strategically offer a soft incentive to residents by placing those at premium locations nearer to a business' entrance.

The convergence of transportation and energy provided by EVs is one Oklahoma City is well positioned to take advantage of. Not only are we a high VMT community with auto-centric infrastructure but our renewable energy resources are plentiful enough to serve as reliable means of generating electricity for a vehicular system. Whether through distributed generation such as combined EVSE of charging outlets and PV solar panels or a substantial increase of the amount of grid power generated by wind, the reality of drastically reducing transportation emissions is a present day feasibility. While realistically it will require gradual changes, policies, and market-driven adoptions, the environmental and economic benefits are more than sufficient to warrant further action - especially after consideration of the cost of doing nothing.

The projected market growth of total battery electric vehicles represents an opportunity for Oklahoma City. Local and regional VMT not reduced by

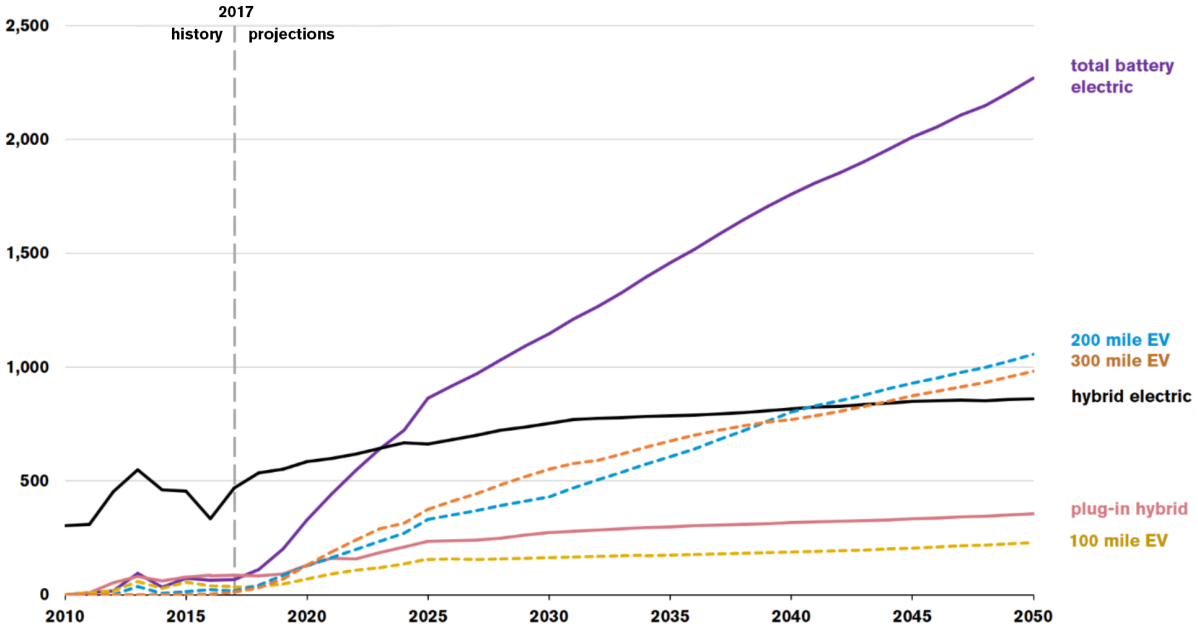
expanded bicycle, pedestrian, and transit infrastructure, safety, and service can be accommodated through technology that simultaneously reduces emissions and provides more revenue to the City. Additional EIA projections show combined sales of new electric, plug-in hybrid electric, and hybrid vehicles will grow from 4% in 2017 to 19% in 2050. The combined share of sales attributable to gasoline and flex-fuel vehicles is projected to decline from 95% in 2017 to 78% in 2050 due to the growth in the sales of electric vehicles. Passenger cars are projected to gain market share relative to light-duty trucks because of higher fuel efficiency in periods when motor gasoline prices are projected to increase and because crossover vehicles, often classified as passenger cars, increase in availability and popularity. New vehicles of all fuel types show significant improvements in fuel economy because of compliance with increasing fuel economy standards. New vehicle fuel economy is projected to rise by 45% from 2017 to 2050.

The EIA estimates Oklahoma's statewide electricity generation mix is 41.22% natural gas, 31.88% wind, and 22.69% coal with the remainder made up of small percentages of hydroelectric, biomass, solar, oil, and miscellaneous fossil fuels. The percentage of wind-generated electricity in Oklahoma places us third in the nation, meaning more than a quarter of statewide power is generated without CO_2 emissions. As a result, electric vehicles in Oklahoma see reduced emissions not just from nonexistent tailpipe pollutants but also reduced pollutants from the generation of electricity that powers them. Thus, growth in all electric vehicles as well as renewable forms of electricity generation would generate significant reductions in emissions. Unfortunately, this may not be true of Oklahoma City EVs as OG&E's generation mix differs notably from the statewide generation mix, relying more on coal and natural gas with only about 10% of electricity generated renewably, principally wind. This is where that convergence of transportation and energy becomes important: part of the emissions reduction of EVs is determined by how the electricity used to power it is generated. All-electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and hybrid electric vehicles (HEVs) typically produce fewer tailpipe emissions than conventional vehicles. When measuring well-to-wheel emissions, electricity source is important: for PHEVs and EVs, part or all of the power provided comes from off-board sources of electricity. There are emissions associated with the majority of electricity production nationwide and this is reflected in OG&E's generation mix. EVs and PHEVs running only on electricity have zero tailpipe emissions, but emissions may be produced by the source of electrical power such as a coal-fired power plant. In areas that use relatively low-polluting energy sources for electricity generation, PHEVs and EVs typically have a well-to-wheel emissions advantage over similar conventional vehicles running on gas or diesel. Regions that depend heavily on conventional fossil fuels for electricity generation, may not see a well-to-wheel emissions benefit.

Ideally, a greater share of OG&E's electricity generation would come from renewable sources, thereby eliminating source emissions - CO_2 and nitrogen oxides and volatile organic compounds in particular - but also contributing by powering personal vehicles with little to no tailpipe emissions themselves.

Ultimately, the challenge with alternative fuels in general, but especially EVs, is determining what role local government can play in its expansion. Certainly, there is a revenue-based incentive for the City to see more EVs on the road as a result of both the OG&E franchise agreement remittance and the sales tax levied on utility bills. Yet the cost of infrastructure expansion is significant and it isn't clear precisely

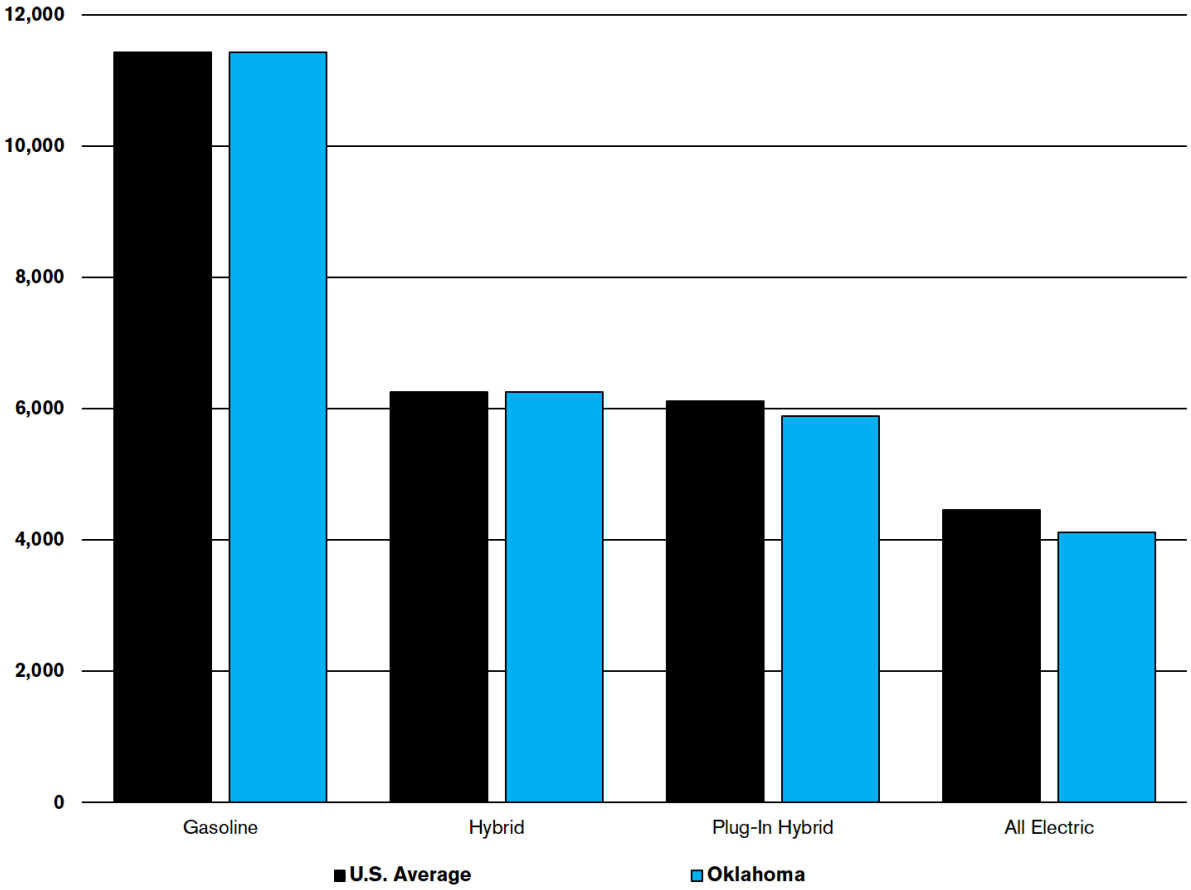
Figure AQ-11: Projected U.S. Sales of New Battery Powered Vehicles Per Thousand Vehicles, 2010 - 2050



Source: U.S. Energy Information Administration

There is little question as to whether or not electric vehicles will continue to penetrate the personal vehicle market; rather, the question is how the necessary charging infrastructure will keep pace.

Figure AQ-12: CO2 Emissions Comparison by Vehicle Type



Source: U.S. Energy Information Administration

Gasoline vehicles emit almost four tons more CO_2 than all electric vehicles.

"Oklahoma has a long history of alternative fuels leadership ... The state also looks toward a future with more electric vehicles on our roads as the availability of these vehicles increases and costs come down. Increased use of alternative fuels in transportation advances the nation's energy security and assists in regional efforts to remain in attainment of National Ambient Air Quality Standards."

- J. Michael Patterson
Former Executive Director
Oklahoma Department of Transportation

upon whom that cost will fall. It was not until January 2019 that the Oklahoma Corporation Commission allowed for the exemption of electric vehicle supply equipment/charging infrastructure from electricity resale laws. This is significant as it allows for customers to be charged and pay for electricity consumption "at the pump" rather than aggregating the electricity consumption costs into the property owner's account. But this harkens back to the chicken and the egg conundrum: will gas stations, parking garages, and business pay for the installation of EV charging stations without a notable presence of EVs driven by regional consumers? While the focus on adding public charging stations will be needed, some strategic focus will shift to increasing workplace charging and other strategies that increase demand for EVs.

The long-term effects of an underequipped EV-ready region, one without widespread, publicly-available charging infrastructure, could include decreased tourism and associated spending as EV drivers instead plan their trips from charging point to charging point.

Our Plan

Without strong efforts to reduce our emissions - both of CO_2 and ground-level ozone and its precursors - not only will the quality of our air degrade but so will the health of the public and the health of our economy.

Rather than suffer the burden of a federal nonattainment designation or a prospective emissions tax, Oklahoma City can work to proactively and responsibly curb emissions through more expanded bicycle and pedestrian infrastructure as well as expanded transit service. Determining a role in the expansion of alternative fuels is also necessary as helping that market develop in Oklahoma City can help replace existing, high-emissions VMT with low-to-no emissions commutes. We also cannot ignore the fiscal limitations we face in sustaining our transportation infrastructure and the increasingly outdated approach through which we receive street and road funding.

Safe, healthy air is a fundamental signifier of quality of life. As part of a transportation system that works for all users, eliminating emissions and pollutants must be part of the equation and at this crucial point in time we have the option of doing it ourselves or doing so under federal requirements.

Our Goals

EMISSIONS

1. **Safeguard Oklahoma City's attainment designation.**
2. **Secure funding for transportation infrastructure.**

Our Initiatives

Air Quality Initiatives	Goals 1	2
1. Reduce transportation emissions.	■	
2. Increase funding for transportation infrastructure.	■	■

"Good air quality in central Oklahoma is also an economic development issue. Companies that look to locate here consider our air quality as an important factor that contributes to their financial success and the health of their employees."

- Roy Williams
President and CEO
Greater Oklahoma City Chamber

INITIATIVE 1

REDUCE TRANSPORTATION EMISSIONS

Establish a greenhouse gas emissions reduction target. To measure Oklahoma City's progress reducing transportation sector greenhouse gas (GHG) emissions, we must first establish an emissions benchmark by identifying major sources of GHG emissions both for City operations and community-wide. Once established, the inventory should be updated every five years to demonstrate changes in GHG emissions.

Reduce idling in City vehicles. Extended periods of idling in City vehicles not only contributes unnecessary emissions but wastes public resources. A comprehensive analysis should be performed to quantify idling time/fuel losses and a plan developed to recommend strategies to reduce idling.

Improve accessibility and expand the number of shelters at bus stops. To encourage use of the bus system and to protect riders from the extremes of Oklahoma weather, every bus stop should include a shelter from the wind and rain and connect to a network of sidewalks. Negative perceptions of public transit accessibility is a primary deterrent to new riders and creates daily challenges for existing riders.

Increase use of alternative fuel vehicles in City fleet including buses when operationally appropriate. EMBARK operates 49 total buses in the public transit system, 19 of which use CNG for fuel and the remaining 30 use diesel. Diesel engines are a primary source of vehicle emitted particulate matter and nitrogen oxides and provide a major opportunity to reduce emissions associated with public transit service. With more than 2.8 million service miles driven each year, the reduction of more than 31 annual tons of NOx and PM2.5 emissions would equate to about $650,000 in annual health benefits according to the EPA.

Support electric vehicles. Electric vehicle use reduces emissions and supplements City revenue for road maintenance through sales tax and franchise fee collections. Providing and promoting a public network of reliable fuel sources for EV users will remove perceived barriers to EV ownership and minimize emissions associated with metro-area commutes.

Support bicycle commuting. Residents have voiced support for more choices in how to get to work. The City should create a safe environment for bicycle commuters and provide secure bicycle parking solutions to encourage choosing active transportation. Decreasing the number of single occupancy vehicles in Oklahoma City metro commutes will not only reduce congestion and associated emissions, but will also mitigate wear and tear on highways and City streets.

Analyze potential long-term impacts of automated vehicles. Driverless vehicles are a major component in long-term transportation planning, as many sectors such as freight and ride sharing are already conducting on-road tests to refine the technology. Oklahoma City, located at an intersection of major freight corridors, is positioned to take advantage of this opportunity, but must adapt policy positions and infrastructure that will embrace the benefits and minimize disruptions.

POLICIES

AQ-1: Partner with regional and state agencies to estimate economic impact of nonattainment.

