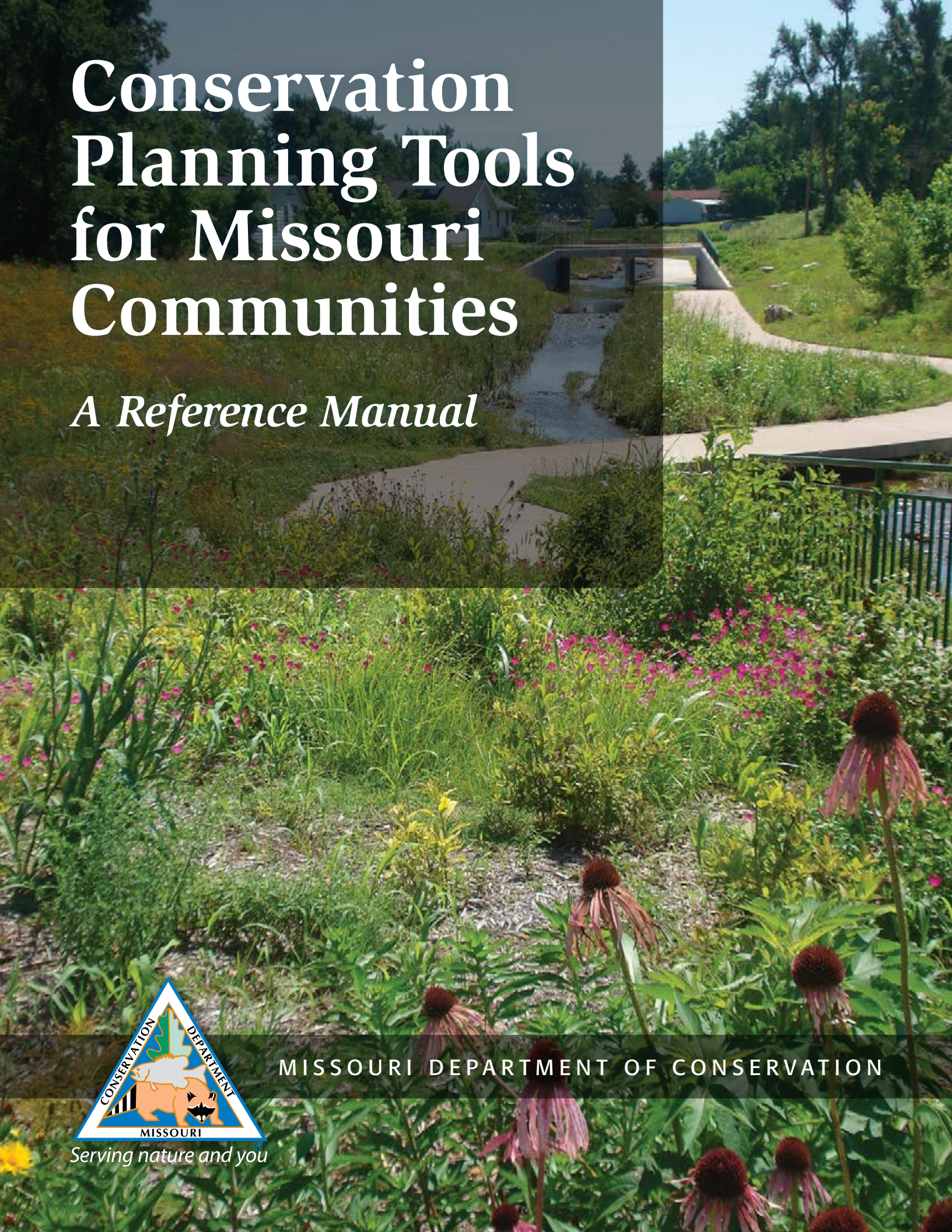
Conservation Planning Tools for Missouri Communities

A Reference Manual



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Cover: Section of Jordan Creek in Springfield, Missouri, daylighted and planted with native plants in the riparian corridor.
Photo courtesy of City of Springfield, Missouri.

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By Ronda Burnett

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Executive Summary

An exciting facet of community conservation is that it shifts the paradigm of thinking that cities are incompatible with natural resource conservation to a realization that there are stewardship practices suitable for every land use and every population density. A snapshot of Missouri today shows us that:

- Communities across the state help protect aquatic and terrestrial wildlife habitats every time they invest money and other resources to lower pollution levels from urban services such as energy production, drinking water and wastewater treatment, and solid waste management, i.e., landfills and recycling programs.

- Community forestry, rainwater management, and open-space programs provide residents of even the biggest cities with opportunities to connect with nature close to home.

- Green infrastructure is changing the way our communities are managed by replacing or supplementing aging gray infrastructure while providing multiple social, environmental, and economic benefits.

- And, more and more, market forces are integrating nature into the built environment through green certification programs and customer demands.

This manual was written for and is dedicated to the planners who work for city, county, and regional planning agencies throughout Missouri. The goal is to assemble in one document a comprehensive overview of the planning tools that you can use to transform your jurisdiction into a conservation community. The purpose of this manual is to inspire you and provide you with ideas for how to implement conservation planning tools in ways that will benefit the place you call home and the people you call neighbors.

Planners today understand the importance of planning for the three E's: equity, economy, and environment. While many of the tools in this manual can be applied to each of these areas, when it comes to community conservation there is no cookie-cutter approach. The landscape of Missouri is very different from one part of the state to another as are the native plant and wildlife species. Conservation planning tools work best when they are customized to the place where they are adopted and applied. Missouri recently became the first state to finish mapping all our ecological sites. The attendant ecological site descriptions (ESD) are informative and innovative planning tools that have the potential to revolutionize the way we regulate development and plan for growth. ESD data will allow planners and community decision makers to feel confident that they are implementing the "right rules in the right places."

Planners advocate for the public interest and therefore shall have a special concern for the long-term consequences of present actions (American Planning Assocation, 2016). That is a tall order. But it is worthwhile, and we are up to the challenge. The tools assembled in this manual can help us achieve it.

— Ronda Burnett

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Introduction

"Harmony with land is like harmony with a friend; you cannot cherish his right hand and chop off his left."

—Aldo Leopold

Missouri Department of Conservation

The Missouri Department of Conservation works with communities across the state that want to connect to nature. Whether the goal is to decrease the negative impacts of urbanization on fish, forests, and wildlife or to benefit from the wiser use of natural resources, more communities turn to MDC every year for technical assistance. To leverage limited staff time and resources, this planning manual was written as a way to efficiently promote conservation practices that are applicable to the growth and management of all Missouri communities. Conservation planning tools are used by planners of all specialties including housing, land use, and transportation. This manual compiles those tools into one place with a focus on how they can be applied in Missouri.

MDC History, Mission, and Strategic Plan

In 1935, a group of concerned citizens formed the Conservation Federation of Missouri and drafted a constitutional amendment to form a commission to restore Missouri's wildlife and forests. At the time, it was estimated there were fewer than 2,000 deer in the state and no more than 3,500 turkeys. Through the initiative petition process, the people of Missouri placed the amendment that would create a nonpolitical Conservation Commission on the ballot in 1936. The vote was 879,213 to 351,962 in favor of the amendment (Missouri Department of Conservation, 2008). MDC is guided by and receives direction from the Conservation Commission. The mission of MDC is to protect and manage the fish, forest, and wildlife resources of the state; to facilitate and provide opportunity for all citizens to use, enjoy, and learn about these resources. The vision of MDC is a future with healthy fish, forests, and wildlife where all people appreciate nature.

Community Conservation

MDC is committed to helping citizens connect with fish, forests, and wildlife where they live, through a statewide approach to community conservation. This commitment is reflected in the goals set forth in MDC's 2019–2024 Strategic Plan. One goal is to enhance the relevance of conservation in the state and another is to connect Missourians with fish, forest, and wildlife resources. MDC will strive to achieve these goals by engaging and partnering with local communities to increase access to nature and promote the conservation of fish, forests, and wildlife.

Comprehensive Conservation Strategy (CCS)

This strategy was developed to help MDC achieve its goal, within the constraints of limited budgets and staff time, of conserving the biodiversity of fish, forest, and wildlife resources in the state along with the healthy land and water needed for species survival. MDC uses guidance from landscape-level assessments and priority-setting exercises to decide where and how best to invest in conservation actions that will sustain fish and wildlife populations across the entire state. Strategic habitat conservation is a structured decision-making process intended to increase effectiveness and decrease random acts of conservation that spread resources too thin. This process has led to the designation of priority geographies: areas where resource management has heightened focus because of concerns about fragile habitats or plant or wildlife species of special concerns. It has also highlighted the need for partnerships where collaborative efforts can advance conservation on private property or within local jurisdictions. The building blocks of the CCS are the area plans, habitat assessments, species plans, recovery plans, etc. that have been developed by MDC and conservation partners. Significant input into the CCS is provided by the following:

- **Missouri's Forest Resource Assessment and Strategy:** Missouri's trees, woodlands, and forests are a resource to behold, providing us with clean water, clean air, high-quality wildlife habitat, diverse outdoor recreational opportunities, and a forest products industry that contributes $5.7 billion to Missouri's economy annually. Ensuring that these benefits are sustained and enhanced for Missourians today and into the future is a priority for MDC. This strategy serves as a blueprint for maintaining and enhancing the health and benefits of our forest resources (MDC & USDAFS, 2010).

- **Missouri State Wildlife Action Plan:** State wildlife plans promote strategic planning and prioritization in the management of fish and wildlife diversity, so that limited resources are leveraged to the maximum possible benefit for wildlife diversity conservation (Missouri Department of Conservation, 2015b).

Land-Use Law

Before zoning, land-use conflicts were predominantly resolved through nuisance law suits, and legislation typically dealt with specific problems such as building heights. In 1916, New York City was the first to adopt a comprehensive zoning ordinance that assigned land uses to zoning districts throughout the city. All states now have legislation authorizing municipal zoning and comprehensive planning. State planning and zoning legislation is based on separate Standard Acts that were drafted by the U.S. Department of Commerce in the 1920s. The planning act should have come first, but the strong political demand for legislation authorizing zoning led to the publication of the zoning act first. This inverted publication sequence contributed to the early failure to integrate zoning with the planning process. Zoning plans establish standards that regulate the detailed use of property, whereas a comprehensive plan is future-oriented and general (Mandelker, 1997).

- Standard Zoning Enabling Act (1924): Provides a common statutory basis for zoning that makes court decisions on zoning applicable nationwide (Mandelker, 1997).

- Standard City Planning Enabling Act (1928): Provides the authority for planning and specifies the role local agencies are to play in that process. It also specifies the issues and elements that local comprehensive plans are required to address (Mandelker, 1997).

Urban Planning and Conservation: Milestone Ideas

- **1850–1900: The intrinsic character of land should guide its use**
  - » The idea of a greenbelt is introduced in England to prevent one town from growing into another
  - » Frederick Law Olmstead develops the concept of linked systems of parks and parkways

- **1900–1920: Conserving natural places for future generations**
  - » President Theodore Roosevelt's love for the great outdoors sets the stage for the National Park System with input from preservationist John Muir and conservationist Gifford Pinchot
  - » Warren Manning uses the overlay technique to analyze a site's natural and cultural information

- **1930–1950: Linkage established between ecology and design**
  - » Victor Shelford calls for the preservation of natural areas and buffer zones
  - » Aldo Leopold introduces the concept of a land ethic
  - » Benton MacKaye develops the discipline of regional planning

- **1960s: Scientific, definable process for land-use planning and suitability analyses; Protecting core areas of wilderness**
  - » Rachel Carson publishes Silent Spring, bringing attention to man's impact on nature (1962)
  - » Congress passes the Wilderness Act (1964)
  - » William H. Whyte coins the term "greenway"
  - » Ian McHarg argues that ecology should serve as the basis for design
  - » Philip Lewis creates a method of landscape analysis that includes vegetation, scenery, and environmental corridors
  - » Sciences emerge – Landscape Ecology and Island Biogeography – to study the relationships between biological communities and the physical environment

- **1970–1980: Linkages between natural areas are needed to protect biodiversity and ecosystem processes**
  - » Conservation Biology is introduced as a discipline
  - » Geographic Information System (GIS) is introduced as a tool for regional planning

- **1990s: Landscape scale focus; Participatory decision-making**
  - » Planning efforts to create statewide greenway systems
  - » Green infrastructure grows as a tool to guide land conservation and development
  - » Center for Watershed Protection founded by Tom Schueler (1992)
  - » President Clinton forms a Council on Sustainable Development (1993)
  - » Low-impact Development Center co-founded by Neil Weinstein and Larry Coffman (1998)
  - » Randal Arendt publishes books on conservation and development including, Growing Greener: Putting Conservation into Local Plans and Ordinances (1999)

- **2000s: Era of rainwater management; Application of green infrastructure practices**
  - » Missouri Department of Conservation forms a Private Land Services Division and hires Urban Watershed Conservationists – later retitled as Community Conservation Planners (2000)
  - » U.S. Environmental Protection Agency (U.S. EPA) directs National Pollutant Discharge Elimination System (NPDES) permitting authorities to begin issuing permits for Phase II-designated small municipal separate storm sewer systems (MS4s) in communities with a population greater than 10,000 (2002)
  - » U.S. EPA publishes the Water Quality Scorecard – Incorporating Green Infrastructure Practices at the Municipal, Neighborhood, and Site Scales (2009)
- **2010–present: Community conservation connects cities to nature; Urban biodiversity evaluated**
  - » University of Arkansas Community Design Center publishes Low-impact Development – a design manual for urban areas (2010)
  - » U.S. EPA and states begin to implement the Integrated Municipal Stormwater and Wastewater Planning Approach Framework (2012)
  - » Urban Land Institute publishes Conservation Communities – Creating Value with Nature, Open Space, and Agriculture by Ed McMahon (2014)
  - » Water Environment Federation publishes Green Infrastructure Implementation (2014)
  - » Lincoln Institute of Land Policy publishes Nature and Cities – The Ecological Imperative in Urban Design and Planning (2016)

Census Information

Table 1. Demographics: Missouri vs. the United States

	Missouri	United States
Population	6,083,672	321,418,821
Square Miles	68,746.5	3,536,097.4
People per square mile	88.5	90.9
Median age	38.4	37.8
Per capita income	$27,384	$29,979
Poverty	14.8 percent	14.7 percent
Transportation to work	23.6 minutes	26.4 minutes
Persons per household	2.5	2.7

(Census Reporter, 2015, based on data from the U.S. Census Bureau, American Community Survey)

Urban and Rural Missouri

The U.S. Census Bureau's urban-rural classification is fundamentally a delineation of geographical areas, identifying both individual urban areas and the rural areas of the nation. The U.S. Census Bureau's urban areas represent densely developed territory, and encompass residential, commercial, and other non-residential urban land uses. Urban areas are delineated after each decennial census by applying specified criteria to decennial census data. Rural areas encompass all population, housing, and territory not included within an urban area. The U.S. Census Bureau identifies two types of urban areas (U.S. Census Bureau, 2010):

- Urbanized Areas (UAs) consist of 50,000 or more people

- Urban Clusters (UCs) consist of at least 2,500 and less than 50,000 people

The Missouri Census Data Center has the following to say on urban and rural classifications (2017):

- Urban and rural designations are assigned at the census block level. Census blocks are the smallest geographic units that the U.S. Census Bureau recognizes in its geographic scheme. Any other kind of geographic area – a city, county, school district, ZIP code, etc. – will not necessarily be classified as completely urban or rural.
- Only 33 out of 114 counties in Missouri are classified as being entirely rural. There are no counties in the state that are 100 percent urban, except the independent city of St. Louis.
- Only about 2.5 percent of Missouri's rural population lived on farms in 2000; that comes to about 1 of every 12 rural residents. Most live in areas that look very much like suburbs or in small towns.

Table 2. Population Distribution between Rural and Urban Land

Geography	Rural Land Classification	Rural Population	Urban Land Classification	Urban Population
Missouri	97.4 percent	31 percent	2.6 percent	69 percent
United States	97.4 percent	21 percent	2.6 percent	79 percent

Based on data from the 2000 Census

Prior to Census 2000, the definition of "urban" used city limits. Instead of having a requirement for a place (city) of 50,000 or more to form the core of an urban area (UA), there is now a more sophisticated way of identifying densely settled population clusters of 50,000 or more. Jefferson City, for example, did not qualify as a UA in 1990 because the city's population was less than 40,000. Under the new criteria, however, the area does qualify because it takes into account not just the population living within the city limits, but the entire densely-settled area that includes most of the city. The more important change in the urban/rural definition came in how areas outside of UAs were classified. The new geographic entity involved is called an urban cluster (UC). A UC is defined using the same concept as a UA, except that the central population threshold is lowered from 50,000 to 10,000. So, for example, there is a Poplar Bluff UC, because that city and its immediate environs have a population between 10,000 and 50,000. This central cluster area has nothing to do with city boundaries, and everything to do with dense population settlement. If you live on the outskirts of Poplar Bluff, but are part of either the densely settled core or of the less densely settled adjacent area, then you are within the UC – and hence classified as urban. Under the old definition, if you lived outside an "urbanized area" (large city), then you were classified as urban if and only if you lived within a place of 2,500 or more population. That definition was applicable when people lived "in town" or out in the "open country."

But population dynamics have changed; today, if people living in unincorporated areas adjacent to smaller towns (such as Poplar Bluff) are living in densely settled areas they are classified as urban. On the other hand, people living in a small town of 2,500 or more that does not meet the criterion of having a 10,000-person population cluster associated with it, are classified as rural instead of urban under the new definition.

Urban is sometimes confused with "metropolitan" or, more recently, "micropolitan." But the two concepts are significantly different. Metro- and micropolitan areas are comprised of complete counties; counties on the outer fringes of metro areas often have the majority of their land areas and significant portions of their populations classified as rural. The metropolitan concept has more to do with whether you live in an area where you are either within or have access to an urban center. The ability to commute to work in an urban center is the primary criterion for being included in a metro area.

Urban/rural designations are concerned with the density of population in an immediate area, not how far away that area is from an urban center. In the 2000 census, 31 percent of Missouri's population was classified as living in a rural area but only 14 percent lived outside of both metropolitan and micropolitan areas (73 percent lived in metropolitan areas and 13 percent in micropolitan areas).

Core-Based Statistical Areas

Metropolitan and micropolitan statistical areas are geographic entities delineated by the Office of Management and Budget according to published standards that are applied to Census Bureau data. These standards were last updated in 2010 and the current metropolitan and micropolitan statistical area delineations were announced in 2015. The term "Core-Based Statistical Area" (CBSA) is a collective term for both metropolitan and micropolitan statistical areas. It is derived from the general concept that a metropolitan or micropolitan statistical area is composed of a "core" that contains a substantial population nucleus, together with adjacent communities that have a high degree of economic and social integration with that core. The 2010 standards establish that each CBSA must contain at least one urban area with a population of 10,000 or more. Each metropolitan statistical area must have at least one urbanized area of 50,000 or more inhabitants. Each micropolitan statistical area must have at least one urban cluster of at least 10,000 but less than 50,000 inhabitants (U.S. Census Bureau, 2017).

Counties form the geographic "building blocks" for metropolitan and micropolitan statistical areas throughout the United States and Puerto Rico. Under the standards, the county (or counties) in which at least 50 percent of the population resides within urban areas of 10,000 or more population, or that contain at least 5,000 people residing within a single urban area of 10,000 or more population, is identified as a "central county" (counties). Additional "outlying counties" are included in the CBSA if they meet specified requirements of commuting to or from the central counties (U.S. Census Bureau, 2017).

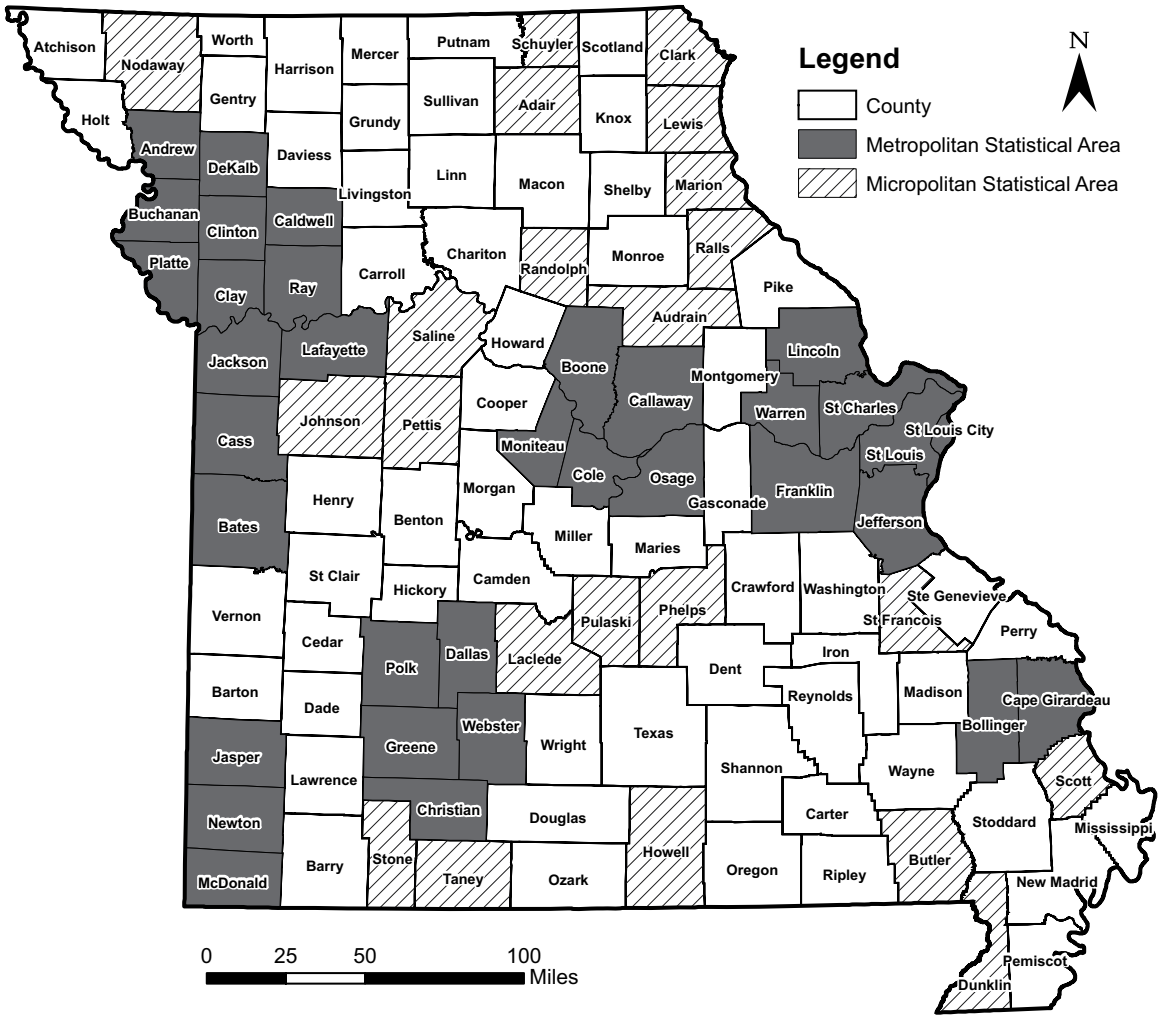


Figure 1. Core-Based Statistical Areas
(Cartography by Ronda Burnett, MDC, based on data from U.S. Census Bureau 2016)

Missouri Government

Classification of Counties (Missouri Revisor of Statutes, 2016)

Title VI, County, Township and Political Subdivision Government

Chapter 46 – Establishment and boundaries of counties

- Section 46.040. Effective 08/28/1939. State divided into 114 counties and one city (St. Louis).

Chapter 48 – County classification

- Section 48.020. Effective 05/25/2010. Classification of counties into four classes for purpose of organization and power. The classes are based on the assessed value of the county with first-class counties having the highest assessed value.

Chapter 65 – Township organization counties

- Section 65.010. Effective 08/28/1945. There is hereby provided an alternative form of county government for counties of the third and fourth classes as authorized under the provisions of Section 9, Article VI of the Constitution of Missouri, 1945, to be known as the "township organization" form of county government. Any county of the third and fourth class in this state may adopt this alternative form of county government.

Table 3. Number of Counties by Classification (Harrison, 2016)

Class 1	19	Of which, 4 are Charter Counties
Class 2	2	
Class 3	89	Of which, 21 are Townships
Class 4	4	Class 4 counties operate under the laws of Class 2 counties

Classification of Municipalities (Kander, 2015)

Missouri statutes classify municipalities on the basis of population and limit the form of government options of each classification. The statutes provide that a community may incorporate as a city of the third class, fourth class or village on the basis of the population at the time of incorporation. [1]Once a community is incorporated under a given classification, the municipality does not automatically change classification with a gain or loss of population. A municipality may change classification only when the change is approved by a majority vote of the people.

There are certain forms of government permitted for each classification of municipality. Villages are permitted only one form of government – an elected board of trustees, five in number if the village has less than 2,500 population and nine if more than 2,500 population. Fourth-class cities are permitted to have either a mayor/board of aldermen form or a mayor/city administrator/aldermen form. The board of aldermen may adopt a city administrator form by ordinance, without a vote of the people. Third-class cities are granted greater flexibility with the authority to establish a mayor/council form, a council/manager form, a commission form or a mayor/city administrator/council form. Finally, constitutional charter cities may adopt any form of government that the people approve in the charter.

Table 4. Classification of Missouri Municipalities

Class	Population Requirement	# of Class in the State	Form of Government
Village	Less than 500	273	Board of trustees
4th Class	500–2,999	579	Mayor/board of aldermen Mayor/city administrator/aldermen
3rd Class	3,000–29,999	60	Mayor/council Mayor/city administrator/council Council/manager Commission
Constitutional Charter/Home Rule	More than 5,000	40	To be decided by the people
Special Charter	No requirement	8	As set forth in the individual special charter
[2]CDP	N/A	57	N/A

[1]From 1821 to 1875, the Missouri General Assembly passed special charters for specific cities, until the 1875 Constitution prohibited further granting and amending of special charters. However, eight Missouri municipalities are still operating under special charters granted before 1875. They are Augusta, Carrollton, Chillicothe, LaGrange, Liberty, Miami, Missouri City and Pleasant Hill. If the voters of these municipalities decide to relinquish their special charters, they will be governed by the appropriate sections of the statutes relevant to their population classification.

[2]CDP: Census designated places are delineated for the decennial census as the statistical counterparts of incorporated places.

Title VII, Cities, Towns and Villages (Missouri Revisor of Statutes, 2016)

Chapter 82 – Constitutional charter cities (Home Rule)

- Section 82.300. Effective 08/28/2009. Any city with a population of 400,000 or more inhabitants which is located in more than one county may enact all needful ordinances for preserving order, securing persons or property from violence, danger and destruction, protecting public and private property and for promoting the general interests and ensuring the good government of the city, and for the protection, regulation and orderly government of parks, public grounds and other public property of the city, both within and beyond the corporate limits of such city.

County Planning and Zoning Authority (Missouri Revisor of Statutes, 2016)

Title VI, County, Township and Political Subdivision Government: Chapter 64 – County planning and zoning

Title VI, County, Township and Political Subdivision Government: Chapter 65 – Township organization counties

- Section 64.040. Effective 08/28/1941. The county planning commission shall have power to make, adopt and may publish an official master plan of the county for the purpose of bringing about coordinated physical development in accordance with present and future needs. The master plan shall be developed so as to conserve the natural resources of the county, to insure efficient expenditure of public funds, and to promote the health, safety, convenience, prosperity and general welfare of the inhabitants. Such master plan may include, among other things, studies and recommendations relative to the location, character and extent of highways, railroads, bus, streetcar and other transportation routes, bridges, public buildings, schools, parks, parkways, forests, wildlife refuges, dams, and projects affecting conservation of natural resources . . .

- Section 65.650. Effective 08/28/1989. The township planning and zoning proposal shall provide for the preparation, adoption, amendment, extension and carrying out of a township plan for all areas of the township outside the corporate limits of any city, town or village which has adopted a city plan in accordance with the laws of the state. Upon the adoption of the township plan there is created in that township a township planning commission.