AQ-2: Conduct greenhouse gas emissions inventories at minimum every five years to capture both City operations and community-wide emissions.

AQ-3: Use emissions data to establish reduction targets.

AQ-4: Develop an emissions reductions strategy.

AQ-5: Increase the number of publicly-available electric vehicle charging ports and promote locations online.

AQ-6: Conduct analysis of City fleet use and establish target for percentage of fleet comprised of electric vehicles.

AQ-7: Develop strategy and implement process to reduce idling in municipal vehicles.

AQ-8: Promote local, state, and federal alternative fuel incentives and vehicle emissions standards.

AQ-9: Require "EV-ready" construction to ensure new public buildings are suitable for electric vehicle supply equipment.

INITIATIVE 2

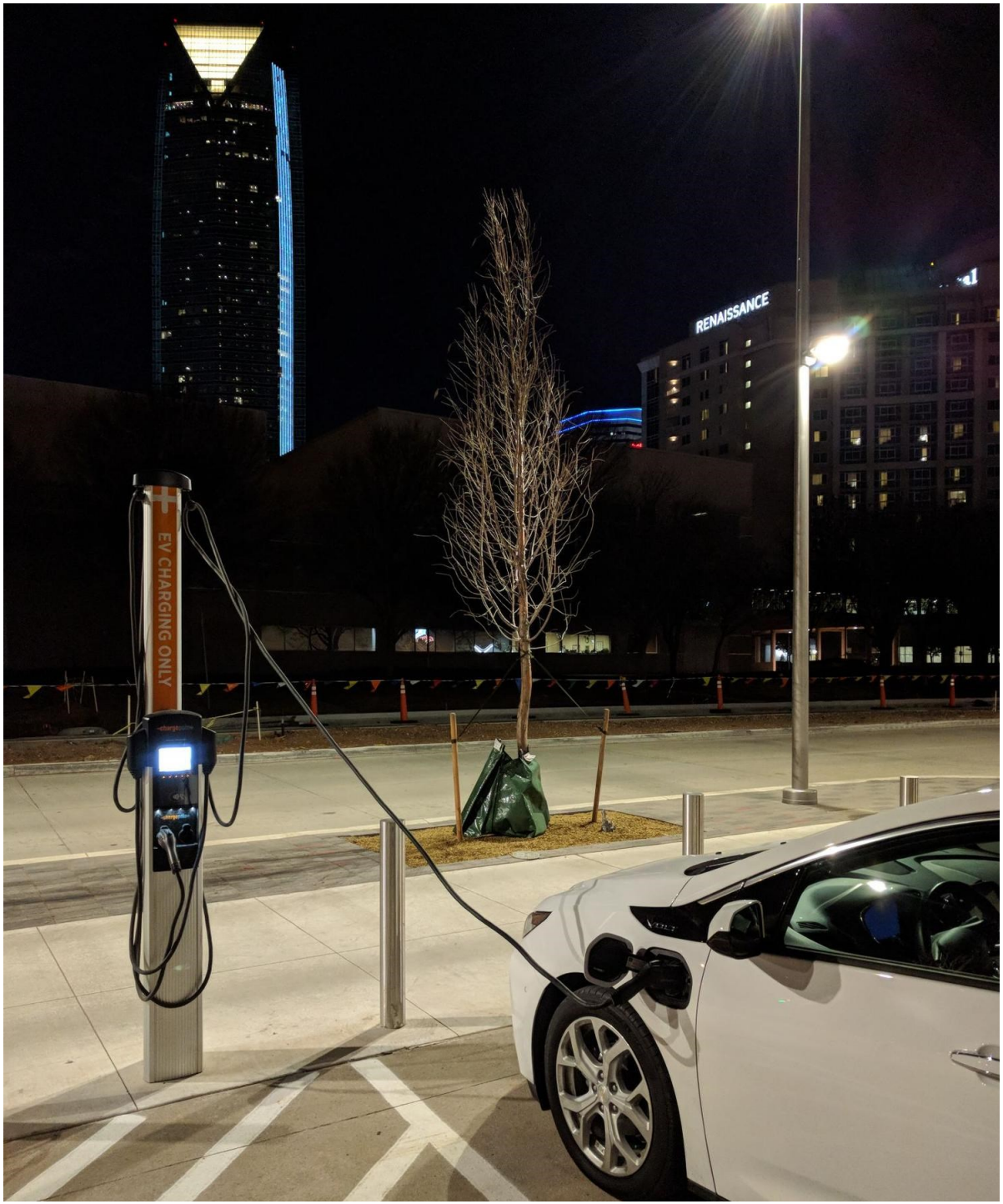
SECURE FUNDING FOR TRANSPORTATION INFRASTRUCTURE

Support development of statewide fuel tax alternatives. Fuel efficiency standards established in the 1970s coupled with the introduction of a growing number of alternative fuel vehicles on Oklahoma roads will continue the downward trajectory of local tax remittances from gasoline and diesel consumption. Municipal agencies responsible for street maintenance need assured funding for the future.

Partner with local, regional, and state agencies to study effects of nonattainment. The three-year regional air quality values are edging near the EPA's threshold for a non-attainment designation. This designation would initiate new processes, like New Source Review and Transportation Conformity, that would affect the City's economy. It is vital to understand the reach of these impacts before a non-attainment designation is affirmed.

POLICY

AQ-10: Advocate to amend the state apportionment formula for motor fuels to increase gasoline and diesel tax remittance to cities and towns.



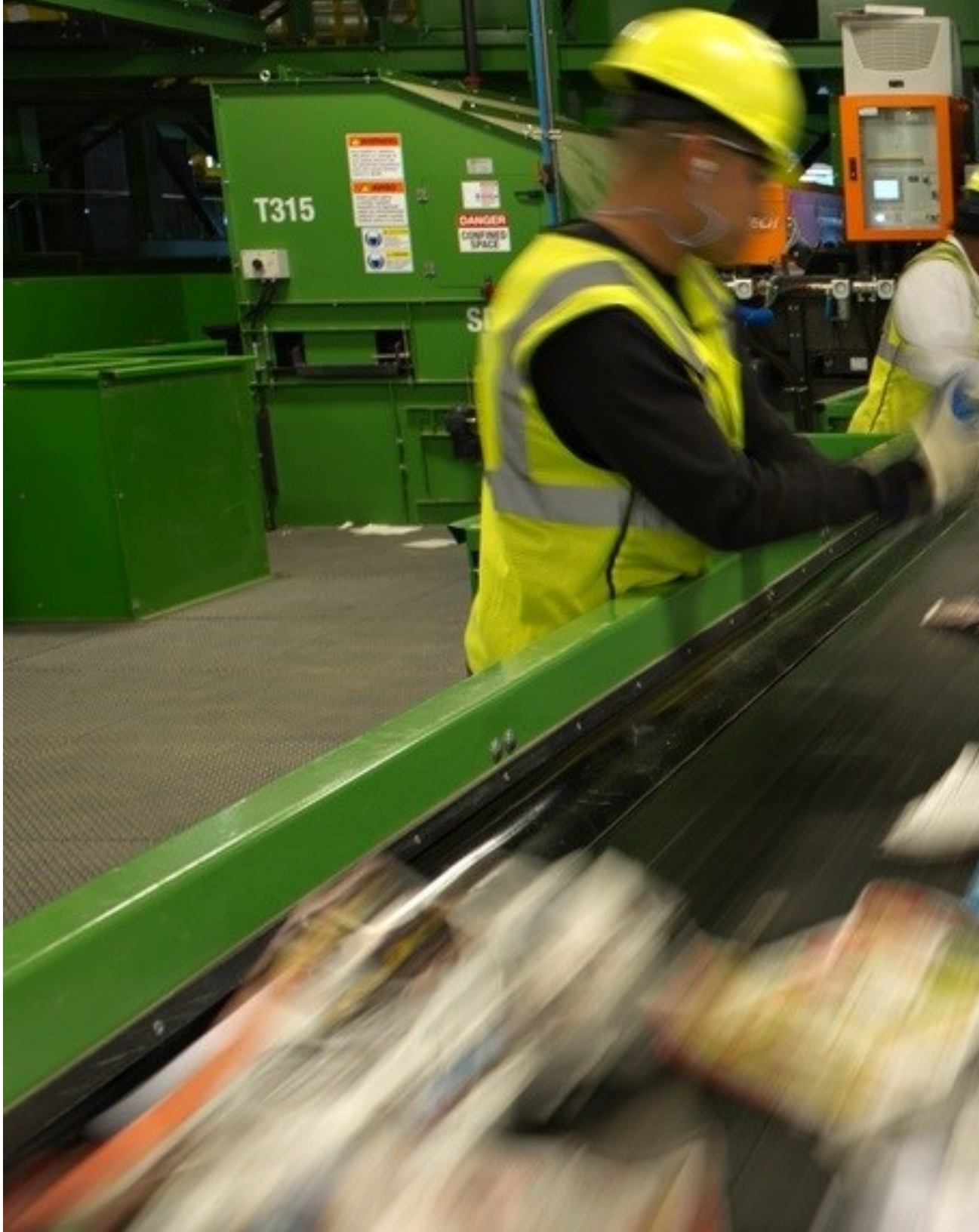
RIGHT: An electric vehicle is connected to a charging port at the recently renovated Santa Fe Transit Hub along E.K. Gaylord Blvd.

chapter five

waste reduction

CHAPTER 5:

WASTE & RECYCLING



Our Situation

Oklahoma City residents and businesses "throw away" most of what they use on a daily basis. The problem is that "away" means buried in a landfill. In *Waste & Recycling*, we examine the economic, environmental, and public health impacts of landfilling a majority of Oklahoma City's waste, market factors that affect recycling, and the industries that recover and reuse materials. We propose to enhance existing recycling programs, expand efforts to recover materials in sectors beyond single-family residential, and emphasize the role of producer responsibility in waste generation and reduction.

From FY15 to FY17, an average of more than 97% of the total materials collected at the curbside, including bulk waste and recycling collections, were sent to landfills. In those three years, Oklahoma City residents sent an annual average of more than 295,000 tons of waste materials from their curbsides to landfills in the city. That equates to about 3,077 pounds of landfilled waste per Oklahoma City recycling customer (192,389) annually – more than double the 1,352 pounds of landfilled trash per recycling customer in Austin, Texas and 1,400 pounds more than the U.S. average of 1,635 pounds per person (**Figure WR-1**).

Oklahoma City's land area and low population density means waste haulers need to drive more to collect and deliver trash and recycling. More heavy trucks driving further distances means higher costs to the waste company, City, and, ultimately, residents. Burying waste under existing mountains of trash might seem cost-effective today, but this method of waste management degrades nearby land values and disproportionately impacts low-income residents.

The nearly 300,000-ton annual average for residential waste collected at the curbside during that time frame represents only 18% of the total tonnage received at these three landfills. This effectively means about 82% of the materials arriving at landfills in Oklahoma City originates from non-residential uses or other municipalities.

Each year, Norman and Moore send a combined average of nearly 122,000 tons of residential waste to Southeast Landfill (about 22% of Southeast Landfill's total average annual tonnage), while Midwest City and Edmond combined deliver around 99,000 tons of residential waste to East Oak Landfill (about 25% of East Oak's total average annual tonnage). Yukon and Mustang both bury residential trash in a Union City landfill owned by Oklahoma Environmental Management Authority, a public trust that serves communities outside Oklahoma City.

Including Oklahoma City tonnage, residential curbside trash collections from municipalities in the metro area with more than 50,000 residents (Moore, Norman, Edmond, and Midwest City) comprise approximately 32% of the average annual tonnage received at the three active landfills in Oklahoma City. As such, it's apparent that most of the materials delivered to these landfills originates from sources beyond curbside residential solid waste customers, such as commercial (office, multi-family, retail, etc.), industrial, construction/demolition.

In addition to routine waste generation, the effects of Oklahoma's severe weather can produce spikes in the amount of waste sent to landfills. Following severe weather and tornado events in May 2013, Oklahoma City crews collected and landfilled more than 798,000 tons of debris which is more than 2.7 times the average annual amount of waste generated by all the City's residential curbside solid waste customers. Including storm debris from other cities affected by the disaster declaration, the tonnage sent to two landfills in Oklahoma City increased by a combined 47% (34% and 61%) over the previous year.

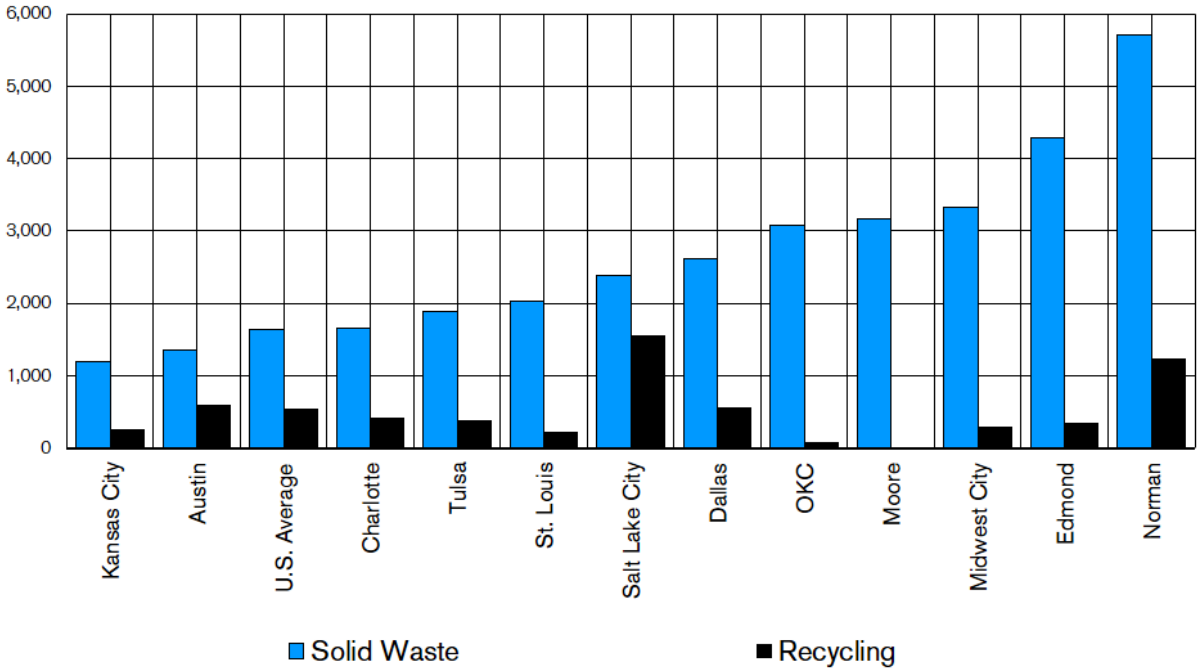
The most prominent alternative to landfills is recovery of materials through recycling. In addition to delaying costly landfill expansions, recycling conserves natural resources by reducing demand for

raw materials and supports several industry sectors associated with the collection, separation, cleaning, production, distribution, storage, and transportation of paper, metals, plastics, glass, rubber, construction and demolition materials, electronics, and organics. Materials made from recycled content reduce energy needs and produce less pollution compared to manufacturing new products using virgin materials when considering the embodied energy required to extract and process raw resources like ore, oil, or wood. Aluminum production, for example, uses a tremendous amount of heat and electricity – more than any other manufactured product in the U.S. – to isolate the aluminum metal from aluminum ore. If a manufacturer is using recycled aluminum metal, the metal skips this energy-intensive extraction and refinement process and requires 94% less energy to produce aluminum from ore.