Table 5. County Planning and Zoning – Year Authorized

Class of County	Year	Chapter Code	Description
First Class Charter	1941	64.040	Master plan of county authorized
	1974	64.010	County planning commission authorized
	2014	64.090	Planning and zoning powers of county commission defined
First Class Non-Charter	1959	64.261	Zoning districts authorized
	1994	64.211	Creation of county planning board authorized after voter approval
Second and Third Class	1951	64.630	Division of territory into districts authorized
	1971	64.550	Master plan of county authorized
	1978	64.530	Planning or zoning to be adopted after voter approval
	1986	64.640	County commission may prescribe zoning regulations
First Class Non-Charter, Second, Third, or Fourth Class	1974	64.850	County commission may prescribe zoning regulations after voter approval
	1978	64.845	County commission may present to the voters the question for the establishment of county zoning
		64.885	County commission may present to the voters the question for the establishment of county planning and zoning
Township	1989	65.650	The township board may submit to the voters a proposition to adopt township planning & zoning
		65.662	The township planning commission may make, adopt and publish an official master plan
		65.680	Division of unincorporated territory into districts is authorized
		65.682	The township board may appoint a township zoning commission

City Planning and Zoning Authority (Missouri Revisor of Statutes, 2016)

Title VII, Cities, Towns and Villages: Chapter 89 – Zoning and planning

- Section 89.010. Effective 08/28/2007. Applicability of law. The provisions of sections 89.010 to 89.140 shall apply to all cities, towns and villages in this state. As used in this subsection, "transect-based zoning" means a zoning classification system that prescriptively arranges uses, elements, and environments according to a geographic cross-section that range across a continuum from rural to urban, with the range of environments providing the basis for organizing the components of the constructed world, including buildings, lots, land use, street, and all other physical elements of the human habitat, with the objective of creating sustainable communities and emphasizing bicycle lanes, street connectivity, and sidewalks, and permitting high-density and mixed-use development in urban areas.

- Section 89.040. Effective 08/28/1959. Purpose of regulations. Such regulations shall be made in accordance with a comprehensive plan and designed to lessen congestion in the streets; to secure safety from fire, panic and other dangers; to promote health and the general welfare; to provide adequate light and air; to prevent the overcrowding of land; to avoid undue concentration of population; to preserve features of historical significance; to facilitate the adequate provision of transportation, water, sewerage, schools, parks, and other public requirements.

- Section 89.340. Effective 08/28/1963. City plan. The commission shall make and adopt a city plan for the physical development of the municipality. The city plan, with the accompanying maps, plats, charts and descriptive and explanatory matter, shall show the commission's recommendations for the physical development and uses of land, and may include, among other things, the general location, character and extent of streets and other public ways, grounds, places and spaces; the general location and extent of public utilities and terminals, whether publicly or privately owned, the acceptance, widening, removal, extension, relocation, narrowing, vacation, abandonment or change of use of any of the foregoing; the general character, extent and layout of the replanning of blighted districts and slum areas. The commission may also prepare a zoning plan for the regulation of the height, area, bulk, location and use of private, nonprofit and public structures and premises, and of population density, but the adoption, enforcement and administration of the zoning plan shall conform to the provisions of sections 89.010 to 89.250.

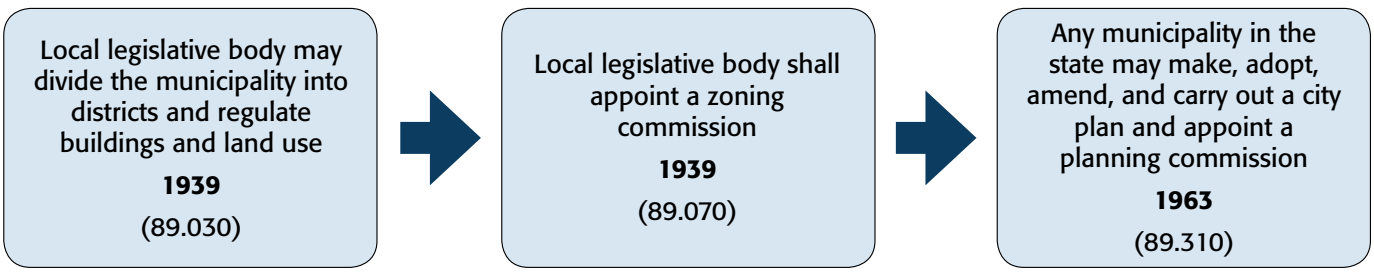
- Section 89.350. Effective 08/28/1963. In the preparation of the city plan, the commission shall make careful and comprehensive surveys and studies of the existing conditions and probable future growth of the municipality. The plan shall be made with the general purpose of guiding and accomplishing a coordinated development of the municipality which will, in accordance with existing and future needs, best promote the general welfare, as well as efficiency and economy in the process of development.

County Compliance With Stormwater Rules (Missouri Revisor of Statutes, 2016)

Title VI, County, Township and Political Subdivision Government: Chapter 64 – County planning and zoning

- Section 64.907. Effective 08/28/2003.

1. Any county subject to Environmental Protection Agency rules 40 C.F.R. Parts 9, 122, 123, and 124 concerning storm water discharges is authorized to adopt rules, regulations, or ordinances reasonably necessary to comply with such federal regulations including but not limited to rules, regulations, or ordinances which promote the best storm water management practices in regulating storm water discharges established by the Environmental Protection Agency.



2. Any county adopting rules, regulations, or ordinances under subsection 1 of this section is authorized to establish by rule, regulation, or ordinance a storm water control utility or other entity to administer any such rules, regulations, or ordinances adopted under subsection 1 of this section which shall include authority to impose user fees to fund the administration of such rules, regulations, or ordinances.

3. Any county adopting rules, regulations, or ordinances under subsection 1 of this section is authorized to establish by rule, regulation, or ordinance a storm water control utility tax in such amount as is deemed reasonable and necessary to fund public storm water control projects if such tax is approved by majority of the votes cast.

4. The tax authorized in this section shall be in addition to the charge for the storm water control and all other taxes imposed by law, and the proceeds of such tax shall be used by the county solely for storm water control. Such tax shall be stated separately from all.

5. Other charges and taxes.

Mission Statements of State Departments Critical for Conservation Success

- Economic Development – To create an environment that encourages economic growth by supporting Missouri's businesses and diverse industries, strengthening our communities, developing a talented and skilled workforce, and maintaining a high quality of life (Missouri Department of Economic Development, n.d.).

- Health and Senior Services – To be the leader in promoting, protecting and partnering for health (Missouri Department of Health and Senior Services, n.d.).

- Natural Resources – To protect our air, land and water; preserve our unique natural and historic places; and provide recreational and learning opportunities for everyone (Missouri Department of Natural Resources, n.d.-a).

- Transportation – To provide a world-class transportation experience that delights our customers and promotes a prosperous Missouri (Missouri Department of Transportation, 2012).

Special Focus on the Missouri Department of Transportation (MoDOT)

Missouri's rich landscape is endowed with incredible natural and cultural diversity. From the urban centers at St. Louis and Kansas City, to the rolling hills of the Missouri Ozarks, the "Show-Me State" is home to a wide variety of natural environments and cultural heritage. MoDOT recognizes the richness of our state's diverse environment, and it aspires to balance Missouri's transportation needs with environmental sensitivity and responsibility (Missouri Department of Transportation, 2013b).

In 1969, the U.S. Congress passed the **National Environmental Policy Act (NEPA)** in response to increasing public concern about the state of the environment. NEPA establishes a national policy to protect the environment, which includes the assessment of potential environmental impacts of all major federal actions. Any project that receives federal funds or permits falls under the umbrella of NEPA, including Missouri Department of Transportation projects that are administered by the Federal Highway Administration (FHWA) and other federal transportation agencies (Missouri Department of Transportation, 2013b).

In addition to NEPA, MoDOT is also mandated to consider the potential impacts of its federally-funded or permitted projects on the cultural environment. In order to comply with federal mandates such as NEPA and the National Historic Preservation Act (NHPA) of 1966, MoDOT employs a staff of highly-qualified environmental and historic preservation professionals. This staff includes experts in the areas of: archaeology, architectural history, bridge history, air quality, community impacts, farmland protection, floodplain management, NEPA compliance, noise analysis, public lands, solid and hazardous wastes, threatened and endangered species, water quality, and wetland and stream protection (Missouri Department of Transportation 2013b).

As well as ensuring project compliance with national mandates such as those set forth by NEPA and NHPA, MoDOT makes every effort to act as a good steward of our state's natural and cultural resources. Missouri has been at the forefront of conservation efforts since the 1930s, and MoDOT strives to continue that precedence (Missouri Department of Transportation, 2013b).

Examples of MoDOT's efforts include:

- Adopt-A-Highway program – Initiated in 1987, this program involves volunteers across the state working together to clean up Missouri. Currently, more than

5,200 groups and 50,000 volunteers are focused on making Missouri's roadsides cleaner and more attractive for our residents and visitors. More than 6,200 miles of roadway have been adopted. Adopter groups include commercial and private enterprises, civic and nonprofit organizations, families, and individuals. MoDOT spends about $6 million annually to remove litter from more than 385,000 acres of right of way along 34,000 state highway miles. Adopters perform about $1 million a year in litter cleanup and beautification efforts. MoDOT provides adopters with a certificate of appreciation, a safety training video, safety materials, and a sign with the group's name posted on each end of the adopted highway section. MoDOT provides trash bags and pick up and disposal of the bags of collected litter. Adopters have four options: (1) Clean up litter; (2) Mow; (3) Beautify through landscaping; and (4) Plant native Missouri wildflowers and grasses (Missouri Department of Transportation, 2013a).

- Roadside vegetation management strategy – MoDOT planners look for opportunities to promote the use of native plant species, control invasive plant species, and protect pollinator habitat along the roadsides they manage throughout the state.
- Tree mitigation – Prior to 2006, MoDOT was committed to planting two trees for each six-inch-or-larger tree removed by construction operations. This resulted in the planting of 131,100 trees to replace 67,000 trees that were removed in 2005. Since that time, MoDOT and the Missouri Department of Conservation have agreed to a tree-distribution and planting program that maximizes the number of trees MoDOT plants to compensate for those it removes on construction projects. This arrangement counters difficulties experienced by MoDOT that were associated with limited amounts of right of way on which to plant; clear zone requirements, mowing operations, and late-in-the-year plantings. Under the agreement, MoDOT compensates MDC for the production costs of trees that MDC then distributes to nonprofit organizations, other state agencies for reforestation projects, and for Arbor Day and Earth Day events (Missouri Department of Transportation, 2006). Beginning in 2014, an agreement between the two state agencies established that MoDOT will reimburse MDC for up to 250,000 tree and shrub seedlings each year at a cost not to exceed $75,000 (Missouri Department of Conservation, 2014a).

Characteristics of Conservation Communities

"It would promise us a more serene and confident future if, at the start of our sixth century of residence in America, we began to listen to the land, and hear what it says, and know what it can and cannot do."

(Stegner & Stegner, 2006)

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1. Development policies and management decisions are based on ecological site data where appropriate.

2. Conservation development practices incorporate and protect existing soils, topography, vegetation, wildlife, and hydrology when land is developed or redeveloped.

3. Community forests are maintained for health and functionality.

4. Invasive plant species are prohibited and eradicated when found.

5. Native plants are allowed by right for use in residential and commercial landscaping.

    - a. **Native plants** are those that have grown in a particular region since the end of the last ice age during the Pleistocene epoch, approximately 10,000–12,000 years ago, and have adapted to the geography, hydrology, and climate of that region.

    - b. **Ecotype** (aka genotype) refers to a geographically limited population of a species adapted to a specific set of environmental conditions (Cullina, 2008). Ecotype seed is harvested from plants that were grown in conditions very similar to the ones present at the project location where they will be planted. Ecotype plants are the ones that grow locally or in the same region as where the project site is located. Even though a species may be native to Missouri, plants growing in different parts of the state will exhibit subtle differences in appearance and tolerance to environmental conditions.

6. Landscaping standards for developers and in-house guidelines for local government departments, i.e., parks and recreation, public works, school districts, etc., promote native plants over the use of nonnative plants or **cultivars** (a contraction of cultivated variety). A cultivar is a variety of a plant developed from a natural species and maintained under cultivation (Chopra et al., 2005). A cultivar does not provide quality habitat, i.e., the minimum level of food and shelter needed by wildlife and insects, like the native variety of the same plant does.

7. Public investments in infrastructure favor green over gray infrastructure where applicable. When integrated within the built environment and maintained for functionality, the natural systems and/or resources that comprise green infrastructure use ecosystem services to accomplish tasks that are traditionally associated with gray infrastructure, e.g., rainwater management, wastewater treatment, air quality protection, etc.

    - a. **Ecosystem services** are the benefits of nature to people, households, communities, and economies. They can be categorized as (GreenFacts, 2017):

        i. *Provisioning services* such as food, fiber, fresh water;

        ii *Regulating services* such as flood control, disease control, and climate regulation (carbon sequestration);

            A. **Carbon sequestration** is the process of increasing the carbon content of a reservoir other than the atmosphere (Chopra et al., 2005).

        iii. *Supporting services* such as soil formation and retention, crop pollination, and the nutrient cycling that maintains the conditions for life on Earth; and

        iv. *Cultural services,* which are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience including, e.g., knowledge systems, and social relations.

    - b. **Green infrastructure** consists of strategically planned and managed networks of natural lands and engineered systems, working landscapes and other open spaces that conserve ecosystem values and functions and provide associated benefits to human populations (Benedict & McMahon, 2006).

- c. **Gray infrastructure** (aka built or constructed infrastructure) consists of man-made systems that support communities, including roads and other transportation systems, stormwater management systems, and utilities (Benedict & McMahon, 2006).

- d. **Maintenance** is the ongoing expenditures to preserve and extend the life of existing facilities (Kansas City, 2006).

- e. **Working lands** (aka working landscapes) are lands that have been modified by humans to produce food, fiber, or other materials; working lands include lands used for agricultural protection, forestry, ranching, and mining (Benedict & McMahon, 2006).