In Oklahoma City, more than 90% of the City's solid waste customers in single-family residential households have access to curbside recycling and customers outside the curbside program area can recycle at drop-off locations. In July 2018, the City introduced 96-gallon rolling carts to replace 18-gallon containers. Through the first year of collections, this drastic capacity boost increased the amount of recyclable materials diverted from landfills by 134% compared to FY18 (7,348.98 tons collected July 2017 to June 2018).

The success of the expanded residential recycling program is a testament to the desire of residents to recycle more of the materials they "throw away." Commercial and multifamily properties generate higher volumes of waste than residential properties, but there is no public collection or incentive program to increase landfill diversion from these sites. In Oklahoma City, one in four residents (159,327) live in properties with more than two residential units and are unlikely to have convenient access to recycling. Of 136 multifamily properties contacted by phone in the summer of 2018, only 10% said they offer recycling service to tenants. With few exceptions, most commercial and multifamily property owners choose to only pay for hauling of waste to landfills as required by state law (41 OK Stat § 41-118).

Figure WR-1: Average Pounds of Landfilled Solid Waste Per Municipal Recycling Customer, FY15 - FY17



Oklahoma City residents with access to the curbside recycling program landfill more materials per customer than many peer cities across the U.S., but account for less landfilled waste per customer than other cities in the metro area. The pounds landfilled per person is expected to decrease as the available data does not include the introduction of the larger-capacity recycling carts. Despite this positive change, the data highlights a need for a broader shift in perception and greater diversion of materials beyond the curbside recycling program.

Recycling viability has long been subject to the fluctuations of economic markets as the value of recovered materials are tied to commodity prices and industry demand for processing and manufacturing. However, the industry is facing unprecedented challenges due to tighter regulations and outright bans on some materials from scrap export destinations like China, Vietnam, Thailand, Malaysia, and Indonesia. Most recyclables collected in Oklahoma City are processed in the U.S. or Mexico, but increased scrutiny abroad has led to a flood of new materials arriving at domestic processing facilities. These surplus materials and global market shifts have sunk commodity prices and tightened domestic contamination thresholds.

To establish a sustainable, circular economy and mitigate negative land use impacts associated with waste disposal, we must provide more recycling access to residents and businesses, compost/mulch more green waste, and seize economic development opportunities to incubate local processing capacity.

Landfills

There are three active, privately-owned landfills within Oklahoma City: Southeast Oklahoma City Landfill owned (majority share – 45%) by Republic Services, Inc.; East Oak Landfill owned by Waste Management, Inc.; and OKC Waste Disposal Landfill owned by Waste Connections, Inc. A fourth landfill, Northeast Landfill, owned by WCA, operates outside the city limits in Spencer and only accepts construction and demolition debris. Oklahoma City spends about $5 million each year for these four landfills to accept residential and commercial waste.

While landfills may not be the most desirable long-term option for waste disposal, the regulations governing the design and operation of modern landfills have significantly advanced since the days when city dumps employed thousands of hogs. Siting location specifications, hazardous material prohibitions, engineered structure designs, and reclamation and reuse requirements all foster greater environmental protection from use of landfills. Modern landfill design also requires protective liners of clay or plastic to support collection and treatment of any liquid (also known as leachate) that could contaminate groundwater.

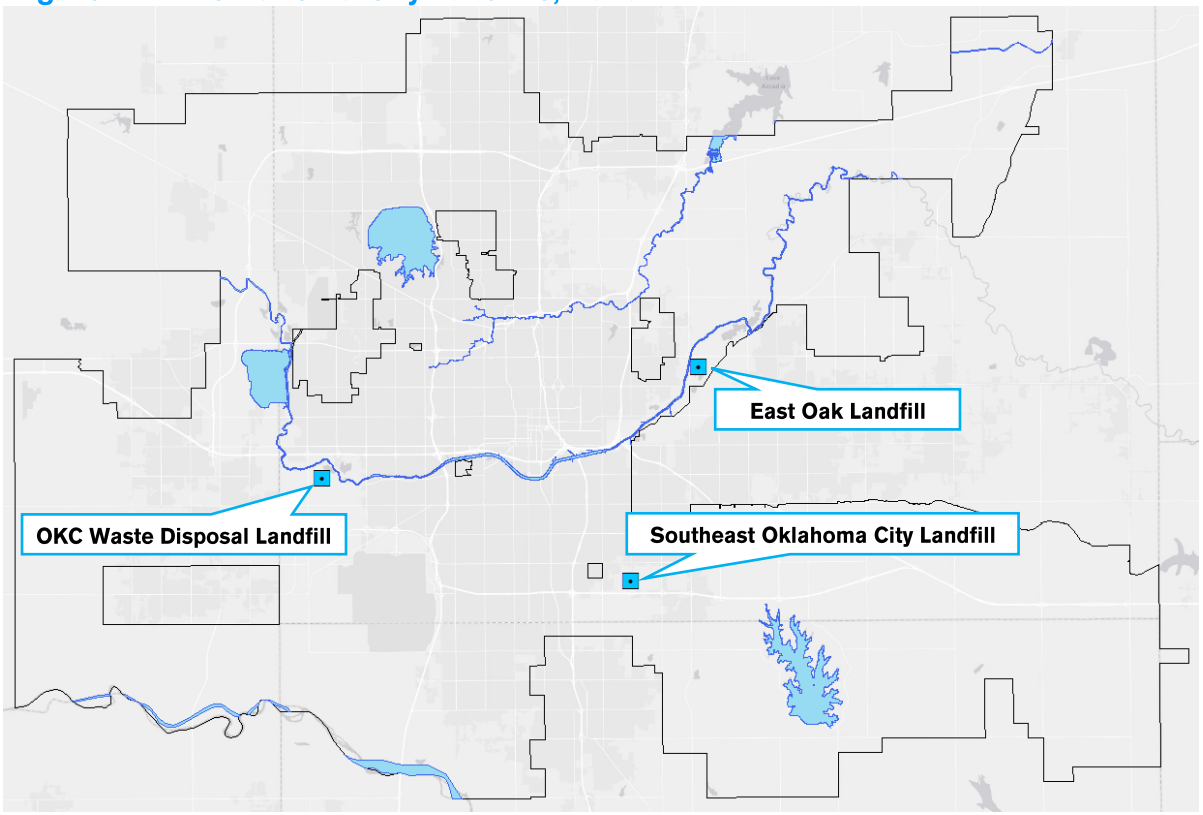
As landfills near capacity, owners can either close or seek to expand the boundary of the site which also affords additional vertical capacity. If the owner decides to close a landfill, the waste is typically sealed under a polyethylene cap, compacted soil, and grass seed. State law requires the entity that owns the landfill to maintain financial assurance of the site after closure and provide post-closure care for a minimum of 30 years. Alternatively, this presents development opportunity for the site to continue to provide community benefit, such as park space, golf courses, or energy production.

In Atlanta, Republic Services used a dual-purpose landfill closure system that included a 10-acre solar array atop Hickory Ridge Landfill to both meet regulatory requirements of closure and provide enough electricity to meet the needs of 224 homes. Balloon Park in Albuquerque, Tifft Nature Preserve in Buffalo, Cesar Chavez Park in Berkeley, McAlpine Creek Soccer Complex in Charlotte, and Rogers Park Golf Course in Tampa are just a few examples of highly-successful parks created in the place of closed landfills. As data is scarce for disposal sites closed prior to 1990, Oklahoma City officially has one closed landfill, Fillsand, which is owned by Republic Services, Inc. and located north of I-40 between Council Road and Morgan Road. Fillsand's location offers several reuse possibilities with Oklahoma City's West River Trail winding along its western edge and proximity to OG&E's Mustang power plant.

Closing a landfill presents opportunities for redevelopment, but also creates new, more expensive challenges: deciding where to place the next one and how to efficiently route refuse trucks to the new location. Living next door to the metro area's buried trash is less than ideal for most homeowners and moving the landfill to the outskirts of the city can drastically increase fuel and maintenance costs for haulers and subsequently residents.

Expanding a landfill often involves rezoning nearby properties to widen the base which allows the landfill to grow taller, too. Most recently, Oklahoma City Council approved a zoning change in 2012 to allow expansion of Southeast Oklahoma City Landfill near SE 59th and South Bryant from 153 acres to 373.96 acres. The approval and expansion extended the estimated year of closure per annual regulatory

Figure WR-2: Oklahoma City Landfills, 2019



Three landfills, all privately-owned and operated, are currently permitted within Oklahoma City.

reports to the EPA from 2021 to 2053, avoiding closure of the site and eventual opening of another landfill in or around the city.

While expansion can delay major investments and a lengthy public process needed to create a new site to bury materials, landfill growth increases the number of households whose property values are negatively affected by proximity to a high-volume disposal site.

Property values are important, even for a sales tax-reliant city, as they directly affect a municipality's ability to leverage debt through general obligation bonds.

Landfill Gas Capture. As organic materials break down over time at these landfills, a potentially dangerous byproduct is produced – landfill gas. Landfill gas is largely a combination of carbon dioxide and methane, both potent greenhouse gasses that trap heat in the atmosphere and contribute to climate change.

Landfills in Oklahoma are required to limit methane emissions to 5% by volume and the Clean Air Act requires larger facilities with gas emissions greater than 55 tons per year to install a system to collect and either destroy or reuse landfill gas. All three active landfills in Oklahoma City have installed gas-capture technology and can provide profitable opportunities for industrial or manufacturing near the landfill or can be used to fuel refuse truck fleets, displacing diesel fuel and reducing smog-causing NOx emissions.

Most recently, Republic Services partnered with Aria Energy and BP PLC to capture, refine, and sell methane produced at Southeast Landfill. According to developers of the $25 million project, the facility is expected to offset more than 16,000 tons of methane emissions. At the East Oak Landfill, a joint venture called ENVIA between Waste Management, NRG, Ventech, and Velocys constructed a gas-to-liquids plant that can simultaneously process both landfill gas and natural gas to produce diesel, synthetic waxes, kerosene, synthetic motor oil, and other oils used in fuel blending and processing. The products made from this process do not contain aromatics or sulfur so they burn cleaner than petroleum-derived fuels with lower emissions of nitrogen oxides, sulfur oxides, and particulates.

ABOVE: HICKORY RIDGE LANDFILL IN ATLANTA, GEORGIA

Hickory Ridge Landfill reached capacity and was capped in 2011 by a $5 million investment by Republic Services, offset in-part by a $2 million grant from the Georgia Environmental Finance Authority (GEFA). 7,000 thin-film photovoltaic solar panels were attached to a geomembrane designed for roofing applications, and vertically-anchored to the sides of the landfill to provide a protective seal. This alternative to a traditional landfill cap not only generates revenue from obsolete land, but also reduce maintenance costs of mowing and soil replacement.

Land Use Impacts. Due to recent expansions, the landfills in Oklahoma City are not short on capacity today. OKC Waste Disposal has estimated capacity to operate for another 10 years while East Oak and Southeast have estimated capacity for 20 and 40 years, respectively. However, with each expansion, more existing properties are impacted and more land in the city is effectively unusable for development, at least until the landfill closes.

Multiple studies have documented the effect on property value based on proximity to landfills.

While these studies differ in methodology and cannot be reliably replicated within the context of Oklahoma City, the body of literature provides a foundation to understand what impact landfills might have on nearby development.

A 2010 study published in the *Journal of Real Estate Research* suggests the percentage of property value depressed is a function of the quantity of waste the landfill accepts per day. Landfills categorized as high-volume - defined as those receiving 500 tons or more per day - made the largest impact on property value in the study sample.

All three of the landfills in Oklahoma City meet this definition of high-volume with each averaging well over 1,000 tons per day. The following three pages feature each of the three active landfills within Oklahoma City mapped with corresponding radii to highlight residential development within. All show three boundaries based on distances of half-mile, one and a half miles, and two and a half miles from the landfill parcels. An outer limit of 2.5 miles was used as an average of outer limits applied in prior studies.

Additionally, Census data was pulled from EPA's EJSCREEN tool for information on the residents within these areas. While the addition of a new landfill in Oklahoma City is unlikely as existing landfills would pursue expansion rather than closure, there is an inescapable future wherein our waste compels the addition of a landfill.

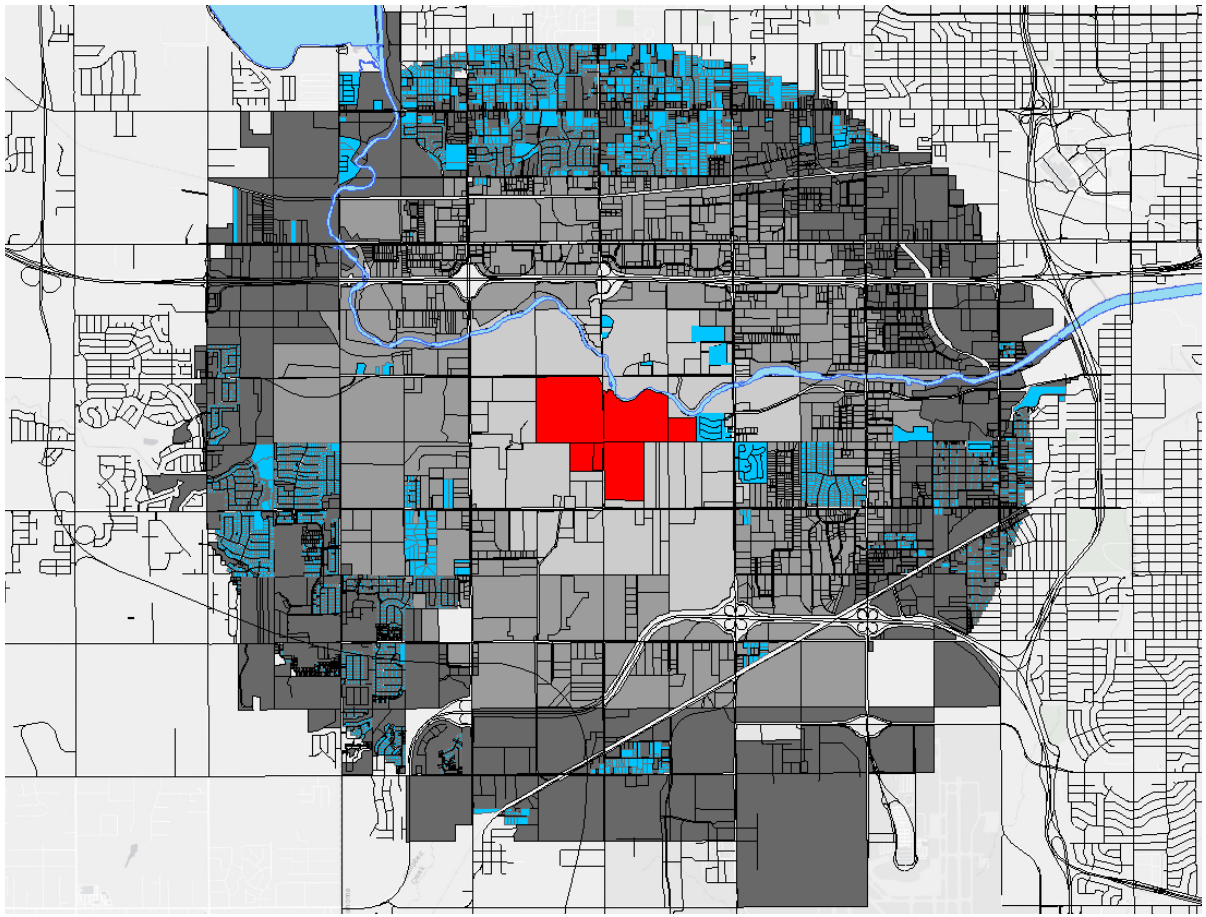
This reality will grow no easier as the years and decades progress and Oklahoma City - as well as abutting suburban communities - continue to expand within their corporate limits. The sprawling land area of Oklahoma City complicates waste service from a logistical (and therefore financial) perspective but, above all, the addition of any new landfill raises questions of environmental justice and how the selection of such a site might impact the properties and residents surrounding it. These are long-term but important questions about Oklahoma City's future growth.