8. Growth is managed in a way so as to avoid habitat fragmentation.

    - a. **Habitat** is the natural environment of an organism; habitat contains the elements of a landscape that the plant or animal needs for survival (Benedict & McMahon, 2006).

    - b. **Fragmentation** is the breaking up of large and continuous ecosystems and communities into smaller areas surrounded by altered or disturbed land (cool-season pasture, cropland, roads, developments, impoundments, utilities) (Nelson, 2005).

9. Standards for green buildings and bird-safe buildings are implemented.

    - a. **Green buildings** are structures that incorporate the principles of sustainable design—design in which the impact of a building on the environment will be minimal over the lifetime of that building. Green buildings incorporate principles of energy and resource efficiency, practical applications of waste reduction and pollution prevention, good indoor air quality and natural light to promote occupant health and productivity, and transportation efficiency in design and construction, during use and reuse (EPA as cited by Davidson & Dolnick, 2004).

    - b. **Bird-safe buildings** are structures that incorporate practices, i.e., design features, materials, and building placement that help reduce injury and mortality in birds caused by collisions with buildings.

10. Ecological design trends are embraced.

    - a. **Biophilia** was coined by Edward O. Wilson who links scientific studies of the brain to the ability of nature to heal, comfort, and inspire human beings. Biophilia influences designers to create buildings and spaces that have a sympathetic relationship with the environment. This approach has been particularly important in the design of health facilities – its relevance demonstrated by shorter hospital stays and lower absenteeism by staff (Steiner et al., 2016).

    - b. **Net-positive design** requires that the interaction among all biotic or abiotic systems of a given project result in change for the better (Steiner et al., 2016). **Biotic** refers to the living components of the environment, e.g., trees, insects, fungi, etc. (Nelson, 2005). **Abiotic** refers to the nonliving components of the environment, e.g., soil type, slope, aspect, etc. (Nelson, 2005).

    - c. **Regenerative design** suggests that the role of the designer and planner is to revitalize the integrity, function, and organization of all systems that are part of a project – including human, social systems. It emphasizes the need to connect human consciousness to a particular, unique place and the critical task of building the capability of people to engage with that place in healthy relationships (Steiner et al., 2016).

    - d. **Resilience** was viewed by Aldo Leopold as the ability of an environment to self-renew by way of existing ecological systems (Leopold, 1949 as cited by Steiner, 2016). Frederick Steiner and his colleagues suggest that the capacity to be resilient is found in both an avoidance of places too dangerous or too expensive to adapt to and also in imaginative, adaptive strategies that accept natural processes (including catastrophes) in design (Steiner et al., 2013 as cited by Steiner, 2016).

11. Citizen scientists engage with professional conservationists to monitor local wildlife and resource systems.

    - a. **Citizen science** is a type of volunteer activity that is intended to collect landscape level data and leverage the time and resources of conservation professionals by engaging the public in the monitoring of nature.

    - b. **Case study: Missouri Forestkeepers Network** – Educates people about Missouri's

trees and forests and enlists volunteers. Volunteers monitor forest health and management, advocate for trees, and participate in education workshops. The program is a partnership between the Missouri Department of Conservation (n.d.-b) and Forest ReLeaf of Missouri.

- c. **Case study: Missouri Master Naturalist** – Supports conservation efforts and natural resource education in local communities. After a training course, volunteers can participate in native habitat restoration, bird monitoring, and youth education. A chapter's local conservation partners provide service projects and ongoing training. The program is a partnership between the Missouri Department of Conservation (n.d.-b) and the University of Missouri Extension.

- d. **Case study: Missouri Stream Team** – Focuses on the health of Missouri streams through education, advocacy, and projects. Volunteers can monitor water quality, stabilize stream banks, and plant streamside trees. This program is a partnership between the Missouri Department of Conservation (n.d.-b), the Conservation Federation of Missouri, and the Missouri Department of Natural Resources.

- e. **Case study: No MOre Trash!** – Missouri's litter-prevention campaign. Through education and clean-up programs, volunteers protect Missouri's natural beauty and wildlife from the harmful effects of litter (Missouri Department of Conservation, n.d.-b).

12. Surface waters, i.e., streams, springs, and ponds/lakes/impoundments, are managed with native plant buffers that protect against nonpoint source pollution and provide habitat to wildlife, and they are accessible to the community from access points on public land.

    - a. **Nonpoint source pollution** refers to the dispersed pollutants that are picked up and carried by rainfall or snowmelt as it moves over and through the ground. It is any source of water pollution that is not a point source (Temple Terrace, FL as cited by Davidson & Dolnick, 2004). **Point source pollution** refers to a discrete source from which pollution is generated before it enters receiving waters, such as a sewer outfall, a smokestack, or an industrial waste pipe (California Planning Roundtable as cited by Davidson & Dolnick, 2004).

    - b. **Case study: Springfield, MO** – Stream signs have been installed at 27 locations on Galloway, Jordan, Wilsons, Fassnight and South creeks and Ward Branch. "We want to encourage the public to recognize that our urban streams are a valuable water resource providing natural habitat and recreational opportunities for our community to enjoy." —Todd Wagner, Principal Storm Water Engineer

Figure 2. Stream Sign

13. The stormwater management (aka rainwater management) regime establishes treatment trains on a watershed scale that filter nonpoint source pollution from runoff while reducing its velocity and volume. It favors surface drainage over buried infrastructure, i.e., pipes and culverts. It daylights previously buried streams and it utilizes native plants in all vegetated practices (see Appendix J for a list of stormwater management practices that incorporate native plants).

    - a. **Stormwater management** consists of the collecting, conveyance, channeling, holding, retaining, detaining, infiltrating, diverting, treating, or filtering of surface water, groundwater, and/or runoff, together with applicable managerial (nonstructural) measures (Redmond, WA as cited by Davidson & Dolnick, 2004).

        i. **Groundwater** is water occurring below the earth's surface in bedrock and soil (Nelson, 2005).

        ii. **Runoff** is precipitation that gets discharged into stream channels from a land area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or throughflow from groundwater (Nelson, 2005). Filtering runoff helps to

remove nonpoint source pollution from it before the water enters an aquatic habitat.

- b. **Stormwater management systems** include all practices utilized by a jurisdiction to manage rainfall. On a watershed scale, the management of stormwater begins with pollution prevention (e.g., pet ordinances, buffer requirements, public education), followed by source controls (e.g., sweeping, illicit discharge detection and elimination), onsite stormwater best management practices (BMPs) (e.g., rain gardens, permeable pavement), and regional BMPs (e.g., constructed pond or wetland, large underground infiltration system) (Minnesota Pollution Control Agency, 2015).

- c. **Stormwater treatment train** is a metaphor that describes how individual practices within a stormwater management system are linked together, like train cars, by the flow of runoff from one practice into another as it moves from the upper reaches of a watershed towards a receiving water body at the low point of the basin. The term has loosely been used since the mid-1980s to represent a multi-BMP approach to managing the quantity and quality of stormwater runoff and has often included prevention and source control practices (Minnesota Pollution Control Agency, 2015).

- d. **Daylighting** is the practice of uncovering a previously buried urban stream so that sunlight can once again reach the surface of the water flowing in it. Stream daylighting revitalizes streams by uncovering some or all of a previously covered river, stream, or stormwater drainage. Although most stream daylighting involves restoring a stream to a more natural state, other forms include architectural and cultural restoration. Architectural restoration involves restoring a stream to the open air while confining the channel within concrete walls, whereas cultural restoration celebrates a buried stream through markers or public art used to inform the public of the historic path, although the stream remains buried (Trice, n.d.).

    i. **Case study: Springfield, MO** – In 2006, the City resurrected Jordan Creek from an undersized concrete tunnel. The first of its kind in Springfield, this project involved removing inadequate drainage tunnels and reconstructing a new "stream" ecosystem through a greenway corridor with a safe pedestrian trail connecting two parks. This trail makes a vital connection in the Vision 20/20 Comprehensive Parks, Open Space, and Greenways plan. The daylighting project provides 100-year flood capacity to protect adjacent properties and remove them from the floodplain while enhancing water quality and providing natural habitat and community recreational opportunities. The project promotes the idea that urban streams are a valuable resource to be enjoyed rather than a nuisance to be tunneled underground (Springfield, n.d.).

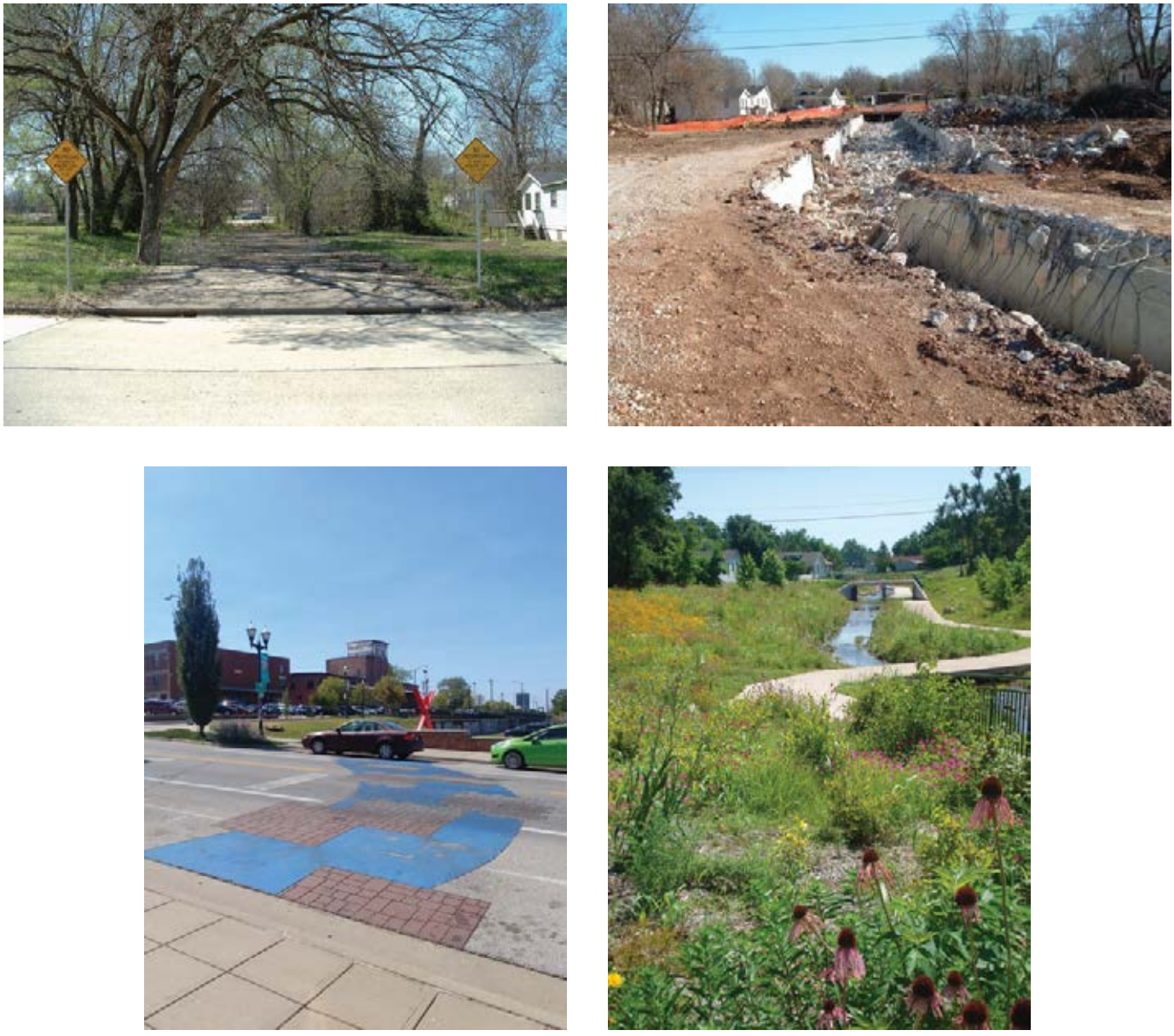


Figure 3. Jordan Creek in Springfield, Missouri (clockwise from top left): Stormwater inlets along the curb drain into the buried stream; demolition work to daylight a section of the stream; cultural restoration of a still-buried section of the stream where it crosses underneath a downtown street; section of daylighted stream with a greenway trail and native plants established within the riparian corridor.

Initiatives that Promote Biodiversity and Sustainable Development

"I think we are building a more holistic kind of citizenship with these modest investments in environmental education. Nature is in every neighborhood and environmental education is the key to knowing how to find it."

— David Bragdon, President of the Metro Council, a regional government in the Portland, Oregon metropolitan area (Benedict & McMahon, 2006)

- **Arbor Day Foundation programs** (2017)
  - **Tree Campus USA** – A national program that helps colleges and universities establish and sustain healthy community forests.
  - **Tree City USA** – In cooperation with the U.S. Forest Service and the National Association of State Foresters, the Tree City USA program has been greening up cities and towns across the U.S. since 1976. It is a nationwide movement that provides the framework necessary for communities to manage and expand their public trees. As of 2015, 88 Missouri communities have made the commitment to be a Tree City USA. They achieved this status by meeting four core standards of sound urban forestry management: maintaining a tree board or department, having a community tree ordinance, spending at least $2 per capita on urban forestry, and celebrating Arbor Day.
  - **Tree Line USA** – A national program that recognizes best practices in utility arboriculture.
- **BiodiverseCity St. Louis** – This community initiative promotes, protects and plans for biodiversity throughout the greater St. Louis region. It consists of a growing network of organizations and individuals throughout the greater St. Louis region who share a stake in improving quality of life for all through actions that welcome nature into urban, suburban and rural communities (MBG, n.d.).
- **Biophilic Cities** – Biophilic cities are cities of abundant nature in close proximity to large numbers of residents. Biophilic cities value residents' innate connection and access to nature through abundant opportunities to be outside and to enjoy the multisensory aspects of nature by protecting and promoting nature within the city. The Biophilic Cities Project aims to advance the theory and practice of planning for biophilic cities through a combination of collaborative research, dialogue and exchange, and teaching. Its principal researchers at the University of Virginia's School of Architecture partner with city collaborators to assess and monitor biophilic urban qualities and conditions, to identify obstacles and impediments to achieving more biophilic cities, and to identify and document best practices in biophilic urban design and planning (Biophilic Cities, 2017).
- **Green City Coalition** – This is an effort in St. Louis to address both vacancy and inequitable access to quality outdoor spaces. Building upon the success of the Urban Vitality and Ecology Initiative that formed in 2013, the mission of the coalition is to create and conserve ecologically rich urban green spaces that promote healthy, vibrant and engaged communities through a deeper connection with nature.
  - **Urban Vitality and Ecology Initiative** – This was an initiative in St. Louis to connect people to urban natural resources in ways that maximize economic impact and social benefits (St. Louis, 2017).
- **International Dark-Sky Association** – An International Dark-Sky Community is a town, city, municipality or other legally organized community that has shown exceptional dedication to the preservation of the night sky through the implementation and enforcement of a quality outdoor lighting ordinance, dark sky education and citizen support of dark skies. Dark Sky Communities excel in their efforts to promote responsible lighting and dark sky stewardship, and they set good examples for surrounding communities (International Dark-Sky Association, n.d.-a).
  - Wildlife is all around us, whether we live in urban or rural settings. Choices made by various jurisdictions about outdoor lighting impact all species and are especially important for locations in or near sensitive habitats. Bad lighting policies can have lethal consequences for wildlife, but good policies can actually help restore healthy urban ecosystems (International Dark-Sky Association, n.d.-b).

- **Kansas City Native Plant Initiative (KCNPI)** – Formalized in 2016, the inspiration for KCNPI originated from a talk given by Doug Ladd at a Westport Garden Club (WGC) meeting two years earlier. Upon learning of the potential to reintegrate ecologically sustainable landscapes into the cultural fabric and identity of the Kansas City Metropolitan area, WGC sought out others who share an interest in native landscapes. This effort resulted in a group of 35 organizations meeting as the KCNPI with a shared vision of a future of beautiful, native landscapes connecting heartland communities where nature and people thrive together (KCNPI, 2017).

- **Mayors for Monarchs** – Mayors and other local government executives are taking action to save the monarch butterfly, an iconic species whose populations have declined by 90 percent in the last 20 years. Through the National Wildlife Federation's Mayors' Monarch Pledge (see examples in Appendix B), cities and municipalities are committing to create habitat and educate citizens about how they can make a difference at home (NWF, 2017).

- **Nature in the City** – This is a program in Fort Collins, Colorado that seeks to increase people's connection to nature while enhancing wildlife habitat. To achieve this, Nature in the City activates innovative partnerships, policies, and projects (Fort Collins, n.d.).

- **OneSTL** – This is a plan for sustainable development that includes a vision, goals, and objectives that outline a sustainable future for the St. Louis region as well as strategies, tools, and resources for achieving that vision (East–West Gateway Council of Governments, 2018a). The OneSTL website includes a Sustainable Solutions Toolkit, which is a resource that contains guidance for programs, projects, and policies that local governments can use to make their community more sustainable (East–West Gateway Council of Governments, 2018b).

- **Urban Biodiversity Inventory Framework** – To better understand and preserve urban biodiversity, cities need a way to assess and track changes over time so that appropriate management decisions can be made. The Urban Biodiversity Inventory Framework and its companion online platform provide a methodology for tracking urban biodiversity data (Samara Group LLC, 2017). The City of St. Louis was one of five partner city representatives that assisted with development of this framework.

- **Vibrant Cities Lab** – Decades of research shows that urban forests deliver measurable economic benefits, reduce strain on hard infrastructure, and improve people's health and quality of life. Vibrant Cities Lab is a joint project of the U.S. Forest Service, American Forests, and the National Association of Regional Councils that merges research with best practices for implementing green infrastructure projects in communities (Vibrant Cities Lab, n.d.).

Special Focus on the Missouri Department of Conservation

Community Conservation Planning program: Operating under the motto, "Connecting Communities to Nature," this program provides technical advice, planning assistance, and partnership opportunities to communities for the improvement and conservation of fish, forest, and wildlife resources, and integration of the built and natural environments. Created in the year 2000, this program is administered by MDC's Private Land Services Division.

Community Forestry program: Administered by MDC's Forestry Division, this program provides planning and technical assistance to communities that want to improve the health of urban and community trees and forests. Planning for and justifying investments in urban forest infrastructure is easier for local decision makers when the existing condition and maintenance needs of the urban forest is known. Community foresters offer insights into the benefits of urban forest infrastructure, provide advice on how to manage threats such as pests, diseases, and natural disasters, and promote partnership opportunities between statewide organizations (i.e., Missouri Community Forestry Council), local communities, nonprofit organizations (i.e., Forest ReLeaf of Missouri and Bridging the Gap), and Missouri citizens. Additionally, they promote and administer the Arbor Day Foundation programs described above in Missouri.

Urban Wildlife program: This program is administered by MDC's Wildlife Division. It provides planning and technical assistance to communities regarding the management of native wildlife and high-quality habitat in urban areas. Urban Wildlife Biologists also provide advice on how to manage for nuisance and invasive species that negatively impact the quality of life and economic vitality of Missouri communities.

Planning Process

"A river is a powerful way to focus a community because people derive a sense of place from it. It's the spine that links the watershed together and provides a bioregional focus to planning and ecological design for which there's no peer."

— Daniel Iacofano

When a community is ready to connect to nature and enjoy the economic, environmental, and social benefits associated with healthy fish, forest, and wildlife resources, there are a series of steps that can be taken.

A good place to start is with a **natural resource inventory** (NRI). The NRI is a report that contains maps and descriptions of existing natural resources within the city, county, or other geography of interest such as a metropolitan statistical area or a designated urban growth area. This report helps a community understand the context of where it is located in the natural world, i.e., the ecological sites it was built on, the name of its watershed and where the watershed drains, which plants and wildlife species are native to the area, etc. Understanding the elements and functions of the natural world, i.e., its ecosystem services, provides decision makers with scientifically justifiable reasons for the management recommendations they make. It also allows natural resources to be accurately valued and helps to create a strong sense of place within the community. **Sense of place** (aka identity) is the sum of attributes of a locality, neighborhood or property that give it a unique and distinctive character (Kansas City, 2006).

Elements of an NRI:

- Ecological site descriptions
- Geography – land forms (topography), river systems (hydrology), watershed boundaries
- Geology – soils, surface and subsurface rocks
- Natural community types (see Appendix F)
- Vegetation – native plants and existing plant communities
- Wildlife

An inventory will identify, quantify, and locate existing natural resources within a community. Once complete, the next step is to assess the condition of the resources. Unlike an inventory that is concerned with quantities, an assessment evaluates quality, i.e., health, functionality, level of maintenance, etc. Knowledge of pre-development conditions can provide a baseline against which to judge the present-day health of natural resources, but an assessment of functionality will depend on the needs of the community. Other qualitative attributes that may be evaluated are those that contribute to the community's sense of place as well as to the overall sense of well-being experienced by residents and visitors.

Equipped with the results of an NRI and an assessment of the physical condition of local natural resources, planners and community leaders can work with the public to craft a vision and set goals related to becoming a conservation community. Guiding principles that may be discussed during this step of the process include:

- **Ecosystem management** – An approach to natural resource management that focuses on sustaining ecosystems to meet both ecological and human needs in the future. Ecosystem management is adaptive to changing needs and new information. It promotes a shared vision of a desired future by integrating social, environmental and economic perspectives to manage geographically defined natural ecological systems (United Nations Environment Programme, n.d.-b). An **ecosystem** is a dynamic complex of plant, animal and microorganism communities and their nonliving environment interacting as a functional unit (United Nations Environment Programme, n.d.-a).
- **Ecosystem value**
  - » **Ecosystem, capital value** – The present value of the stream of ecosystem services that an ecosystem will generate under a particular management or institutional regime (Chopra et al., 2005).
  - » **Ecosystem, direct use value** – The benefits derived from the services provided by an ecosystem that are used directly by an economic agent. These include consumptive uses (e.g., harvesting goods) and non-consumptive uses (e.g., enjoyment of scenic beauty). Agents are often physically present in an ecosystem to receive direct use value (Chopra et al., 2005).
  - » **Ecosystem, indirect use value** – The benefits derived from the goods and services provided by an ecosystem that are used indirectly by an

economic agent. For example, an agent at some distance from an ecosystem may derive benefits from drinking water that has been purified as it passed through the ecosystem (Chopra et al., 2005).

- **Ecosystem, wise use** – Sustainable utilization for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem (Chopra et al., 2005).
- **Equity** – Fairness of rights, distribution, and access. Depending on context, this can refer to resources, services, or power (Chopra et al., 2005).
- **Land ethic** – The desire humans have to conserve, protect, and respect the native landscape and other natural resources; a recognition that the well-being of all life – including human life – is dependent upon the proper functioning of the ecosystem (Benedict & McMahon, 2006).
- **Stewardship** – The sense of responsibility for, desire to participate in, or taking charge of the protection and management of land and water resources (Benedict & McMahon, 2006).

Once a vision has been developed, a community conservation implementation plan can be written to identify the steps that will enable a community to achieve its conservation goals and objectives. The entity or department responsible for each action item should be identified in the plan along with a timeline for implementation and the cost associated with each recommendation. Costs should be given in terms of a complete life-cycle including maintenance expenses and not just the upfront price. Strategies for plan implementation will vary by community but may involve updates to or revisions of the:

- Comprehensive plan
- Design standards and guidelines
- Development codes, regulations, and strategies
- Growth management strategy
- Operational and maintenance (O&M) plans of departments that manage public land, i.e., parks and recreation, public works, transportation, etc.
- Ordinances
- Resource management plans
- Zoning code

Recommended revisions may identify places in the existing regulations where there is a hurdle to community conservation. Removal of these hurdles is often the low-hanging fruit of plan implementation.

As action items in the plan are completed, the results should be monitored and evaluated to gauge how effective each change was at helping the community connect to nature. Changes to long-term operations and maintenance (O&M) practices on public land, i.e., the park system or the urban forest, should be included in the evaluation as well as the impact of revised planning policies on private development.

Useful Data

"The proper use of science is not to conquer nature but to live in it."

—Barry Commoner

Community conservation planning strategies can be applied across the urban-to-rural transect and at all scales ranging from a city parcel to a multi-county region and beyond. To conduct a spatial analysis of a project area, regardless of its scale, there is no better tool than a **geographic information system (GIS)**. GIS is a computerized system organizing data sets through a geographical referencing of all data included in its collection (Chopra et al., 2005). GIS data sets can be developed in-house with information gathered from inventories or they can be downloaded from websites such as:

- **Center for Applied Research and Environmental Systems (CARES)** – A mapping and data visualization center at the University of Missouri. CARES integrates technology and information to support decision making processes (University of Missouri, 2015).

- **Missouri Spatial Data Information Service (MSDIS)** – A spatial data retrieval and archival system. GIS technology is emerging worldwide as the standard tool for integrated management of geographic information. Geographic information, often referred to as spatial information, can be defined as any piece of information that can be referenced by an x, y location. GIS technology enables managers and users of geographic information to achieve higher levels of information integration and to perform more complex analyses than are practically feasible in manual environments (University of Missouri Department of Geography, 2011).

- **Web Soil Survey (WSS)** – Provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA-NRCS and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties (USDA-Natural Resources Conservation Service, 2017).

Metropolitan planning organizations and regional planning councils may also have spatial information, such as refined land cover data, that can be shared upon request with local planners.

Once a data set has been created or downloaded, it can be analyzed, either individually or in conjunction with any or all other data sets available to the planner. The ability to study each resource in a geographic area and then consider the big picture of all components, both natural resources and man-made elements together, allows for patterns and trends to emerge and for relationships amongst disparate components to be better understood.

The NRI developed for a community will be composed of a combination of locally developed data (i.e., an inventory of the community forest) and data sets downloaded from a state or national source (i.e., soils, topography, watersheds, etc.) When the available data have been compiled into the NRI, it will provide a comprehensive snapshot of all existing natural resources and enable community leaders to make informed planning policy decisions involving those resources. Inventories that focus on a single resource are useful in guiding the management decisions of the department(s) responsible for that resource, i.e., a tree inventory used by the parks department and the street division of public works or a watershed inventory used by the stormwater division of public works.

- **Tree inventory** – Street and park tree inventories provide information for the planning, design, planting, maintenance, and removal of community trees. An inventory of trees and planting spaces is a prerequisite in planning for and making sound management decisions including budget strategies and priorities. An inventory can provide the locations of trees that require pruning or removal to reduce risk, the number of trees located within the public right-of-way, the value of ecosystem services trees provide, and the number of available planting sites. In addition, an inventory can help to identify insect or disease problems or young trees that require irrigation, pruning, and other maintenance (Penn State Extension, 2017). **i-Tree** is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefit assessment tools. The i-Tree tools help communities of all sizes to strengthen their forest management and advocacy efforts by quantifying the structure of trees and forests and the environmental services that trees provide (USDA Forest Service, n.d.).

- **Case study: Mid-America Regional Council (MARC) i-Tree Eco Project** — To better understand the ecosystem services and values provided by trees, the U.S. Forest Service, Northern Research Station, developed the Urban Forest Effects model, which is now known as i-Tree Eco. In 2010, an assessment was conducted in the greater Kansas City region and

the data was analyzed using the i-Tree Eco model to determine forest structure, potential risk to trees from various insects and diseases, air pollution removal, carbon storage, annual carbon removal (sequestration), and changes in building energy use. Results from i-Tree models are used to advance the understanding of tree and forest resources; improve urban and rural forest policies, planning and management; provide data to support the potential inclusion of trees within environmental regulations; and determine how trees affect the environment and consequently enhance human health and environmental quality in urban and rural areas (Mid-America Regional Council, 2017a).

MDC has developed two statewide inventories that are available to planners: a natural heritage inventory and one that describes the ecological sites of the state (an overview of ecological site descriptions begins on page 28).

The **natural heritage inventory** catalogs occurrences in the state of **species of conservation concern**, which are plants, animals, and natural communities the Missouri Department of Conservation is concerned about due to population declines or apparent vulnerability (Nelson, 2005). The Missouri Natural Heritage Program collects/locates, compiles, and shares species and natural communities of conservation concern information for the management and conservation of Missouri's biological diversity. All information (1,200 tracked elements and over 30,000 element occurrences) is held in the Natural Heritage Program Database (Missouri Department of Conservation, n.d.-a).