It is important to recognize that rather than an argument against landfills, the application of this methodology to Oklahoma City is intended to demonstrate the potential return on greater waste diversion. The benefits are two-fold: first, a reduction in landfilled waste delays landfill expansion which would require additional parcels and increase the radii of impacted properties; and second, any depression of property value affects the amount of bonding debt the City can access through general obligation bonds for decennial operating and maintenance funds.

Source: Richard B. Meeks, the Oklahoman, 1946

The management of solid waste has progressed tremendously since the early-to-mid 20th century. This photo appeared in the January 10, 1946 edition of *The Oklahoman* as City leaders rebuffed accusations from County officials regarding the status of the dump as a "public nuisance and general health hazard."

Figure WR-3: Residential Development Near OKC Waste Disposal Landfill



Landfill Parcels

Boundary One: 0 to 0.5 Miles from Landfill Parcels

Boundary Two: 0.5 to 1.5 Miles from Landfill Parcels

Boundary Three: 1.5 to 2.5 Miles from Landfill Parcels

Residential Parcels

OKC Waste Disposal Landfill

7600 SW 15th Street

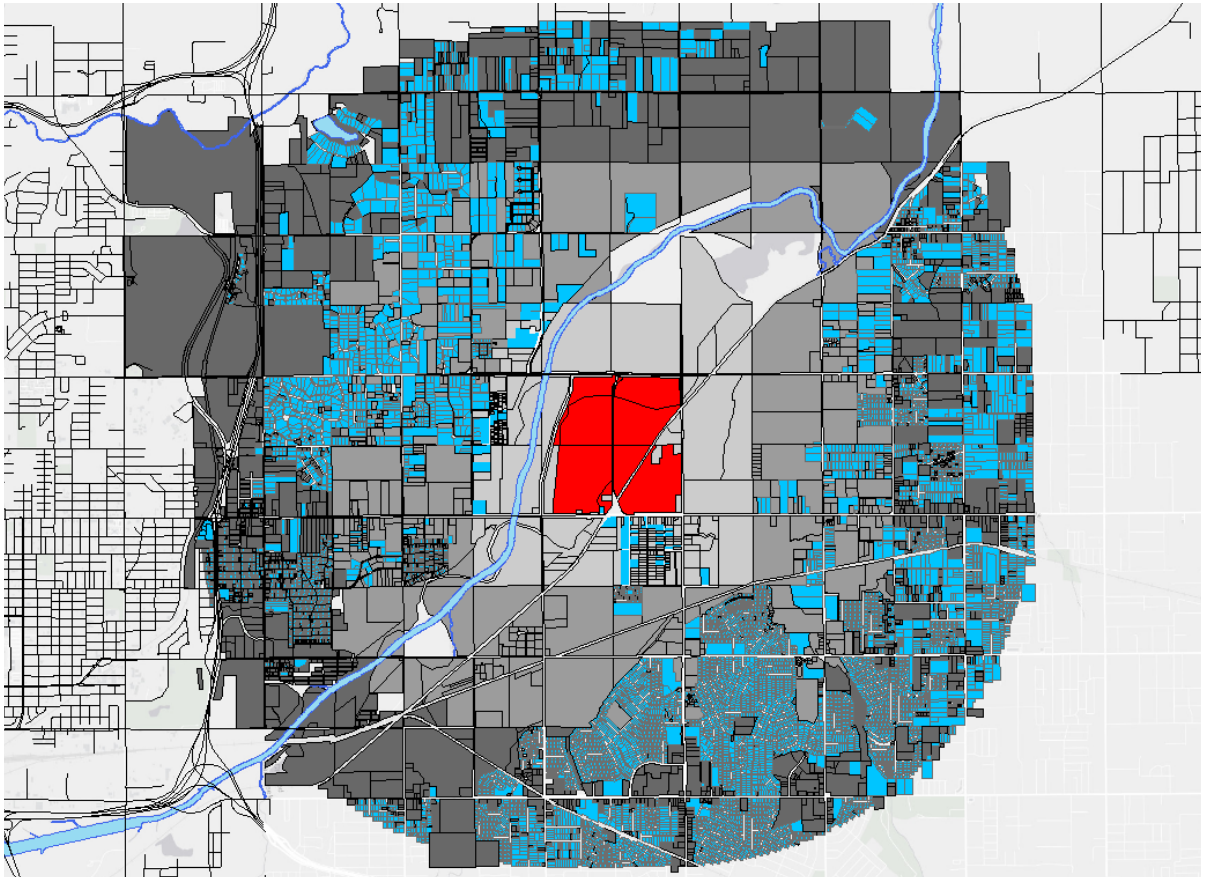
Opened:	1981
Estimated Closure:	2025
Surface Area of Waste:	136 acres
Waste Capacity:	9.7mm tons
Average Annual CO_2 Emissions:	257,138 tons

The entire area within 2.5 miles of the OKC Waste Disposal Landfill parcels is comprised of approximately 9,572 parcels of which about 55% are residential. Those residential parcels, however, only make up about 10% of land area as residential parcels are significantly smaller than commercial and industrial parcels. American Community Survey five-year estimates from 2012 to 2016 place the area's population at 25,702 with a 49% minority population.

Within Boundary One are 136 parcels of which 35 are residential, with the majority (77%) of these residential properties being mobile homes; however, these residential parcels are 4% of Boundary One's total acreage.

The 33 industrial parcels of Boundary One comprise almost 35% of the area and the 49 undeveloped parcels making up the largest share at about 47%. Boundary Two encompasses 1,753 parcels with 612, or about 35%, residential. Industrial is still a major use with 755 parcels making up almost half of Boundary Two's land area. In Boundary Three, 60% of parcels are residential but comprise just about 17% its land area.

Figure WR-4: Residential Development Near East Oak Landfill



Landfill Parcels

Boundary One: 0 to 0.5 Miles from Landfill Parcels

Boundary Two: 0.5 to 1.5 Miles from Landfill Parcels

Boundary Three: 1.5 to 2.5 Miles from Landfill Parcels

Residential Parcels

East Oak Landfill

3201 Moseley Road

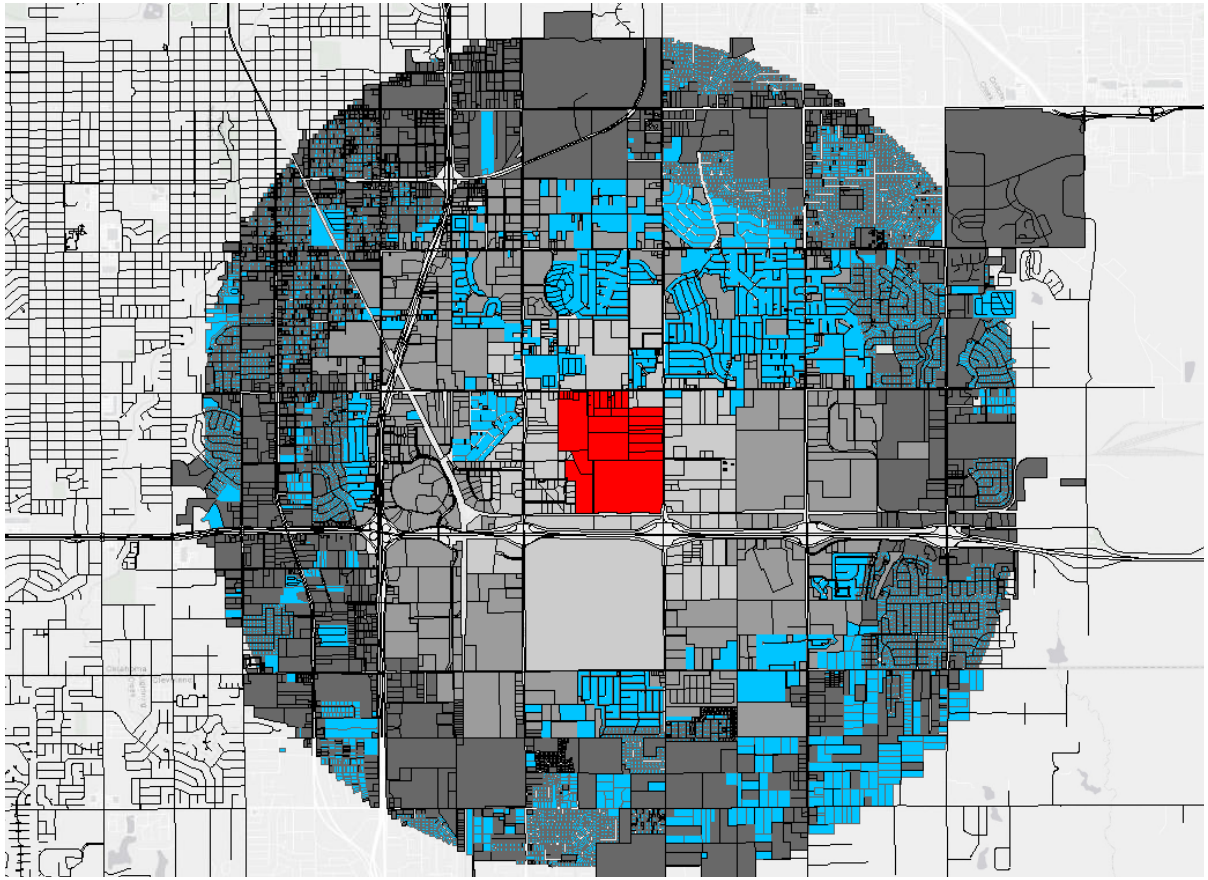
Opened:	1973
Estimated Closure:	2039
Surface Area of Waste:	167 acres
Waste Capacity:	19mm tons
Average Annual CO_2 Emissions:	165,748 tons

The 2.5 mile radius from the East Oak Landfill parcels includes portions of Oklahoma City as well as Midwest City, Spencer, Forest Park, Lake Aluma, and unincorporated portions of Oklahoma County. Within this total area, five-year estimates from 2012 to 2016 via the American Community Survey place population at 30,663 with 14,354 housing units.

About half of the parcels in Boundary One are residential yet make up just 10% of the land area closest to the landfill. Boundary Two is 90% residential and Boundary Three is 91% residential, primarily because neighboring municipalities have dense residential development nearby.

East Oak is sited within a 100-year floodplain but because it was permitted prior to the 1994 adoption of certain state laws, it is exempt from current floodplain siting restrictions but must nonetheless comply with state statutes to ensure the landfill does not restrict the floodplain's storage capacity, flow, or result in floodwaters carrying away solid waste.

Figure WR-5: Residential Development Near Southeast Landfill



Landfill Parcels

Boundary One: 0 to 0.5 Miles from Landfill Parcels

Boundary Two: 0.5 to 1.5 Miles from Landfill Parcels

Boundary Three: 1.5 to 2.5 Miles from Landfill Parcels

Residential Parcels

Southeast Landfill

7001 South Bryant Avenue

Opened:	1950
Estimated Closure:	2067
Surface Area of Waste:	150 acres
Waste Capacity:	38mm tons
Average Annual CO_2 Emissions:	121,495 tons

The 2.5 mile radius of the Southeast Landfill is occupied by a significant amount of residential parcels which is not surprising given its proximity to the crossroads of I-35 and I-240. In Boundary One, about 78% of parcels are residential but just 12% of land area. Parcels in both Boundary Two and Boundary Three are predominately residential at 85% and 88%, respectively. In Boundary Two, 28% of the total land area is residential while in Boundary Three the residential coverage is about 40%.

Recycling

Recycling is comprised of a series of processes that involve several industries each with quality standards to ensure recovered materials can be used to make new products. First, recoverable materials – plastics, non-ferrous metals (aluminum, tin), fibers (paper and cardboard), and glass – whether collected commingled ("single stream") or pre-sorted are transported by a refuse hauling company to a Materials Recovery Facility (MRF).

MRFs are specialized facilities that accept discarded materials from residential and commercial sources then separate and prepare recyclables for end-user manufacturers. At the MRF, the materials are thoroughly sorted by type and compressed into bales. The bales of recyclables must be cleaned and prepared at processing centers before the materials are suitable for sale to manufacturers who can use the recovered raw materials to make new products. To reach manufacturers' cleanliness and granularity requirements, each material undergoes unique, thorough processing before they are sold and used for new products.

Aluminum is baled and sent to a processing plant where it is shredded, melted and formed into a raw material called ingot which is used to make aluminum sheets that are sold to manufacturers to make new products. In Oklahoma, there are numerous metal recycling facilities that help keep costs competitive.

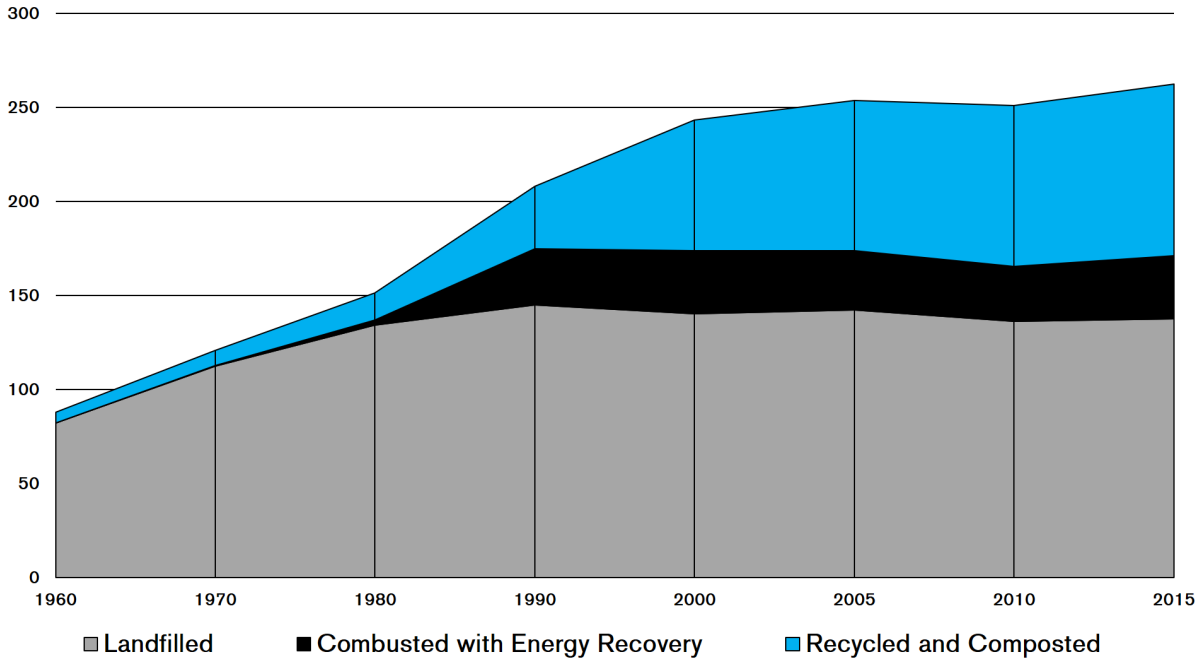
Paper is sorted, baled, and sold to a pulping facility where it is soaked and heated to separate fibers and ink. The pulp is screened to remove additional impurities like adhesive and then pressed into sheets for marketing to a variety of end uses. Like recycled metals, there are several paper mills that can process paper fibers for recycling in Oklahoma, which reduces shipping costs.