In 2002, the U.S. Army Corps of Engineers helped fund the Natural Heritage Review Website because it gave Corps staff a secure and quick way to check for sensitive resources in areas where it was considering issuing a Clean Water Act Section 404 wetland/stream permit. This site was also available to developers and other agencies to use as a preliminary review for environmental compliance of proposed development projects. In 2013, MDC partnered with the Missouri Department of Transportation to use a Federal Highway Administration grant called "SHRP2 Implementing Eco-logical Implementation Assistance Program," for scoping where several agency stakeholders participated in planning efforts to help update the website.

The updated website contains geospatial data layers for reviewing submitted projects. The "Natural Heritage Environmental Review" layer contains all element occurrence records buffered by one mile. Element occurrence records are considered sensitive information so exact site locations and species names are not provided without an agreement or a direct environmental review report by the Environmental Review Coordinator.

To use the website, users draw their project boundary using the interactive map and provide additional project information. Then the website searches the Natural Heritage Database for records within the project boundary. Once the search is completed one of three possible reports is generated.

- Level 1: No known natural heritage program element records – no further coordination is needed with MDC;
- Level 2: State level concerns – additional coordination with MDC required;
- Level 3: Federal (and possibly state) level concerns – additional coordination with the U.S. Fish and Wildlife Service and possibly MDC required.

Larger-Scale Applications

"It [environment] is, in short, as much the ambience created by a community of human beings as it is the flora and fauna, the topography and climate. And it is possible to destroy it with a resurgent barbarism as it is with a bulldozer's blade."

(Stegner, 2006)

Natural systems cross political boundaries and are connected to a larger ecological framework so some conservation goals can only be achieved by working on a larger scale than an individual city or county. Large-scale and holistic planning approaches include:

- **Ecosystem approach** – A method for sustaining or restoring ecological systems and their functions and values. It is goal driven and is based on a collaboratively developed vision of desired future conditions that integrates ecological, economic, and social factors. It is applied within a geographic framework defined primarily by ecological boundaries (DOT, n.d.-a). The ecosystem approach as defined by the Convention on Biological Diversity is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way (United Nations Environment World Conservation Monitoring Centre, 2014).

- **Landscape approach** – An approach that consists of a suite of components that, taken together, provide a consistent, science-based, adaptive management framework for integrating broad-scale and local-scale resource management information. A landscape approach uses a broad ecological assessment to discern ecological values, patterns of environmental change, and management opportunities that may not be evident when managing smaller land areas. This information can then be used to inform and plan long-term conservation, restoration, and development efforts (Abbey, 2012).

- **Systems approach** – A way of holistically thinking about systems and the structures, functions, and processes in which systems are made up of sets of components that work together for the overall objective of the whole and thereby achieve a behavior or performance that is different than the sum of each of the components taken separately (Benedict & McMahon, 2006).

Conservation planning at the landscape- or regional-scale requires multi-jurisdictional coordination by groups such as regional planning organizations, local governments, nonprofit groups, and large land managers or easement holders. Amongst other stakeholders, participants in the planning process may include representatives from parks departments, transportation departments, greenway or trail groups, land trusts, and utility companies.

- **Greenway** – A linear open space established along either a natural corridor, such as a riverfront, stream valley, or ridgeline, or over land along a railroad right-of-way converted to recreational uses, canals, scenic roads, or other routes; any natural or landscaped course for walking, biking, and other recreational use that links parks, nature reserves, cultural features, and/or historic sites with each other and with populated areas; locally, a strip of land or linear park designated as a parkway or greenbelt (Benedict & McMahon, 2006).

  - **Case study: MetroGreen** – In 1991 the American Society of Landscape Architects held its annual meeting in Kansas City. Over the next 10 years, the society's local Prairie Gateway Chapter worked on a Community Assistance Team Project which became MetroGreen. The MetroGreen Action Plan provides a greenprint for a metropolitan trails system that connects urban and rural green corridors throughout seven counties in the Kansas City region. Implementation of MetroGreen is complex and requires a coordinated effort by the local governments, private interests, and residents of the Kansas City region. MetroGreen is a visionary, large-scale system of interconnected landscape corridors that will span 1,144 miles, link city to countryside, suburb to urban center, and connect residents to nature. To achieve the vision of the plan, MetroGreen will become more than a system of trails and bike paths. MetroGreen will seek to conserve the unique native landscapes of the Kansas City region, and will help resolve the relationship between land development and land stewardship, defining a greenprint for the future (Mid-America Regional Council, 2017b).

- **Land trust** – A privately supported, nonprofit land conservation organization whose purpose is to protect human and natural resources including productive farmland and forests (Benedict & McMahon, 2006).

- **Utilities** – All lines and facilities related to the provision, distribution, collection, transmission, or disposal of water, storm and sanitary sewage, oil, gas, power, information, telecommunication and telephone cable, and includes facilities for the generation of electricity (Renton, WA as cited by Davidson & Dolnick, 2004).

- **Utility easement** – A right-of-way, easement, or use restriction acquired for public use for sewers, pipelines, pole lines, electrical transmission and communication lines, pathways, storm drains, drainage, water transmission lines, and similar purposes (Truckee, CA, as cited by Davidson & Dolnick, 2004).

- **Case study: Ameren** — This electric and natural gas utility company operates in Missouri and Illinois. The company participates in several programs aimed at protecting wildlife and the habitats in which they live (Ameren, 2017).

  - **Wires Over Wildlife (WOW)** – Through a partnership with the Missouri Department of Conservation (MDC), Ameren's Transmission Vegetation Department developed WOW to enhance wildlife habitat on Ameren Missouri's electric transmission rights-of-way.

  - **Flight Diverter Installation** – Ameren Missouri installed flight diverters on transmission lines crossing the Mississippi River near Sioux Energy Center, among other locations, to prevent collisions between trumpeter swans and high-voltage lines.

  - **Energy for Wildlife** – As a certified member of the National Wild Turkey Federation's Energy for Wildlife, Ameren is integrating wildlife management activities into land management programs, including a cooperative effort with Caterpillar to create a 20-acre prairie area located beneath an Ameren Illinois 138kV transmission line that runs through the Caterpillar East Peoria Facility.

  - **Avian Protection Program** – The Avian Protection Program educates and trains field crews on interactions with raptors and also provides safe use of Ameren facilities by retrofitting existing structures with avian safe covers. In addition, new structures have been built with increased conductor spacing to allow raptors safe use of pole tops while perching.

  - **Reflector Installation** – Ameren installed reflectors on power lines and protective coverings where birds like to perch to protect them from contact with high voltage lines.

  - **Reform Wildlife Management Area** – The Reform Wildlife Management Area was created on about 6,000 acres of Ameren Missouri land surrounding Callaway Energy Center to preserve wildlife and educate future generations.

Open Space Connectivity and Wildlife Corridors

Landscape-scale is the ideal level at which to plan for the open space connectivity that will provide wildlife with the travel corridors and connected habitat they need to sustain healthy populations in the state. Travel corridors in Missouri may be contiguous terrestrial corridors or flyways that are utilized by migratory species of birds and butterflies moving between breeding and wintering grounds. At points where a wildlife corridor crosses a road or other transportation corridor, constructed wildlife crossings decrease the risk of vehicular collisions with wildlife.

- **Open space** (aka green space) – Land and water areas retained for use as active or passive recreation areas or for resource protection in an essentially undeveloped state (Cecil County, MD as cited by Davidson & Dolnick, 2004).

  - **Case study: Northwest Arkansas Regional Open Space Plan** – In 2015, the Northwest Arkansas Regional Planning Commission led a public process to develop an open space plan. The purpose of the plan is to develop a coordinated, voluntary program to protect and promote the region's most valued natural landscapes and open spaces. The goal is to preserve these assets; thereby maintaining a high quality of life as the region continues to grow and prosper. This plan identifies the natural landscapes and open spaces that make Northwest Arkansas an attractive place to live, and it includes a comprehensive strategy for the conservation of these natural assets (Northwest Arkansas Regional Planning Commission, n.d.).

- **Green space** (aka open space) – Natural areas, parks, trails, greenways, and other types of open space that are not developed; green space can preserve natural ecological values and functions and provide places for resource-based recreation and other forms of human enjoyment (Benedict & McMahon, 2006).

- **Connectivity** – The creation of functionally contiguous blocks of land or water through linkage of similar ecosystems or native landscapes; the linking of trails, communities, and other human features (Benedict & McMahon, 2006).

A. **B.** **C.**

Figure 4. Wildlife Habitat Nodes and Corridors
(Images courtesy of Benjamin Pennington, 1000 Friends of Florida)

A. Maximum habitat interior (core habitat) and minimum edge.
B. Maximum habitat edge and no interior habitat.
C. Connect core habitat nodes to prevent habitat fragmentation.

- **Wildlife corridor** – Stretches of land that connect otherwise disconnected wildlife habitat; wildlife corridors contribute to greater biodiversity and increased long-term genetic viability and are needed by some species to survive (Benedict & McMahon, 2006).

  - » Maintain large circular nodes (core areas) of habitat to maximize interior habitat and minimize edge. Habitat edges occur at the border of incompatible land and are generally detrimental to priority wildlife species because edges are more accessible to predators and parasites that reduce the survival of their young. For this reason, wider wildlife travel corridors are better. Wildlife also need to be able to travel through uninterrupted, contiguous habitat (North Carolina Wildlife Resources Commission, 2013).

"Fragmentation is the separation of habitat in a landscape. It means chopping a wild place into pieces, or slicing bites off its edge, or putting a road or other divider through the heart of it so that it becomes a conglomerate of smaller, less functional pieces. Fragmentation is what happens when a glass platter falls. Except that landscape fragmentation happens slowly, incrementally. In the moment the first tree fell did the plate begin to slip? At what point did it lay broken at our feet?"

(Ray, 2005)

Roads and Wildlife

The interplay of roads and wildlife is multifaceted. Habitat fragmentation, the spread of invasive plant species along highway rights-of-way, and vehicle collisions with wildlife are negative facets but certainly not the whole story. On the flip side, roadsides can be havens for wildlife and insects that have been pushed out of the adjacent landscape because of poor habitat or pesticide use. Unpaved county roads can supply the grit ingested by some birds for use in digestion of food. Boggy places in ditches can provide amphibians with a place to begin life if the natural micro-wetlands in nearby fields have been graded flat. In places where a roadway is detrimental to wildlife, planners can implement strategies to alleviate the situation. Wildlife crossings decrease the potential for collisions with vehicles. They also reconnect aquatic and terrestrial wildlife with habitat that became inaccessible because of how a low-water bridge or a road was constructed. Landscape-scale habitat fragmentation may be the trickiest issue to remedy because it will require coordination at a regional or state level to address.

- **Wildlife crossing** – Crossing infrastructure provided at key points along transportation corridors to improve safety, reconnect habitats and restore wildlife movement. Wildlife crossings can include underpass tunnels, viaducts, overpasses and bridges, amphibian tunnels, fish ladders, culverts and green roofs (Eidt, 2013).

- Survey findings: According to the Theodore Roosevelt Conservation Partnership (TRCP), America's outdoor infrastructure is just as critical to public safety and the economy as bridges and roads. In a survey of voters who identified as hunters or anglers, the following was found (Weigel, 2017):

  - » 96 percent believe it's important to protect and conserve wildlife habitat and migration corridors

- 70 percent support an increase in funding for highway crossings and fences that help prevent vehicle collisions with wildlife

Management of roadside vegetation can be accomplished in a way that improves wildlife habitat. A field crew can either implement an entire management plan or specialize in one aspect of it as in the case of strike teams that form, typically through multi-agency partnership, to eradicate a specific invasive plant species. Mowing schedules can be based on the needs of pollinators or the timing of migrations. The Federal Highway Administration has assembled a set of best management practices for managers and decision makers focused on pollinators and roadsides. The manual includes tips for raising public awareness and ways to overcome obstacles to practice implementation (U.S. Department of Transportation, 2016). In 2015, an initiative was launched to create a multi-state partnership along Interstate 35 to enhance habitat and engage people about the plight of the monarch butterfly. The I-35 corridor, or the "Monarch Highway," runs along the central flyway of the monarch migration in the states of Minnesota, Iowa, Missouri, Kansas, Oklahoma, and Texas (Monarch Joint Venture, 2017).

- **Case study: Iowa Living Roadway Trust Fund** – In 1988, the Iowa Legislature established the Living Roadway Trust Fund within Iowa Code 314.21. The Iowa Department of Transportation (IDOT) administers this fund, including an annual, competitive grant program that provides funding for integrated roadside vegetation management (IRVM) activities to eligible cities, counties, and applicants with statewide impact. IRVM ensures that roadside vegetation is preserved, planted, and maintained to be safe; visually interesting; ecologically integrated; and useful for many purposes. The goal of IRVM is to provide an alternative to conventional roadside management practices, including the extensive use of mowing and herbicides, which were often too costly to implement on a regular basis, were frequently ineffective, and contributed to an increased potential for surface water contamination. IRVM in Iowa uses native grasses and wildflowers of the original predominantly prairie landscape, which are well-adapted for use on roadsides. Establishing prairie plants in roadside rights of way (IDOT, n.d.):

  - Provides low-maintenance weed and erosion control.
  - Reduces surface runoff and erosion by improving infiltration.
  - Reduces snow drifting and winter glare.
  - Ensures sustainability by increasing species diversity.
  - Enhances wildlife habitat.
  - Beautifies the landscape by providing ever-changing color and texture throughout the year.
  - Preserves our natural heritage.
  - Provides filtering and capture of nutrients, pesticides, and sediment.

- **Case study: Kane County, IL** – For the Stearns Road Bridge Corridor project that was completed in 2010, Kane County wanted to go beyond "minimizing harm" to the environment and established a goal of "undoing harm" and improving environmental conditions within the corridor. Nearly three-quarters of the land acquired for the project has been designated as open space for environmental reasons. The highway right-of-way is a fairly small footprint within the overall green corridor. This design was accomplished through the efforts of many partners who understood that the region's transportation demands could be met without further degrading the environment. The resource agencies — U.S. EPA, U.S. Army Corps of Engineers, U.S. Department of Fish and Wildlife, Illinois Environmental Protection Agency, and Illinois Department of Natural Resources — recognized the value of pursuing the Stearns Corridor alignment over other options since it offered a way to not only protect, but also to enhance various environmental features. The measures made to this end have secured the corridor's future and laid the groundwork for an environmental corridor that happens to have a road in it. Much of the 216 acres of new green space acquired in this project will be turned over to the Forest Preserve District of Kane County for preservation (Kane, 2010).

  Constructed infrastructure consisted of seven highway bridges, five miles of new roadway, nearly three miles of new multi-use path, and four pedestrian bridges. Environmental features of this project include (Kane, 2010):

  - Sensitive wetlands – Since the project is located in a high-quality environment with many stream crossings, erosion control on the earth-moving operation (over 950,000 cubic yards of dirt) was essential to protect the environment. Over 28 acres of erosion control blanket were installed to protect the streams. 65 acres were purchased to create a Wetland Restoration Site in advance of the major construction project to minimize impacts to the Fox River and its tributaries. The new wetland and stormwater treatment area is a functional site for recharge and water quality purposes as well as a

wildlife habitat. Extensive efforts were implemented to encourage wildlife's use of the area, e.g., creek treatments to allow for fish and mussel migration and open structures to allow for wildlife crossings.

- Threatened and endangered species – Construction operations ceased for a "river quiet period" to allow the threatened and endangered river redhorse to spawn. Also, slippershell mussels were relocated to an alternate location to secure their safety as well.

- McLean Fen – The McLean Fen is a wetland fed by groundwater with higher pH (neutral base to alkaline) and serves as a recharge source for the local drinking water supplies in the Fox Valley region. The purchase of the right-of-way containing the recharge area for the McLean Fen protects that area permanently from the pressures of suburban development and sets it aside as open space.

- South Elgin Sedge Meadow/Sand Hill Annex Restoration – The Adaptive Management Plan area included the acquisition of sites that were losing their natural beauty due to impacts from development and land uses. Together, these sites total approximately 35 acres. The county purchased them to ensure their future as green space. The work to restore these areas included selective clearing through controlled burns, and removal of scrub trees, fencing, buildings and driveways.

- Night sky pollution – The project was designed to blend in with the environment, utilizing natural and focused lighting to minimize night sky light pollution.

- Natural environment – To maintain a consistent, natural look across the entire corridor, a single corridor landscaping contract was implemented after project completion to create a uniform environment with native plantings, vegetative swales and other landscaped areas including an observation area around a "dedication stone" unearthed during construction.

Ecological Site Descriptions

Ecological site descriptions (ESD) provide detailed information about the characteristics and function of ecological sites and can be used to guide policy and land management decisions. An **ecological site** is a distinctive kind of land with specific soil and physical characteristics that differ from other kinds of land in its ability to produce a distinctive kind and amount of vegetation and its ability to respond similarly to management actions and natural disturbances (USDA-Natural Resources Conservation Service, n.d.-a). ESD information is presented in four major sections: site characteristics (physiographic, climate, soil, and water features), plant communities (plant species, vegetation states, and ecological dynamics), site interpretations (management alternatives for the site and its related resources), and supporting information (relevant literature, information and data sources) (USDA-Natural Resources Conservation Service, n.d.-b).

The Missouri Department of Conservation has mapped the ecological sites in the state (see Figure 5). To simplify data sharing among user groups, the Department adopted the same naming protocols and organizational structure for ecological sites that is used by the USDA-NRCS. This structure places all ecological sites into two groups: forestland and rangeland. Each group is further divided into subgroups that share soil, landform, and vegetation characteristics.

- **Soil** is the unconsolidated mineral or organic matter on the surface of the earth that has been subjected to and influenced by factors of: parent material, landform, climate, organisms and time and producing a product that differs from the material from which it is derived in many physical, chemical, biological and morphological properties and characteristics (Nelson, 2005). (See Appendix G for additional soil characteristics.)

- **Landform** refers to any physical, recognizable form or feature on the earth's surface, having a characteristic shape and produced by natural causes. Landforms provide an empirical description of similar portions of the earth's surface (Nelson, 2005).

- **Vegetation** refers all the plants or plant life of a place, taken as a whole.

GIS data can be obtained for planning purposes by contacting the Resource Science Division of the Missouri Department of Conservation, located at the Central Regional Office and Conservation Research Center, 3500 E. Gans Road, Columbia, Missouri 65201. Additionally, ESD data is available for viewing, but not for download, through these NRCS websites:

- Web Soil Survey: http://websoilsurvey.nrcs.usda.gov

- Field Office Technical Guide: http://efotg.sc.egov.usda.gov

An overview can be found at http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/ecoscience/desc/.

ESD reports inform planners on the land's ability to respond to disturbance (management activities) and produce certain types of vegetation. This information can be used when making recommendations for plans of any scope be it a regional land-use plan or a site-specific design plan. ESD is especially useful for deciding how to manage large areas of open space; it can guide recommendations for management and re-establishment of appropriate vegetation. This will not only enhance the area's sense of place, but will also help a land manager's efficiency by working with the site as opposed to fighting against a site's inherent characteristics, i.e., trying to grow a forest on land that was historically prairie.

If relatively little disturbance has occurred within an open space management zone or other project location, it may be possible to restore the natural community and its associated ecosystem. A process called ecological reconstruction offers an alternative strategy to **ecological restoration** in places that have become too degraded to be successfully restored. **Ecological reconstruction** is the process of converting a site that has been developed by either urban or agricultural land uses back to its pre-development ecological type. Reconstruction projects are undertaken for many reasons including: to provide habitat for wildlife, to provide ecosystem services for a community's green infrastructure system, to remediate brownfields, and to link a place with its cultural heritage.

An example of a reconstruction project undertaken for cultural heritage purposes is the practice of **landscape preservation**. Not to be confused with a preserve that sets aside land to be untouched by development, in this sense landscape preservation is akin to historic preservation of a building. It is the stewardship of a culturally significant place through management practices that retain the character of the landscape as it was when it was first designed or as it looked when an important event occurred there. Preservation allows for interpretation and remembrance of the way a culture used the land, i.e., carriage routes, battlefields, formal gardens, homesteads, settlements, etc. It also provides a way for honoring the people associated with those places either through their lives, work, or sacrifice.

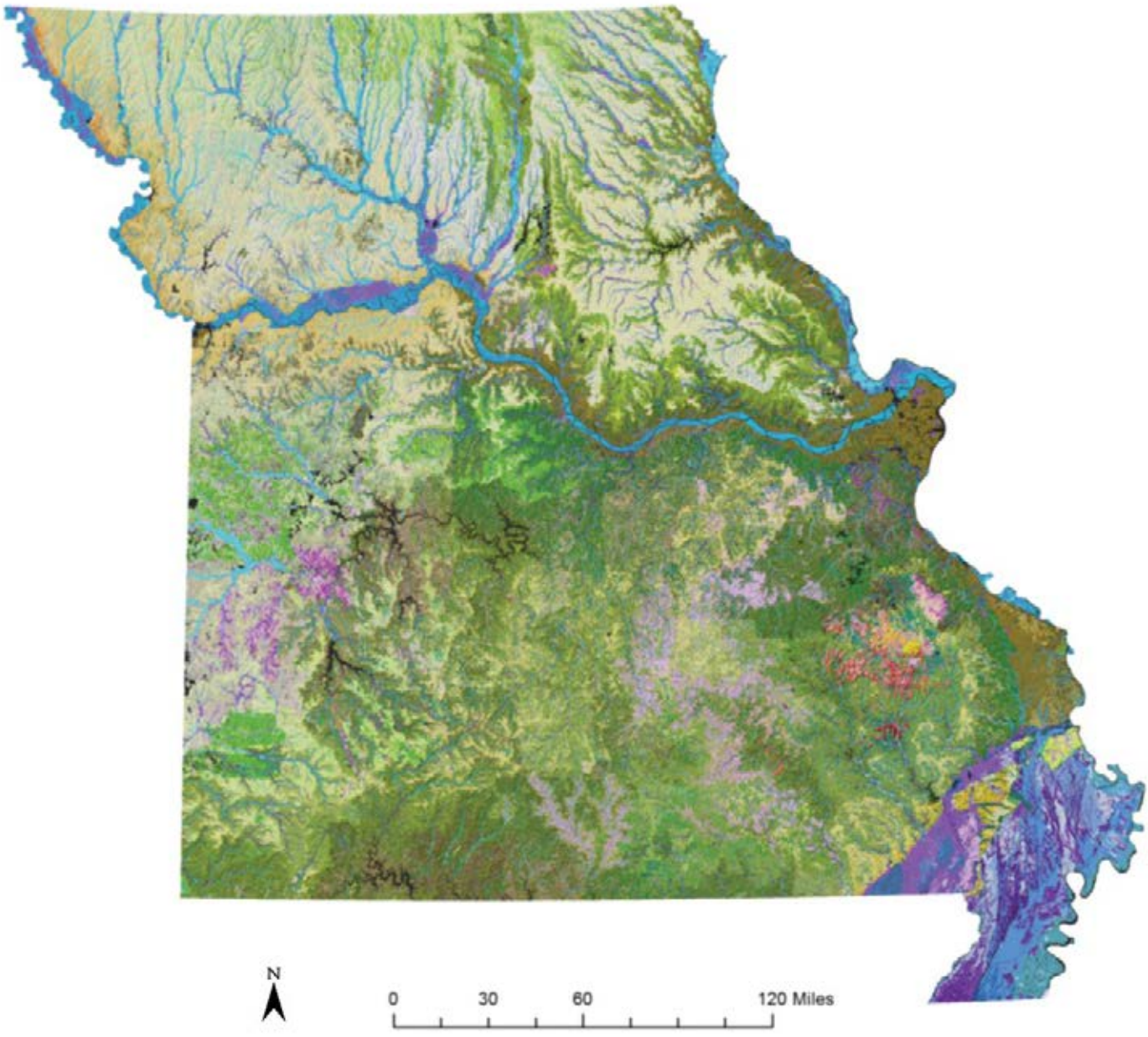


Figure 5. Ecological Sites of Missouri (Struckhoff & Skornia 2015)

Ecological Sites and Natural Resource Inventories

For years, natural resource inventories at a community level have produced existing land cover maps that lump most of the study area into a few major categories: impervious surface, grassland, crops, tree cover, water, and barren/vacant/disturbed land. These broad categories do not convey much information about the ecological characteristics inherent in the community and are minimally useful as a tool for making management decisions. ESD data, on the other hand, can be used to produce maps and fine-grained land cover classification charts that provide decision-makers with a scientific basis for land use and policy recommendations.

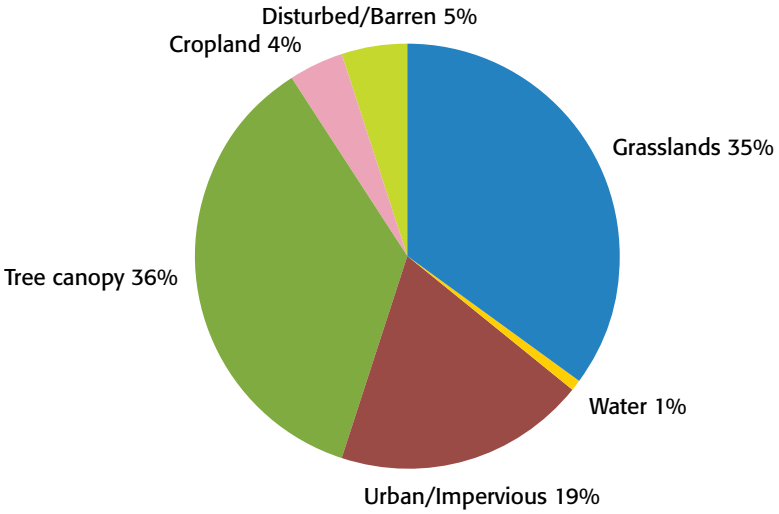


Figure 6. Land-Cover Chart for Columbia, Missouri

For example, the City of Columbia's comprehensive plan includes a standard land cover classification chart that was produced from analysis of high resolution multi-spectral photography collected by the University of Missouri's Geographic Resource Center and verified by field surveys (Columbia, 2013).

ESD data accessed from the NRCS web soil survey includes the percentage of cover within the city for rangeland ecological sites and forestland ecological sites. An analysis of the data shows that Columbia contains both types of ecological sites. Nineteen percent of the community falls into the rangeland category and 81 percent into the forestland category.

The resulting land cover classification charts illustrate the variety of ecological sites that are present within the city. Even a quick skim through the legend of each chart starts to provide an understanding of the natural resources that exist in the area and how they fit together. This knowledge is vital for managing natural resources as green infrastructure and is the first step in empowering a community to become stewards of nature so that it can enjoy the full range of benefits of provided by healthy fish, forest, and wildlife.