Plastic is sorted by type and baled at MRFs as most need to be processed separately from other plastic types. The bales of plastic are sold to processing plants that wash, chop into flakes, and separate using large floatation tanks. Once dried, the flakes are melted and any remaining liquid is screened to remove impurities which translate to potential weaknesses in new products. The screened plastic is chopped into clean, granular pellets that can be sold to manufacturers.

Glass in Oklahoma is typically collected with other waste streams and, as such, often contains significant contamination. At the MRFs, glass is usually broken and discarded to a collection bay early in the sorting process. Depending on the agreement between a buyer and seller, the pieces of broken glass, called glass cullet, may need to be a specific size and/or contain less than an established threshold for contaminants to be sold for a worthwhile price per ton. In fact, many manufacturers require recycled glass be "furnace-ready," which means the cullet must be sorted, cleaned, crushed, and sized – a process called beneficiation.

Glass from Oklahoma City's MRFs must be shipped to one of the two closest beneficiation plants located in Okmulgee – over 100 miles from Oklahoma City – or Midlothian, Texas – over 228 miles away from Oklahoma City. As such, transportation costs present a major challenge to the economics of recycling glass from Oklahoma City.

Figure WR-6: U.S. Municipal Solid Waste By Method of Disposal in Millions of Tons, 1960 - 2015



With renewed attention to the economic and environmental benefits of recycling and better public access to recycling programs, the share of Municipal Solid Waste (MSW) that was recycled and composted in the U.S. more than doubled each decade between 1980 and 2000, but this rate of growth has slowed in recent years.

International Commodity Markets. Modern recycling programs in the U.S. were built on the foundation of China's high demand for scrap materials and low-cost labor. Since the 1980s when Americans only recycled 9.6% of the municipal waste stream, the EPA reports recycling volumes in the U.S. have tripled, passing 89 million tons in 2014 with most of the materials exported to China. According to the Institute of Scrap Recycling Industries Inc., more than two-thirds of U.S. paper and over 40% of plastic collected for recycling in the U.S. were exported to China.

In early 2017, Chinese authorities initiated the 'National Sword' operation to crackdown on use of illegal permits for smuggling operations, but the inspections also targeted contaminated recyclable materials, such as paper with high moisture content and low-grade plastics. After confirming a ban on some materials – specifically recovered mixed paper; recycled PET, PE, PVC and PS; textiles; and vanadium slag – the Chinese government stopped issuing import permits, effectively halting recycling exports from the U.S. and tanking commodity prices.

In November 2017, China established a new contamination rate threshold of 0.5% - far lower than most domestic waste companies can achieve under current program structures and processing systems – and began enforcement in March 2018. As of August 2018, Malaysia, Thailand, and Vietnam followed-through with plans to enact restrictions on new import licenses and bans of some materials, further reducing export options.

Without the recycling import giant as a destination and with alternative scrap importers also diminishing markets in Asia creating a surplus of domestic scrap materials, U.S. processing plants continue to pay less for recovered materials further driving down commodity prices.

End-user convenience (single-stream recycling) has been relied upon to boost recycling participation but has also led to more unrecyclable recyclable materials due to contaminants in the recycling bin. The National Waste and Recycling association estimates an average 25% of the materials Americans attempt to recycle ends up landfilled due to contamination.

Source: China Photos/Getty Images

Used plastic bottles remain heaped up at a recycling mill in Wuhan of Hubei Province, China. In July of 2017, China, which is by far the world's largest importer and recycler of scrap metals, plastic, and paper, notified the World Trade Organization that it planned to effectively ban imports of 24 types of scrap, which its environment ministry called "foreign garbage."

"Everything we use comes in boxes, cartons, bins, the so-called packaging we love so much. The mountain of things we throw away are much greater than the things we use."

- John Steinbeck
"Travels with Charley: In Search of America," 1962

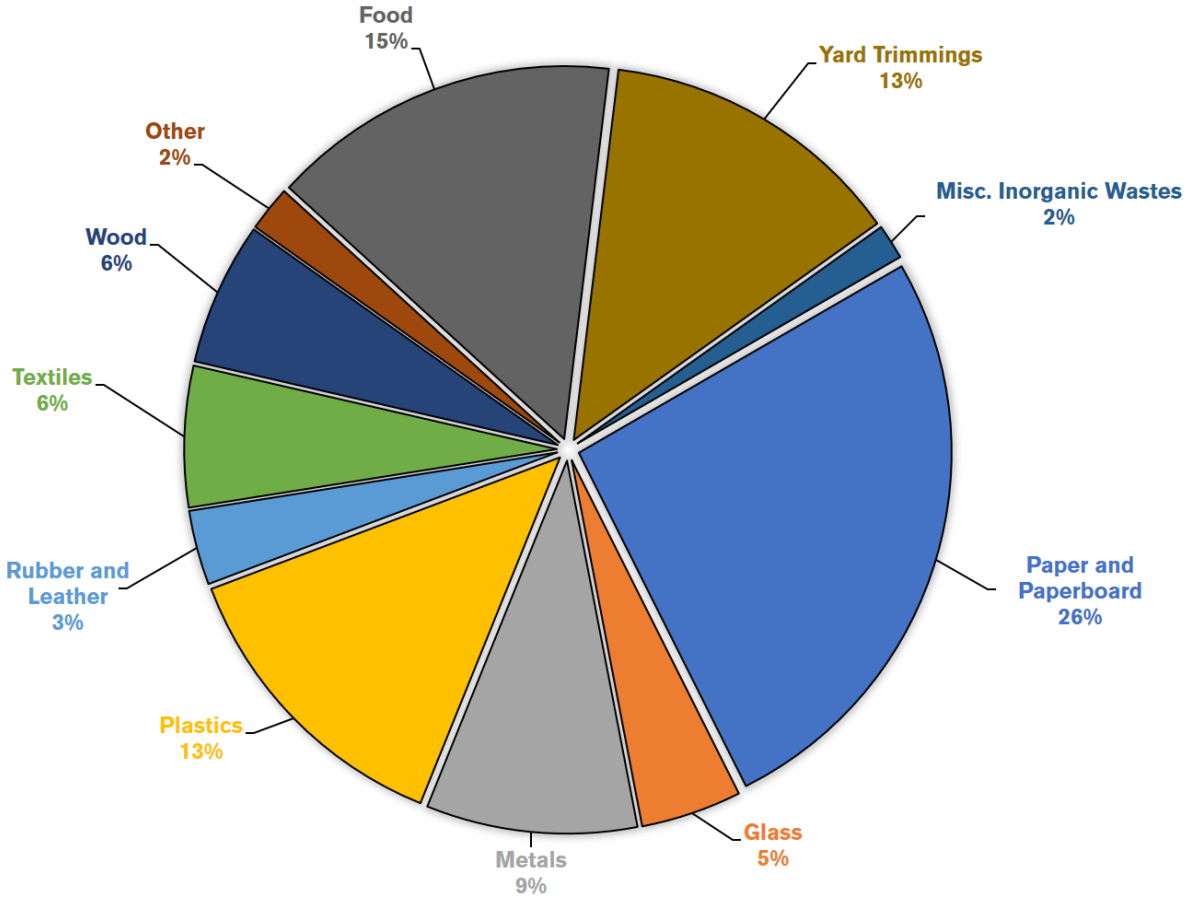
Waste Characterization

To significantly increase the amount of materials recovered through recycling, it's important to understand where the materials originate (sources that create and/or use the materials), but it's crucial to determine which material types are landfilled the most on an annual basis. Landfill owners/operators report total tonnage of waste accepted annually to both the EPA and Oklahoma Department of Environmental Quality (ODEQ), but the report does not include a breakdown of types of materials or source sectors (commercial, residential, industrial) from which the materials were collected. This knowledge gap presents a barrier to strategically prioritizing certain materials for source-reduction and monitoring progress.

In lieu of actual local data, U.S. municipal solid waste averages can provide insight into waste stream trends useful to estimate the gaps in available local data. Additionally, product generation statistics from the EPA help further refine how much of certain materials are generated and landfilled each year. The percentage breakdown of paper and paperboard products generated in the U.S. each year, for example, is likely to generally resemble the percentage make-up of paper products ending up in Oklahoma City landfills.

As paper and paperboard materials made up the largest share (26%) of total MSW and corrugated boxes were by far the leading paper and paperboard product generated in the U.S. in 2015, additional drop-off locations and other incentives to recycle corrugated boxes will help improve landfill diversion rates. Rather than seeking only to influence consumer behavior, policies and programs that work with manufacturers to reduce packaging waste from the point of production have the potential to make longer-lasting gains.

Figure WR-7: U.S. Municipal Solid Waste By Material, 2015



The breakdown by material of the total MSW generated nationally in 2015 depicts organic materials – paper, paperboard, yard trimmings, and food – as comprising more than 54% of the total waste stream. A renewed focus on diversion of these materials is needed to supplement the City's new curbside recycling capacity. It is important to note that over the last few decades, the generation, recycling, and disposal of MSW has changed substantially. Generation of MSW increased (except in recession years) from 88.1 million tons in 1960 to 262.4 million tons in 2015, an almost 200% increase. The generation rate in 1960 was just 2.68 pounds per person per day; it increased to 3.66 pounds per person per day in 1980 and in 2000 reached 4.74 pounds per person per day. The generation rate was 4.48 pounds per person per day in 2015, which was one of the lowest generation rates since 1980.

Hazardous Waste. One category of solid waste that carries additional regulation from both EPA and ODEQ is hazardous waste. Hazardous waste is any solid waste with dangerous properties or that is capable of being harmful to human health or the environment.

Examples of hazardous wastes include industrial wastes, batteries, dangerous gasses, paint, chemicals, cleaners, motor oil, mercury, and pharmaceuticals, among others. If improperly disposed, these materials contaminate soil and groundwater, contribute to harmful air quality, and depending on exposure, can be fatal for people and wildlife.

Mercury, for example, is commonly found in thermostats and fluorescent light bulbs but is a dangerous neurotoxin that can harm the human brain, heart, kidneys, lungs, and immune system and impair the nervous system of young children and unborn babies. Once introduced to the natural environment, microorganisms change mercury into methylmercury, a highly toxic chemical that can concentrate in fish and animals.

Even though mercury thermostats are no longer sold in the U.S., they can remain operable for several decades and are still in use in many buildings in Oklahoma City. While old thermostats containing mercury are often overlooked and landfilled due to the small quantities per device, those seemingly small quantities add up quickly with such a highly-potent substance.

In fact, due to the high potency of the substance, EPA restricts the amount of mercury in drinking water to a mere 0.002 parts per million. That's equivalent to one household thermostat contaminating more water than the average Oklahoma City single-family residential water customer uses over six years.

Pharmaceuticals, or prescription pills, are found in nearly every home and pose a significant risk to water quality if improperly disposed. Flushing old pills down the toilet can not only contaminate water reservoirs and harm wildlife, but will also increase treatment costs of drinking water. Twice per year, the City of Oklahoma City hosts special

collection events at State Fair Park for residents to dispose of pharmaceuticals, as well as other items difficult to safely dispose like tires, ammunition, and electronics/computers.

Additionally, the Oklahoma Bureau of Narcotics Safe Trips for Scripts program offers drop-off locations for safe disposal of pharmaceuticals. While the program's primary target is keeping secondhand narcotics off the street, the secure drop-off sites also prevent the chemical compounds from entering local waterways.

In Oklahoma City, residents can bring most household hazardous wastes, except for radioactive, biomedical, refrigerants, compressed gas containers, tires, or computer equipment, to the City's Household Hazardous Waste Facility, located at 1621 S Portland Ave., for safe recycling, treatment, or disposal.

Residents of the Village, Yukon, Tinker Air Force Base, Shawnee, El Reno, Edmond, Bethany, Warr Acres, and Moore can also recycle their hazardous waste at the facility, but may be charged for the service through their municipality.

ABOVE: HOUSEHOLD HAZARDOUS WASTE

Paints, polishes, and CFL or fluorescent light bulbs are a small sample of materials accepted by the City's Household Hazardous Waste Facility. In the past three fiscal years alone, the Household Hazardous Waste Facility has collected about 975 tons of materials; for scale, that's about 12 times the weight of the Space Shuttle Endeavor.

Organic Waste. Organic waste in the MSW stream includes any biodegradable material including green waste (grass clippings, tree branches, leaves, etc.), paper, and wasted food. On a national scale, EPA estimates paper products have the majority share of the organic waste stream, representing nearly 26% of MSW, with wasted food and yard trimmings comprising 15% and 13%, respectively.

Composting, a natural process through which organic matter decomposes and creates a nutrient-rich soil conditioner, is a more-beneficial alternative to both applying excessive fertilizer and landfilling green waste. Adding compost to soil can assist in erosion control, soil fertility, stimulating healthy root development in plants, and water conservation.

Top-dressing, or adding compost in a thin layer above bare soil, creates a barrier to evaporation reducing need for more frequent irrigation by retaining moisture in the soil. In fact, increasing organic material in soil by as little as 5% quadruples the soil's water holding capacity. On the other hand, adding fertilizer to soil provides food to plants – not the soil.

As plants can consume a finite amount of food, much fertilizer applied to lawns and gardens is washed into storm drains and eventually enters local lakes and streams incrementally altering water quality and damaging aquatic habitats.

Making compost is relatively easy with heat, moisture, and the proper ratio (2:1) of carbon (e.g. leaves, wood chips, shredded newsprint) and nitrogen (e.g. food scraps, coffee grounds, animal manure, grass clippings). Compost production is highly scalable; homeowners can divert as much or as little as needed for lawn amendment or garden supplement, but commercial operations can produce more by increasing the speed of decomposition with higher heat levels and more effective mixing equipment.

The City of Norman recycles an average of 14,000 tons of yard waste at its green waste facility and makes compost and mulch available to residents for free. In FY18, Norman residents diverted 15,856 tons of green waste material from landfills – more than twice the tonnage of recyclables collected in Oklahoma City's curbside recycling program during that time.

There are many sources of routine green waste, like commercial yard maintenance crews, residential bulky waste collections, and vegetative management by utility companies, but large volumes of green waste can accumulate quickly after severe weather. Ice storms, tornadoes, and straight-line winds can generate spikes in green waste arriving in Oklahoma City landfills.

The total amount of debris from green waste will vary wildly depending on a weather event's severity, duration, and proximity to highly-populated areas. Two tornadoes occurring in May of 2010 and 2015, for example, combined to produce just over 3,000 tons of debris that needed to be managed. However, in May of 2013, the tornado event that ravaged densely-populated areas of Moore and south Oklahoma City generated more than 795,000 tons of debris which is more than 2.5 times Oklahoma City's average annual amount of residential curbside solid waste collections.

Another subcategory of the organic waste stream that has gained increasing attention in recent years is wasted food. With less than six percent of the 39 million tons of wasted food produced in the U.S. in 2015 diverted from landfills and incinerators, food represents a major opportunity to reduce both the volume and associated emissions of MSW reaching landfills.

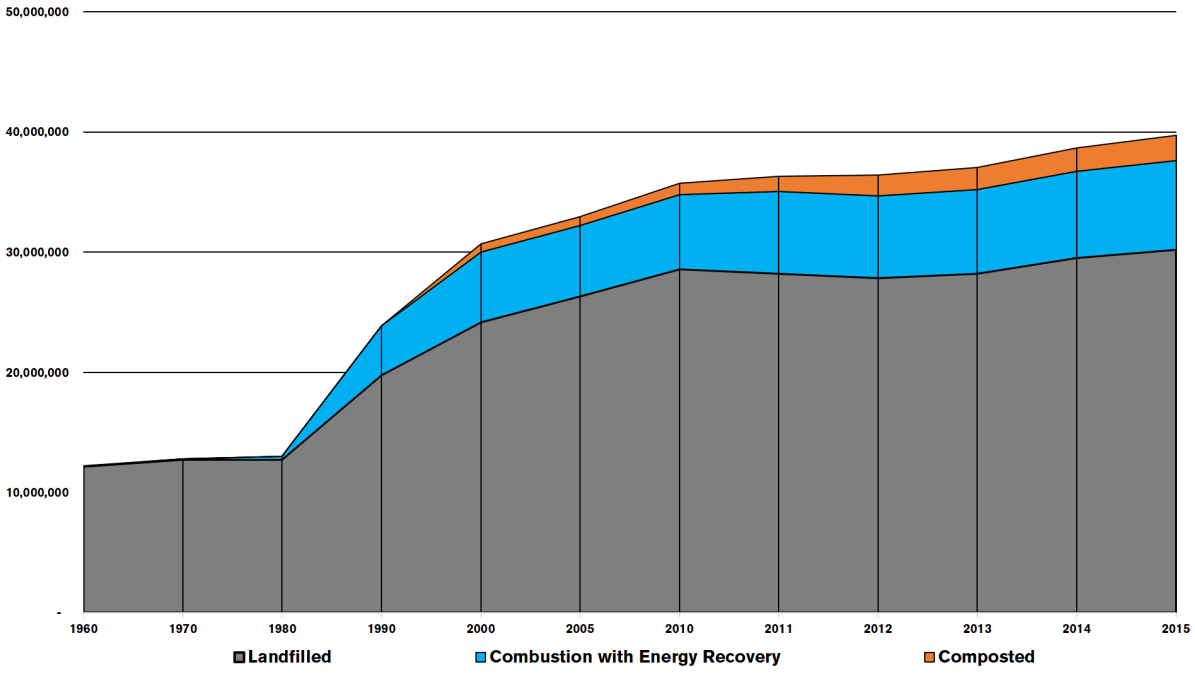
Wasted food breaks down faster than most other materials in landfills and produces the highest percentage of the most potent greenhouse gas – methane.

Photo by Jim Beckel, the Oklahoman, 2015

LEFT: STORM DEBRIS GREEN WASTE

The November ice storm of 2015 devastated Oklahoma, resulting in a state of emergency declaration for all 77 counties. Ice-laden trees fell and took overhead power lines with them, knocking out electricity to roughly 60,000 households statewide. In Oklahoma City, clean-up efforts took months including pick-up of curbside green waste and tree debris. The quantity removed by City personnel and contractors was estimated to exceed 71,000 tons with an estimated cost per ton range of $67 to $71, putting the total debris price tag in a range of $4.8 million to $5.1 million.

Figure WR-8: Food Waste Disposal by Method in Tons, 1960 - 2015



Source: U.S. EPA

Since 1980, an increasing amount of food waste has been diverted from landfills either via composting or combustion with energy recovery. Despite this trend, the total amount of food waste has continued to climb to nearly 40 million tons in 2015.

While the greatest amount of highly-potent greenhouse gas emissions is likely generated during decomposition, emissions are associated with every step of food production and distribution: industry (producing fertilizer), transportation (moving food around), buildings (storing food), energy (refrigerating and cooking food), and agriculture (digesting).

From source reduction to feeding people and animals to industrial uses to composting, a successful food recovery strategy is a product of identifying opportunities, forging connections across industries, and working with a wide variety of partners to maximize effectiveness. There are numerous sources of wasted food, such as: unsold food from retail stores; uneaten prepared food; kitchen trimmings from restaurants, cafeterias, and households; and by-products from food and beverage processing facilities. These streams of wasted food generally fall into one of three broad categories: excess food, food waste, and food loss. Excess food can be recovered and donated to feed people, food loss is unused product that never made it to processing, like unharvested crops, but food waste refers to inedible scraps like spoiled food or plate waste.

Opportunities to divert excess food starts with excess food generators like correctional facilities, schools, food banks, healthcare facilities, hospitality industry, event planners, and food manufacturing, processing, wholesalers, and distributors. In Oklahoma City, the Regional Food Bank of Oklahoma, whose services spread across the western half of the state, is a leader in re-routing excess food from landfills to feed people. In 2017, the organization rescued more than 12.3 million pounds of food through their Retail Food Recovery Program, the equivalent of more than 6.2 million meals.

To defer landfilling food waste not suitable for human consumption, food waste can be used as feedstock for animals, composted, anaerobically digested (AD), or combusted with energy recovery. Interest in the AD process has increased in recent years due, in part, to a renewed focus on eliminating wasted food. AD is a natural process in which microorganisms break down organic wastes and can decompose fats, oils, and greases, solids and liquids used in food processing, and biosolids produced during water treatment. In the Oklahoma City metro, there are four AD facilities, all related to water: Yukon, Del City, and Midwest City use AD processing, but do not use outside waste for AD, while Norman's Water Reclamation Facility does use AD to convert organic material in biosolids to methane and CO_2. None of the facilities are used for food waste.

"There is no such thing as garbage, just useful stuff in the wrong place."

- Alex Steffen

Our Plan

The economic, environmental, and social costs of traditional waste disposal will continue to grow without a combination of practical and innovative solutions including greater recycling, composting, materials reuse, anaerobic digestion, and source reduction. The success of the expanded curbside recycling program illustrates that residents place a high priority on public investments that reap both near- and long-term benefits.

Our plan will implement the vision of plan**okc** by supporting the growth of materials-recovery industries, protecting valuable land for future growth, and integrating life-cycle considerations to purchasing decisions. It acknowledges Oklahoma City's status as a primary stakeholder in the disposal practices of the metro and proposes purchase power aggregation to increase waste diversion from commercial properties and construction/demolition activities. With control of a portion of the MSW stream (residential curbside, hazardous waste) and influence over others (commercial/office/retail, industrial), Oklahoma City is positioned to affect how and where the metro manages waste materials for the next century.

Our Goals

RESOURCE RECOVERY

1. **Recycle or reuse recoverable material.**

SOURCE REDUCTION

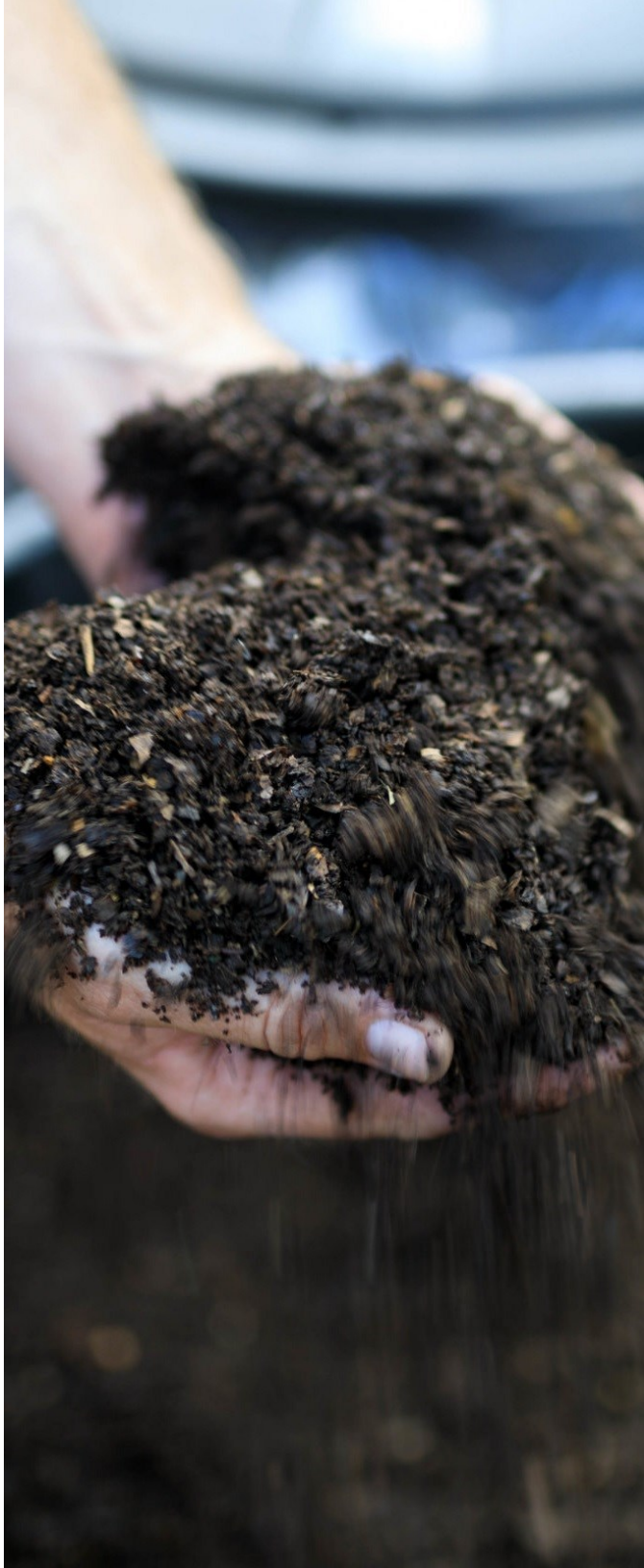
2. **Increase demand for products made with recycled content.**

ENVIRONMENTAL HEALTH

3. **Prevent exposure to hazardous waste.**

Our Initiatives

Waste Reduction Initiatives	Goals 1	2	3
1. Reduce amount of recoverable waste sent to landfills.	■	■	■
2. Purchase products made with recycled content.		■	
3. Increase options for proper hazardous waste disposal.	■	■	■



INITIATIVE 1

REDUCE AMOUNT OF RECOVERABLE WASTE SENT TO LANDFILLS

Identify recycling options for residents and businesses not included in the curbside recycling program. To delay the increased costs associated with landfill expansion or relocation, intervention is needed in the waste streams of commercial, multifamily, and construction sectors. To compliment the recent investment that increased curbside recycling capacity, we will identify recycling options available for the one in four residents living in multifamily properties. Consulting property owners, waste haulers, and residents to determine the right mix of programs, incentives, and policies will be critical to achieving our goals.

Collect recyclable materials in City facilities. Routine collection and hauling of waste materials to landfills from ninety-nine City of Oklahoma City facilities costs about $465,000 on average each year. Recycling is presently available in fewer than 13% of the City's more than 100 staffed locations. Many smaller City facilities, like Police and Fire stations, may already be located on existing collection routes and could potentially provide cost-savings by recycling materials through the curbside program.

Reduce green waste sent to landfills. Routine vegetative maintenance in public spaces and along utility easements combined with unpredictable spikes in green waste volume caused by severe weather events offers ample feedstock to create soil-enriching, water-conserving compost. FEMA standards exist to allow keeping tree limbs and other organics in disaster debris out of landfills without compromising reimbursement eligibility, but these standards are strict and will require formal planning and partnerships. We will develop alternatives to landfilling green waste and offer mulch and compost for residents, businesses, and City operations.

Coordinate and implement a food waste strategy. Creating lasting change in food waste behaviors is more than just interrupting the farm to table to landfill pipeline of our food system. Producers, processors, distributors, and consumers all have stake in shrinking the amount of wasted food sent to landfills and should all be engaged in developing a strategy that achieves results for our community. A proper mix of encouragement, incentives, and regulation will foster healthier, more efficient food production, delivery, and disposal.

POLICIES

WR-1: Provide recycling service in City and Trust facilities.

WR-2: Conduct study of paper-intensive municipal processes and implement strategy to reduce paper consumption.

WR-3: Use paper that contains a minimum of 30% recycled content in City processes.

WR-4: Transition board, council, and commission meetings to paperless agendas and packets.

WR-5: Recycle plastic and metals collected routinely by code enforcement staff and during sign sweeps.

WR-6: Recycle and compost waste from City events.

WR-7: Develop and promote toolkit for community event organizers to pursue zero landfill events.

WR-8: Prioritize green waste diversion from landfills in Debris Management Plan.

WR-9: Study start-up and operational feasibility of municipal green waste/mulch/compost facility.

WR-10: Promote strategies and resources to reduce wasted food.

WR-11: Adopt building codes to reduce debris and total losses during extreme weather and tornado events.

WR-12: Increase recycling access for residents in multifamily properties and commercial businesses through tools such as franchise zones and drop-off locations.

Mixed paper shredded and baled in preparation for shipment to a paper mill.

INITIATIVE 2

PURCHASE PRODUCTS MADE WITH RECYCLED CONTENT

Update and implement the City's Sustainable Purchasing Policy. As commodities are inextricably tied to market values, recycling is only as cost-effective as the markets that exist to process, sell, and recreate new products. To fully support a closed-loop approach to waste management, the City and residents should prioritize buying products that contain recycled content as highly as we do the act of recycling. Likewise, the City should also reduce purchases of products with excessive packaging and/or are packaged in materials not accepted by recycling providers.

Recognizing the pressing need for domestic facilities that can process and manufacture recycled materials, the City's Sustainable Purchasing policy should be implemented and used in new contract language.

POLICY

WR-13: Update the City's Sustainable Purchasing Policy and develop implementation strategy.

INITIATIVE 3

INCREASE OPTIONS FOR PROPER HAZARDOUS WASTE DISPOSAL

Expand options and encourage producer responsibility to safely dispose of hazardous waste. While the dangers and extreme potency of substances like mercury have long been understood and well-documented, there are still unprotected paths for these materials to reach soil, water, and residents. Many thermostats in buildings still contain mercury and, even in small doses, can pose fatal risks when introduced to the natural environment after demolition or remodeling. Pharmaceuticals are often disposed with the best of intentions (to prevent abuse of the substances) in the worst of places: toilets. The unused medications can increase water treatment costs and cause irreparable harm to fish and wildlife.

Transportation can be a barrier to maximizing safe disposal options, either via the Household Hazardous Waste Collection Facility or during bi-annual special drop-off events. Engaging neighborhoods and other stakeholders to explore additional collection locations and events will ensure we can capture more.

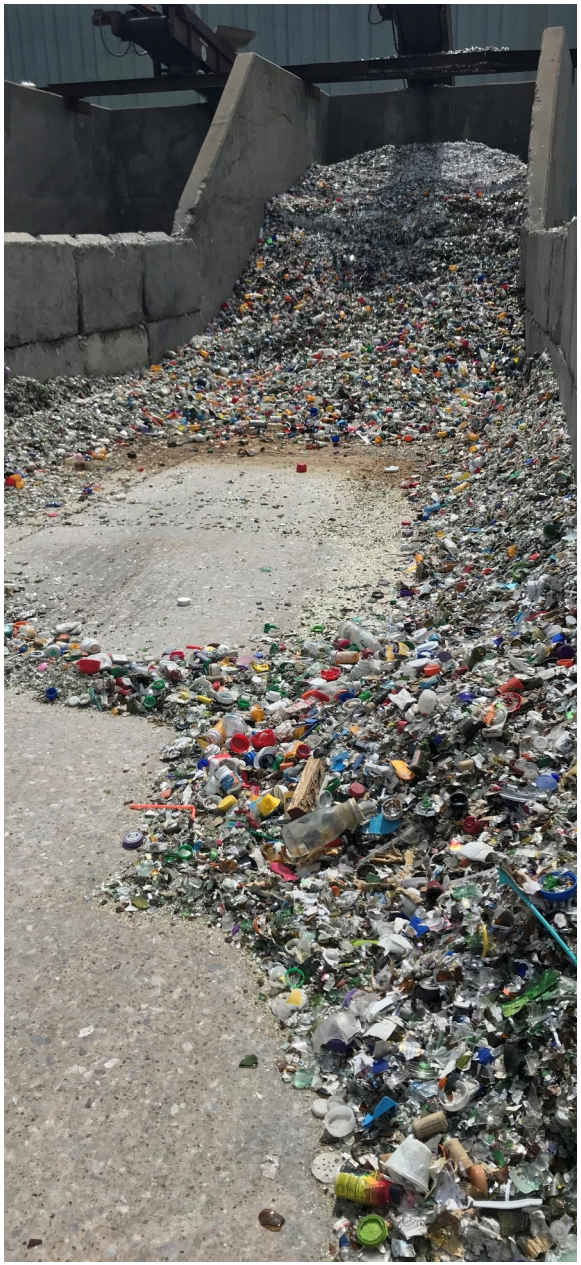
POLICIES

WR-14: Explore additional hazardous waste collection events each year to target specific geographic areas of the city.

WR-15: Increase the number of prescription and sharps drop-off locations.

WR-16: Advocate for requiring battery producers to offer recycling of nickel-cadmium, lithium-ion, and small sealed lead batteries.

WR-17: Require recycling of mercury thermostats when issuing demolition permits.



Remnants of broken glass containers and small plastic detritus at one of Waste Management's multi-reuse facilities in Oklahoma City.

chapter six

policies & implementation

POLICIES & IMPLEMENTATION

EXPLANATION

The following Policies & Implementation chapter is organized by plan topic and includes the following information for each policy:

- The "Type" column classifies each policy by function. For example, some policies may recommend a new process or procedure, a change to an existing process or procedure, and others may recommend a new ordinance to update the municipal code.
- The "Responsible Party" column lists the City departments, key organizations, or other groups responsible for or participating in policy implementation. If more than one responsible party is listed, bold text will indicate the primary responsibility.
- The "Start By" column specifies the time frame during which implementation of each policy will begin. Higher priority and low barrier policies will be acted on sooner. The four options in this column are:
  - 2023: The Responsible Parties would start work any time between plan adoption and the end of 2023. These are the highest priority projects;
  - 2026: Work would begin before the end of 2026;
  - 2029: Work would begin before the end of 2029;
  - Ongoing: May apply to policy decisions the City abides by or actions that are continually done.

Policies

Energy Productivity

EP-1: Allow photovoltaic solar panels by right in all zoning districts.

Start By: 2023
Type: Ordinance/Subdivision Regulation
Participating Parties: Development Services, Planning

EP-2: Increase renewable energy education opportunities and promote completed projects.

Start By: 2023
Type: Policy Decision, Program/Partnership
Participating Parties: Planning, Public Information & Marketing

EP-3: Engage utilities to advance renewable energy use and identify partnership opportunities.

Start By: 2023
Type: Program/Partnership
Participating Parties: Finance, OG&E, Planning

EP-4: Create solar-ready guidelines for builders in Oklahoma City.

Start By: 2023
Type: Process/Procedure
Participating Parties: Development Services, Planning

EP-5: Develop criteria for using renewable energy in City projects and include in the City's Interdepartmental Guidelines on Coordination of Facility Projects.

Start By: 2026
Type: Process/Procedure
Participating Parties: City Manager's Office, General Services, MAPS, Parks & Recreation, Planning, Public Works, Utilities

EP-6: Perform cost-benefit analysis of including renewable energy on new or more than 50% renovated City facilities.

Start By: 2023
Type: Process/Procedure
Participating Parties: Finance, Planning, Public Works

EP-7: Train appropriate staff to use cost-benefit tools to assess return on investment of renewable energy in new construction and major renovation (50% or more) projects.

Start By: 2023
Type: Process/Procedure
Participating Parties: Development Services, Planning

EP-8: Require solar-ready construction for new City facilities that meet criteria established in EP-5.

Start By: 2023
Type: Policy Decision
Participating Parties: Development Services, Planning, Public Works

---

EP-9: Develop criteria for solar ready construction requirements for developments seeking public financial assistance.

Start By: 2023
Type: Ordinance/Subdivision Regulation
Participating Parties: Finance, Planning, Public Works

EP-10: Increase the number of Green Home Loan projects that include renewable energy.

Start By: Ongoing
Type: Funding Resource Strategy, Policy Decision
Participating Parties: Planning

Policies

Energy Productivity

EP-11: Identify opportunities and determine viability of solar energy generation on public property including, but not limited to, under-utilized land, brownfields, or Opportunity Zones.

Start By: 2026
Type: Process/Procedure
Participating Parties: Alliance for Economic Development, Finance, Planning

EP-12: Provide energy code training for plan review, inspection, and code enforcement staff.

Start By: 2023
Type: Process/Procedure
Participating Parties: Development Services, Planning

EP-13: Implement field inspections for energy code compliance.

Start By: 2023
Type: Development Review, Process/Procedure
Participating Parties: Development Services, Planning

EP-14: Perform energy code field inspections for municipal construction and major renovation (50% or more) projects.

Start By: 2023
Type: Policy Decision, Process/Procedure
Participating Parties: Development Services, MAPS, Planning, Public Works

EP-15: Promote utility, state, and federal energy efficiency programs available to property owners and residents.

Start By: 2023
Type: Program/Partnership, Regional/External Agency Coordination
Participating Parties: Planning, Public Information & Marketing

EP-16: Increase funding to expand the Green Home Loan program.

Start By: Ongoing
Type: Funding/Resource Initiative, Policy Decision
Participating Parties: Planning

EP-17: Explore revising public financial assistance policies to include energy efficiency standards.

Start By: 2023
Type: Development Review, Policy Decision
Participating Parties: City Manager's Office, Finance, Planning

EP-18: Connect owners of multi-family properties to energy efficiency resources.

Start By: Ongoing
Type: Program/Partnership
Participating Parties: Planning, Public Information & Marketing

EP-19: Offer technical assistance and promote energy efficiency to businesses engaged in the Commercial District Revitalization Program.

Start By: Ongoing
Type: Program/Partnership
Participating Parties: OG&E, Planning

EP-20: Establish a Commercial Property Assessed Clean Energy (C-PACE) financing program.

Start By: 2023
Type: Program/Partnership, Regional/External Agency Coordination
Participating Parties: City Manager's Office, Oklahoma County, Planning

Policies

Energy Productivity

EP-21: Participate in Corporation Commission rulemaking and tariff processes.

Start By: Ongoing
Type: Process/Procedure
Participating Parties: City Manager's Office, Planning

EP-22: Build regional coalition of municipalities for representation at Corporation Commission.

Start By: 2026
Type: Regional/External Agency Coordination
Participating Parties: City Manager's Office, Oklahoma Municipal League, Planning

EP-23: Partner with educational institutions, including colleges and metro technology centers, to develop renewable energy certificate programs.

Start By: Ongoing
Type: Program/Partnership
Participating Parties: Planning

EP-24: Support renewable energy and alternate energy sector businesses in pursuit of local and state job creation incentives.

Start By: Ongoing
Type: Policy Decision, Process/Procedure
Participating Parties: Finance, Planning

EP-25: Perform third-party commissioning for municipal construction projects or major renovations.

Start By: 2026
Type: Policy Decision, Program/Partnership
Participating Parties: Finance, General Services, MAPS, Public Works

EP-26: Pursue dedicated funding source for on-going energy efficiency improvements in municipal facilities.

Start By: 2023
Type: Funding/Resource Initiative, Program/Partnership
Participating Parties: Finance, General Services, Planning

EP-27: Track municipal facilities in Energy Star Portfolio Manager.

Start By: 2026
Type: Process/Procedure
Participating Parties: Finance, General Services

EP-28: Publish municipal facilities' energy consumption and cost data to the public.

Start By: 2023
Type: Process/Procedure
Participating Parties: Finance, Planning, Public Information & Marketing

---

EP-29: Target cost reductions in City facilities with high energy demands by using performance-based energy efficiency contracts with guaranteed return on investment.

Start By: 2026
Type: Capital Improvement, Program/Partnership
Participating Parties: Finance, General Services, Planning, Utilities

---

EP-30: Develop and pilot process to submit carbon emissions reductions from City projects for sale on market.

Start By: 2026
Type: Policy Decision, Process/Procedure
Participating Parties: Finance, Planning

Policies

Natural and Built Environment

NB-1: Provide low-impact development training for City staff involved in design, review, inspection, and maintenance of low-impact development systems.

Start By: 2023
Type: Process/Procedure, Program/Partnership
Participating Parties: Development Services, MAPS, Parks & Recreation, Planning, Public Works, Utilities

NB-2: Initiate a multi-departmental process to develop an low-impact development implementation strategy.

Start By: 2023
Type: Development Review, Ordinance/Subdivision Regulation, Policy Decision
Participating Parties: Development Services, MAPS, Parks & Recreation, Planning, Public Works, Utilities

NB-3: Incorporate low-impact development techniques developed in NB-2 in City projects and new facilities.

Start By: 2026
Type: Development Review, Ordinance/Subdivision Regulation, Policy Decision
Participating Parties: Development Services, MAPS, Parks & Recreation, Planning, Public Works, Utilities

NB-4: Promote low-impact development features at City facilities with signage and online map.

Start By: 2023
Type: Program/Partnership
Participating Parties: MAPS, Parks & Recreation, Planning, Public Information & Marketing

NB-5: Create a low-impact development guide/manual for architects, engineers, and developers.

Start By: 2026
Type: Program/Partnership
Participating Parties: Development Services, Planning, Public Information & Marketing

NB-6: Identify resources to increase compliance with landscape code.

Start By: 2023
Type: Policy Decision, Process/Procedure
Participating Parties: Development Services, Planning

NB-7: Increase promotion of water quality resources and programs, like Blue Thumb, on the City's website.

Start By: 2023
Type: Program/Partnership
Participating Parties: Planning, Public Information & Marketing, Public Works

NB-8: Review and update list of nuisance vegetation in municipal code.

Start By: 2023
Type: Ordinance/Subdivision Regulation
Participating Parties: Development Services, Parks & Recreation, Planning

NB-9: Inventory use of herbicides and pesticides in parks, develop strategy, and establish targets to reduce use.

Start By: 2023
Type: Program/Partnership
Participating Parties: Finance, Parks & Recreation, Planning

NB-10: Conduct ecological assessments and develop long-term management plans for watersheds.

Start By: 2023
Type: Process/Procedure
Participating Parties: Oklahoma Conservation Commission, Oklahoma Water Resources Board, Planning, Public Works

Policies

Natural and Built Environment

NB-11: Work with Historic Preservation Office to map historic properties in areas vulnerable to flooding.

Start By: 2026
Type: Program/Partnership
Participating Parties: Development Services, Planning, Public Works

NB-12: Discourage alterations to the floodplain with 1% annual chance of flooding (100-year).

Start By: 2026
Type: Development Review, Ordinance/Subdivision Regulation, Policy Decision
Participating Parties: Development Services, Planning, Public Works

NB-13: Conduct historical flood damage assessment and inventory of properties in flood plains.

Start By: 2026
Type: Program/Partnership
Participating Parties: Planning, Public Works

NB-14: Update municipal code to increase elevation requirements for new construction and substantially-improved structures in the 500-year floodplain.

Start By: 2023
Type: Ordinance/Subdivision Regulation, Policy Decision
Participating Parties: Development Services, Planning, Public Works

NB-15: Determine methods to measure, monitor, and report local urban heat island conditions.

Start By: 2026
Type: Program/Partnership
Participating Parties: Information Technology, Planning, Public Information & Marketing

NB-16: Develop and adopt a tree preservation ordinance.

Start By:	2026
Type:	Development Review, Ordinance/Subdivision Regulation, Policy Decision
Participating Parties:	Development Services, Municipal Counselor's Office, Parks & Recreation, Planning, Public Works, Utilities

NB-17: Update municipal code to eliminate minimum parking requirement for new developments.

Start By:	2026
Type:	Ordinance/Subdivision Regulation, Policy Decision
Participating Parties:	Finance, General Services, Planning

NB-18: Use highly-reflective materials for new or replacement roofing on City facilities.

Start By:	2023
Type:	Policy Decision, Process/Procedure
Participating Parties:	General Services, MAPS, Planning, Public Works

NB-19: Develop guidance for green roof installations in Oklahoma City.

Start By:	2026
Type:	Program/Partnership
Participating Parties:	Development Services, Planning, Public Works

NB-20: Develop a cooling plan for the Central Business District.

Start By:	2029
Type:	Program/Partnership
Participating Parties:	Downtown OKC, Parks & Recreation, Planning

NB-21: Develop a pilot leasing program for urban garden plots on public land.

Start By:	2023
Type:	Program/Partnership
Participating Parties:	Parks & Recreation, Planning

Policies

Air Quality

AQ-1: Partner with regional and state agencies to estimate economic impact of nonattainment.

Start By: 2023
Type: Regional/External Agency Coordination
Participating Parties: ACOG, City Manager's Office, Planning

AQ-2: Conduct greenhouse gas emissions inventories at minimum every five years to capture both City operations and community-wide emissions.

Start By: 2023
Type: Policy Decision, Program/Partnership
Participating Parties: Planning

AQ-3: Use emissions data to establish reduction targets.

Start By: 2026
Type: Policy Decision
Participating Parties: City Manager's Office, Planning

AQ-4: Develop an emissions reductions strategy.

Start By: 2026
Type: Funding/Resource Initiative, Program/Partnership
Participating Parties: Planning

AQ-5: Increase the number of publicly-available electric vehicle charging ports and promote locations online.

Start By: Ongoing
Type: Program/Partnership, Regional/External Agency Coordination
Participating Parties: ACOG, EMBARK, OG&E, Planning, Public Information & Marketing

AQ-6: Conduct analysis of City fleet use and establish target for percentage of fleet comprised of electric vehicles.

Start By: 2023
Type: Policy Decision, Process/Procedure, Program/Partnership
Participating Parties: Development Services, EMBARK, General Services, Information Technology, Planning, Public Works, Utilities

AQ-7: Develop strategy and implement process to reduce idling in municipal vehicles.

Start By: 2026
Type: Process/Procedure
Participating Parties: Development Services, EMBARK, Fire General Services, Information Technology, Planning, Police, Public Works, Utilities

AQ-8: Promote local, state, and federal alternative fuel incentives.

Start By: Ongoing
Type: Program/Partnership, Regional/External Agency Coordination
Participating Parties: ACOG, Planning, Public Information & Marketing

AQ-9: Require "EV-ready" construction to ensure new public buildings are suitable for electric vehicle supply equipment.

Start By: 2023
Type: Development Review, Policy Decision, Process/Procedure
Participating Parties: Development Services, EMBARK, Parks & Recreation, Planning, Public Works, Utilities

AQ-10: Advocate to amend the apportionment formula for motor fuels to increase gasoline and diesel tax remittance to cities and towns.

Start By: Ongoing
Type: Funding/Resource Initiative, Legislative Initiative
Participating Parties: City Manager's Office, Finance, Planning

Policies

Waste Reduction

WR-1: Provide recycling service in City and Trust facilities.

Start By: Ongoing
Type: Policy Decision, Program/Partnership
Participating Parties: City Manager's Office, Finance, Planning, Utilities

WR-2: Conduct study of paper-intensive municipal processes and implement strategy to reduce paper consumption.

Start By: 2023
Type: Process/Procedure
Participating Parties: City Clerk's Office, City Manager's Office, Planning, Public Information & Marketing

WR-3: Use paper that contains a minimum of 30% recycled content in City processes.

Start By: Ongoing
Type: Process/Procedure
Participating Parties: City Manager's Office, Finance, Planning, Public Information & Marketing

WR-4: Transition board, council, and commission meetings to paperless agendas and packets.

Start By: Ongoing
Type: Policy Decision, Process/Procedure
Participating Parties: City Clerk's Office, City Manager's Office, Development Services, MAPS, Parks & Recreation, Planning, Public Information & Marketing

WR-5: Recycle plastic and metals collected routinely by code enforcement staff and during sign sweeps.

Start By: 2023
Type: Process/Procedure
Participating Parties: Development Services, Utilities

WR-6: Recycle and compost waste from City events.

Start By: 2026
Type: Policy Decision, Process/Procedure
Participating Parties: City Manager's Office, Planning, Public Information & Marketing, Utilities

WR-7: Develop and promote toolkit for community event organizers to pursue zero landfill events.

Start By: 2026
Type: Program/Partnership
Participating Parties: Planning, Public Information & Marketing

WR-8: Prioritize green waste diversion from landfills in Debris Management Plan.

Start By: 2023
Type: Process/Procedure
Participating Parties: Office of Emergency Management, Parks & Recreation, Planning, Public Works, Utilities

WR-9: Study start-up and operational feasibility of municipal green waste/mulch/compost facility.

Start By: 2026
Type: Capital Improvement, Program/Partnership
Participating Parties: Parks & Recreation, Planning, Utilities

WR-10: Promote strategies and resources to reduce wasted food.

Start By: Ongoing
Type: Program/Partnership
Participating Parties: Planning, Public Information & Marketing

Policies

Waste Reduction

WR-11: Adopt more stringent building codes to reduce debris and total losses during extreme weather and tornado events.

Start By: 2026
Type: Development Review, Ordinance/Subdivision Regulation
Participating Parties: Development Services, Office of Emergency Management, Planning

WR-12: Increase recycling access for residents in multifamily properties and commercial businesses through tools such as franchise zones.

Start By: 2029
Type: Ordinance/Subdivision Regulation, Policy Decision, Program/Partnership
Participating Parties: Downtown OKC, Planning, Utilities

WR-13: Update the City's Sustainable Purchasing Policy and develop implementation strategy.

Start By: 2023
Type: Policy Decision, Process/Procedure
Participating Parties: Finance, Planning

WR-14: Explore additional hazardous waste collection events each year to target specific geographic areas of the city.

Start By: 2023
Type: Program/Partnership
Participating Parties: Planning, Public Works

WR-15: Increase the number of prescription and sharps drop-off locations.

Start By:	Ongoing
Type:	Policy Decision, Program/Partnership
Participating Parties:	City Manager's Office, Planning, Police, Utilities

WR-16: Advocate for requiring battery producers to offer recycling of nickel-cadmium, lithium-ion, and small sealed lead batteries.

Start By:	Ongoing
Type:	Legislative Initiative
Participating Parties:	City Manager's Office, Planning, Utilities

WR-17: Require recycling of mercury thermostats when issuing demolition permits.

Start By:	Ongoing
Type:	Process/Procedure
Participating Parties:	City Manager's Office, Development Services, Planning

INDICATORS

EXPLANATION

The following list of indicators is designed to help monitor progress toward adaptokc goals. Indicators that are existing Leading For Results measures are noted with **(LFR)**.

Baseline year for each indicator is listed in the description and are identified by Calendar Year (CY), Federal Fiscal Year (FFY) or Fiscal Year (FY); the City's fiscal year runs July 1 through June 30 while the FFY runs October 1 through September 30.

Indicators are grouped in two categories: external and internal.

- **External indicators** monitor relevant statistics and trends that contribute to a broader picture of each chapter topic. These trends are useful to monitor, but are outside of the City's direct control. However, these indicators can inform policy decisions or assist in recalibrating priority of recommended actions.
- **Internal indicators** are used to track progress of City operations and effectiveness of actions directly in the City's control.

Indicators will be reported on every five years to gauge the effectiveness of actions taken to implement adaptokc initiatives.

- The **"Goals"** column shows which goal or goals each indicator addresses.
- The **"Current Conditions"** column uses available data for each indicator to set a baseline for evaluation of progress.
- The **"5-Year Target"** and **"10-Year Target"** columns contain expected future values.

Internal Indicators

Energy Productivity

IN-1: Number of City permits issued for residential solar installations.

Baseline Year:	CY 2018
Current Conditions:	11
5-Year Target:	20
10-Year Target:	30

IN-2: Number of kW of renewable energy capacity on City property

Baseline Year:	CY 2018
Current Conditions:	0
5-Year Target:	5
10-Year Target:	50

IN-3: Number of loans issued annually from Green Home Loan program. (LFR)

Baseline Year:	FY19
Current Conditions:	17
5-Year Target:	20
10-Year Target:	40

IN-4: Dollar of loans issued annually from Green Home Loan program. (LFR)

Baseline Year:	FY19
Current Conditions:	$108,600.08
5-Year Target:	$140,000
10-Year Target:	$280,000

IN-5: Number of Millions of British Thermal Units (MMBTU) used for City operations. (LFR)

Baseline Year:	FY19
Current Conditions:	1,677,409
5-Year Target:	1,509,668
10-Year Target:	1,341,927

IN-6: Number of City buildings tracked in ENERGY STAR™ Portfolio Manager.

Baseline Year:	FY19
Current Conditions:	4
5-Year Target:	15
10-Year Target:	30

IN-7: Number of City buildings with an ENERGY STAR™ rating above 75.

Baseline Year:	FY19
Current Conditions:	0
5-Year Target:	4
10-Year Target:	8

Natural and Built Environment

IN-8: Classification of Oklahoma City in FEMA Community Rating System program.

Baseline Year:	FFY 2014
Current Conditions:	8
5-Year Target:	7
10-Year Target:	6

IN-9: Percent reduction in the amount of pesticide and herbicide use in City operations.

Baseline Year:	N/A
Current Conditions:	No Data; Contingent upon completion of NB-9
5-Year Target:	No Data; Contingent upon completion of NB-9
10-Year Target:	No Data; Contingent upon completion of NB-9

Internal Indicators

Natural and Built Environment

IN-10: Number of new trees planted. (LFR)

Baseline Year:	FY19
Current Conditions:	1,001
5-Year Target:	1,000
10-Year Target:	2,000

Air Quality

IN-11: Percent of light- or medium-duty municipal fleet vehicles fueled by alternative fuels.

Baseline Year:	CY 2018
Current Conditions:	4%
5-Year Target:	10%
10-Year Target:	20%

IN-12: Number of metric tons of GHG emissions from City operations.

Baseline Year:	CY 2010
Current Conditions:	761,191
5-Year Target:	TBD
10-Year Target:	TBD

IN-13: Number of miles of separated bicycle lanes.

Baseline Year:	FY19
Current Conditions:	16.2 miles
5-Year Target:	25 miles
10-Year Target:	45 miles

IN-14: Number of trail miles inspected and maintained. (LFR)

Baseline Year:	FY19
Current Conditions:	1,827.30 miles
5-Year Target:	2,000 miles
10-Year Target:	2,100 miles

IN-15: Percent of bus stops with shelter.

Baseline Year:	FY19
Current Conditions:	12.4%
5-Year Target:	15%
10-Year Target:	25%

IN-16: Number of bus passenger trips provided. (LFR)

Baseline Year:	FY19
Current Conditions:	2,921,065 trips
5-Year Target:	3,100,000 trips
10-Year Target:	3,500,000 trips

IN-17: Number of miles of new residential & arterial street sidewalk constructed. (LFR)

Baseline Year:	FY19
Current Conditions:	21
5-Year Target:	30
10-Year Target:	40

Waste Reduction

IN-18: Number of pounds of household hazardous waste reused and recycled. (LFR)

Baseline Year:	FY19
Current Conditions:	272,780
5-Year Target:	300,058 (+10%)
10-Year Target:	330,064 (+20%)

Internal Indicators

Waste Reduction

IN-19: Percent of solid waste stream diverted from landfills through recycling. (LFR)

Baseline Year:	FY19
Current Conditions:	2.94%
5-Year Target:	4%
10-Year Target:	7%

IN-20: Number of net tons of curbside residential recycling collected.

Baseline Year:	FY19
Current Conditions:	17,222
5-Year Target:	18,944
10-Year Target:	20,839

IN-21: Percent of contamination in residential curbside program.

Baseline Year:	FY19
Current Conditions:	25%
5-Year Target:	15%
10-Year Target:	10%

IN-22: Number of average annual pounds landfilled per recycling customer.

Baseline Year:	FY19
Current Conditions:	3,084
5-Year Target:	2,776
10-Year Target:	2,498

IN-23: Percent of City facilities with recycling service.

Baseline Year:	FY19
Current Conditions:	11.1%
5-Year Target:	25%
10-Year Target:	50%

IN-24: Number of sheets of paper purchases annually for City operations from City contract.

Baseline Year:	FY19
Current Conditions:	12,974,460
5-Year Target:	11,677,014
10-Year Target:	9,730,845

IN-25: Percent of total paper purchased from City contract that contains recycled content.

Baseline Year:	FY19
Current Conditions:	2.23%
5-Year Target:	10%
10-Year Target:	30%

External Indicators

Energy Productivity

EX-1: Percent of renewable energy in OG&E's electricity generation mix.

Baseline Year: CY 2018
Current Conditions: 7%

EX-2: Weighted average cost of electricity generation fuel type used by OG&E.

Baseline Year: CY 2018
Current Conditions: ¢2.122

EX-3: Average OG&E residential price per kilowatt-hour.

Baseline Year: CY 2018
Current Conditions: ¢9.26

EX-4: Number of MW of solar energy capacity (DC) from net metering agreements in Oklahoma City.

Baseline Year: CY 2018
Current Conditions: 2.14 MW

EX-5: Percent of State Quality Jobs Act incentives paid to alternate energy sector companies in Oklahoma City.

Baseline Year: FY19
Current Conditions: 0.05%

EX-6: Ratio of solar-industry jobs to general workforce jobs in Oklahoma.

Baseline Year: CY 2018
Current Conditions: 1:2,032

EX-7: Number of environmental/energy building certifications (LEED, Green Globes, WELL, etc.) within Oklahoma City.

Baseline Year: CY 2018
Current Conditions: 26 (23 LEED, 3 Green Globes)

Natural and Built Environment

EX-8: Number of FEMA National Flood Insurance Program claims made within Oklahoma City.

Baseline Year: CY 2018
Current Conditions: 9 claims

EX-9: Number of dollars paid out for FEMA National Flood Insurance Program claims within Oklahoma City.

Baseline Year: CY 2018
Current Conditions: $304,100.25

EX-10: Number of square miles of impervious surfaces citywide.

Baseline Year: CY 2018
Current Conditions: 119.2 square miles

EX-11: Percent of Oklahoma City Census tracts designated as USDA food deserts.

Baseline Year: CY 2016
Current Conditions: 14%

EX-12: Number of FEMA major disaster declarations affecting a county within Oklahoma City.

Baseline Year: CY 2018
Current Conditions: 0 declarations

EX-13: Population density of Oklahoma City.

Baseline Year: CY 2017
Current Conditions: 1,014 persons per square mile

External Indicators

Natural and Built Environment

EX-14: Percent of Oklahoma City classified in 100-year floodplain within Oklahoma City.

Baseline Year: CY 2016
Current Conditions: 13%

EX-15: Number of structures in the 100-year floodplain within Oklahoma City.

Baseline Year: CY 2018
Current Conditions: 6,634 structures

EX-16: Average annual temperature at the Will Rogers World Airport weather monitoring station.

Baseline Year: CY 2018
Current Conditions: 60.07°F

Air Quality

EX-17: Number of days per calendar year of ozone exceedance within the Oklahoma City metro.

Baseline Year: CY 2018
Current Conditions: 11 days

EX-18: Number of public-access electric vehicle service equipment (charging station connections) in Oklahoma City.

Baseline Year: CY 2018
Current Conditions: 33 connections

EX-19: Number of non-electric, public-access alternative fuel stations within Oklahoma City.

Baseline Year: CY 2018
Current Conditions: 45 stations

EX-20: Number of metric tons of citywide GHG emissions.

Baseline Year: CY 2010
Current Conditions: 8,928,907 tons

EX-21: Percent of commutes by public transportation, walking, and biking based on five-year Census estimates.

Baseline Year: CY 2017
Current Conditions: 2.2%

EX-22: Dollars of remittance of gas and diesel tax to Oklahoma City.

Baseline Year: CY 2018
Current Conditions: $1,201,819

EX-23: Metric tons of CO_2 per capita emitted from on-road, non-diesel light duty vehicles in Oklahoma County.

Baseline Year: CY 2014
Current Conditions: 4.79 tons

Waste Reduction

EX-24: Number of metric tons received at East Oak, Southeast, and OKC Waste Disposal landfills.

Baseline Year: CY 2018
Current Conditions: 1,479,215 tons

EX-25: Number of metric tons of GHG emissions (CO_2e) from East Oak, Southeast, and OKC Waste Disposal landfills.

Baseline Year: CY 2018
Current Conditions: 470,930 CO_2e