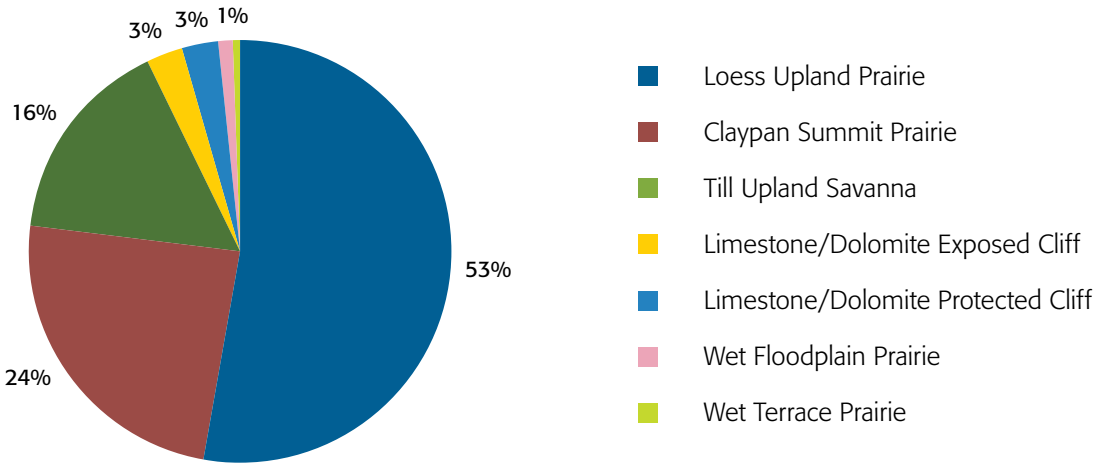


Figure 7. Rangeland Ecological Sites of Columbia, Missouri

Forestland Ecologocal Sites

- Till Upland Woodland
- Loamy Floodplain Forest
- Loamy Upland Woodland
- Calcareous Limestone Exposed Backslope Woodland
- Loess High Terrace Forest
- Chert Limestone/Dolomite Protected Backslope Forest
- Deep Loess Exposed Backslope Woodland
- Interbedded Sedimentary Upland Woodland
- Loamy Exposed Backslope Woodland
- Loamy Limestone/Dolomite Protected Backslope Forest
- Till Exposed Backslope Woodland
- Chert Exposed Backslope Woodland
- Loamy Gravelly Upland Drainageway Forest
- Interbedded Sedimentary Protected Backslope Forest
- Claypan Summit Woodland
- Wet Upland Drainageway Woodland
- Deep Loess Upland Woodland
- Loess Upland Woodland
- Wet Terrace Forest
- Calcareous Limestone Protected Backslope Forest
- Chert Limestone/Dolomite Exposed Backslope Woodland
- Chert Upland Woodland
- Deep Loess Protected Backslope Forest
- Sandy/Loamy Floodplain Forest
- Loamy Limestone/Dolomite Exposed Backslope Woodland
- Loamy Protected Backslope Forest
- Till Protected Backslope Forest
- Chert Protected Backslope Forest
- Interbedded Sedimentary Exposed Backslope Woodland
- Sandy/Gravelly Floodplain Forest
- Loamy Terrace Forest

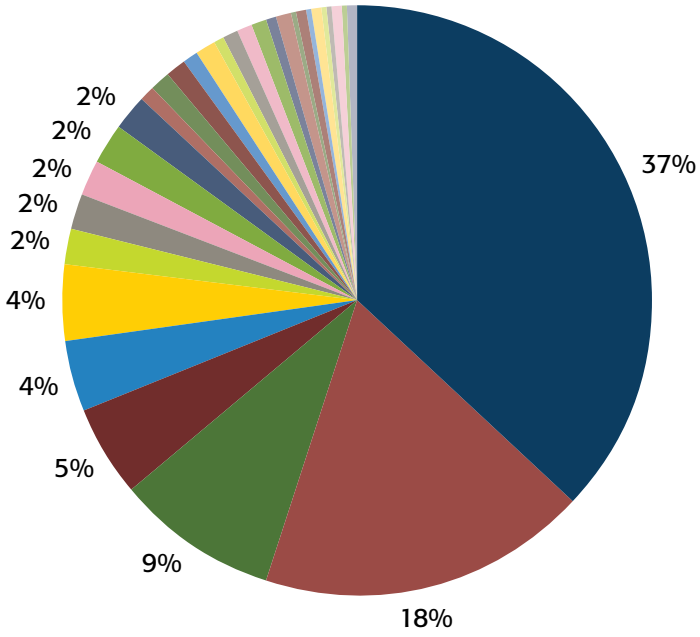


Figure 8. Forestland Ecological Sites of Columbia, Missouri

Ecological Sites and Policy Decisions

Ecological site descriptions can be used to customize community-planning efforts by basing them on site characteristics instead of, or in addition to, land use and density considerations. Some examples include:

Comprehensive plan	Comprehensive plans should state that the contributions of natural resources to human well-being are explicitly recognized and valued by the community and that maintaining their health is a primary objective (Godschalk et al., 2012). Inclusion of an ESD report into the comprehensive plan will help identify which natural resources are located within the community.
Zoning	Natural resource-based zoning bases the design of districts and policies on analyses that include conservation data and maps (North Carolina Wildlife Resources Commission, 2013). An ESD report can provide science-based justifications for zoning codes and will be helpful in locating districts such as: • Conservation zone • Conservation subdivision zone • Forestry zone • Open Space zone
Overlay zoning districts	ESD reports can also help identify locations for overlay zones such as: • Green infrastructure overlay zone • Natural resource protection overlay zone • Sensitive areas overlay zone • Stream setback or riparian overlay zone • Wildlife habitat overlay zone
Ordinances: Clearing/Grading/Land disturbance	Use the soil and landform information in the ESD to customize lists of approved soil erosion control practices
Ordinances: Landscaping	Exempt parcels within prairie ecological sites from tree planting requirements
Ordinances: Plants/Trees/Weeds	Use the vegetation information in the ESD to inform lists of desirable and/or undesirable plants
Ordinances: Slope/Hillside protection	Use the soil and landform information in the ESD to inform decisions on which slopes/hillsides need protection
Ordinances: Stream setback	Base buffer width requirements on ecological sites associated with floodplains and drainage ways adjacent to streams instead of, or in addition to, a minimum distance from the stream
Ordinances: Tree preservation and protection	Enhance tree protection strategies in forest or woodland ecological sites
Design and development codes/ standards: Building codes	In areas where the ESD is associated with habitat for migratory birds, customize building codes to require or incentivize bird-safe building practices within the flyway
Design and development codes/ standards: Low-impact development standards	Exempt development that drains onto managed ecological sites with appropriate hydrological regimes from regulations that require construction of gray infrastructure for stormwater management
Growth management strategies: Smart decline: Vacant lot guidelines	Base the uses allowed, i.e., rainwater management, community forest, etc., on any given lot within a Vacant Lot Management Program on its ESD

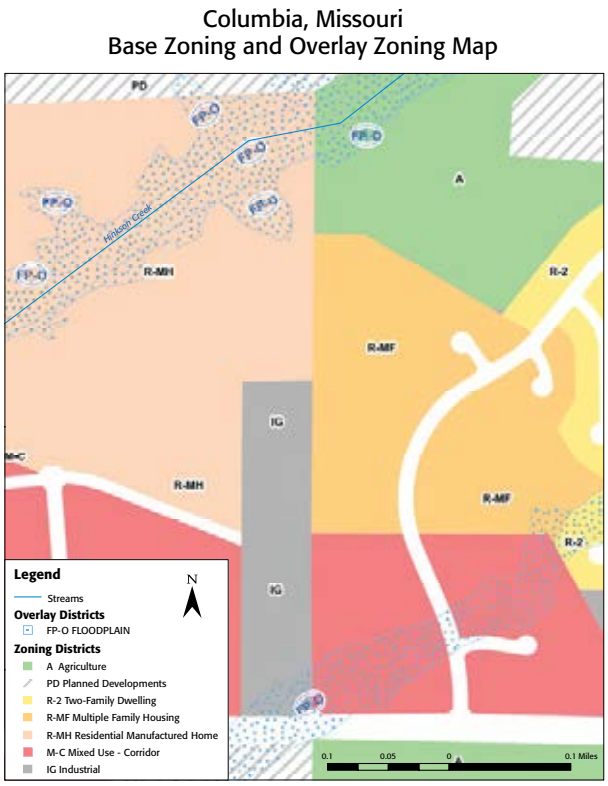


Figure 9. City of Columbia, Missouri – Base Zoning and Overlay Zoning Map
(Cartography by Ronda Burnett, MDC. Map data courtesy of the City of Columbia.)

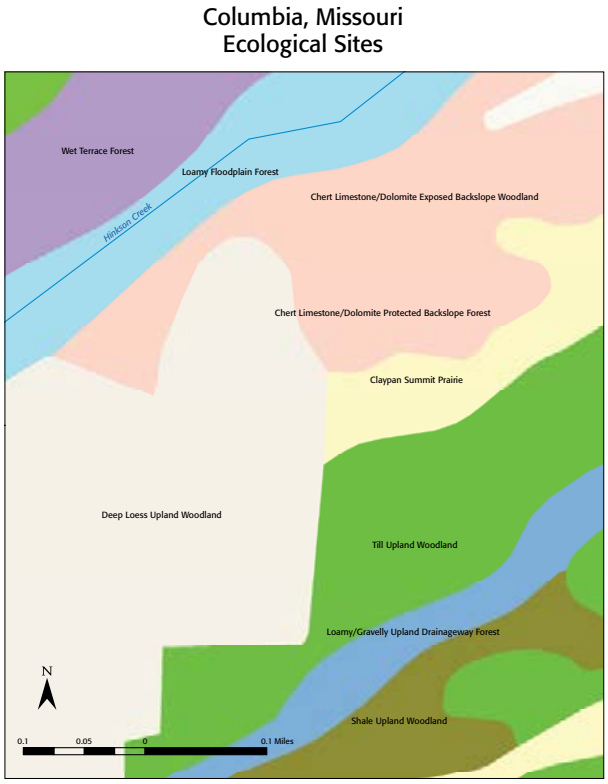


Figure 10. City of Columbia, Missouri – Ecological Sites Map
(Cartography by Ronda Burnett, MDC.)

Conservation Planning Tools

"In the end, our society will be defined not only by what we create but by what we refuse to destroy."

—John C. Sawhill, former president and CEO of The Nature Conservancy and the 12th President of New York University (NYU)

Land use patterns that conserve, buffer, and connect priority wildlife habitats and other natural resources can benefit communities in many ways. These patterns are most assured when incentives and ordinances encourage centered, denser growth patterns, mixed uses, rural cluster development, transit-oriented development, appropriate habitat conservation and low-impact development measures. Greener development decisions can allow for the needed number of development projects while encouraging more efficient land use without harming private property rights. (North Carolina Wildlife Resources Commission, 2013)

Benefits of Natural Resource-Based Land Use Patterns (North Carolina Wildlife Resources Commission, 2013):

- Less tax payer dollars spent on infrastructure maintenance and more funds available to provide business incentives and labor force training.
- More free services provided by nature, such as water quality and quantity.
- Lower transportation costs which improves housing affordability.
- More walking and biking opportunities for healthier, more desirable communities.

Development consists of any building, construction, renovation, mining, extraction, dredging, filling, excavation, or drilling activity or operation; any material change in the use or appearance of any structure or in the land itself; the division of land into parcels; any change in the intensity or use of land, such as an increase in the number of dwelling units in a structure or a change to a commercial or industrial use from a less intensive use; any activity that alters a shore, beach, seacoast, river, stream, lake, pond, canal, marsh, dune area, woodlands, wetland, endangered species habitat, aquifer or other resource area, including coastal construction or other activity (Growing Smart Legislative Guidebook as cited by Davidson & Dolnick, 2004). The **built environment** refers to just those aspects of our surroundings that are constructed by people: buildings, roads, parks, etc. (Greenbelt Alliance, 2017). **Buildout** is the term used when the maximum amount of development allowed on a given site under the current planning and zoning regulations occurs (Greenbelt Alliance, 2017).

A **parcel** is any legally described piece of land designated by the owner or developer as land to be used or developed as a unit, or that has been developed as a unit (Clearwater, FL as cited by Davidson & Dolnick, 2004). The terms greenfield, grayfield, and brownfield can be ascribed to a parcel based on the history of development and/or land use at that location. A **greenfield** has not been previously built upon and is currently viewed as open space or farmland. A **grayfield** has previously been built upon and already has access to infrastructure and other urban services. Structures previously built on the parcel may or may not still be present. In either case, the location is ideal for either infill or redevelopment that follows smart growth and conservation design principles. A **brownfield** is a parcel that has been, or is perceived to have been, contaminated with pollutants that must be cleaned up or remediated before the site can be reoccupied or redeveloped. The remediation process and the degree to which a parcel is cleaned up is determined both by the type of pollution present at the site and the intensity of the future desired land use. Broadly referred to as phytotechnology, **phytoremediation** is a clean-up method that uses vegetation to contain, sequester, remove, or degrade inorganic and organic contaminants in soil, sediment, surface water, and groundwater (Hettiarachchi et al., 2012).

- **Case study: Phytoremediation database** – Through a cooperative effort with the USDA-NRCS Plant Materials Center, faculty in the Kansas State University Department of Agronomy developed a phytoremediation database to facilitate the identification of plants that have potential for successful phytoremediation for specific contaminants. The database allows searching by contaminant or plant species, includes references to published research studies, and classifies the phytoremediation success based on eight phytoremediation mechanisms (Kansas State University, 2015).

Development regulations consist of zoning and subdivision codes as well as a wide range of other regulations that control the location and nature of real property disturbance or development (Morley et al., 2016). Land disturbance consists of any activity that affects the ground surface and/or vegetation, i.e., clearing, grubbing, cut/fill, grading, excavating for foundations, etc. (St. Louis County, 2017).

- **Land development regulations** – Regulations that include any zoning, subdivision, impact fee, site plan, corridor map, floodplain or stormwater regulations, or other governmental controls that affect the use, density, or intensity of land (Growing Smart Legislative Guidebook as cited by Davidson & Dolnick, 2004).

- **Subdivision regulations** – Regulations that provide public control over subdivisions of land into lots for sale and development. The regulations require all subdivisions developers to obtain approval of detailed plans before they can record and sell lots. The plans must satisfy requirements and standards pertaining to the size and shape of lots, design and construction of streets, water and sewer lines, other public facilities, and other concerns such as protecting environmental features (Porter, 1997).

- **Unified development code** – A land development code that includes subdivision, site planning, and zoning controls all in one document (Albuquerque, NM as cited by Davidson & Dolnick, 2004).

Comprehensive Plans

Also known as the general plan, the **comprehensive plan** is the foundational policy document for local governments, establishing a framework to guide decisions over the next 10 to 20 years. Comprehensive plans are named as such because they cover a broad range of topics of communitywide concern. All states either allow or require local governments to prepare comprehensive plans and many states require local development regulations to be in conformance with an adopted comprehensive plan. While enabling laws vary from state to state, common topics for plan elements include land use, transportation, housing, economic development, and community facilities. In recent years an increasing number of localities have added elements addressing green infrastructure, hazard mitigation, and climate adaptation to their comprehensive plans (Morley et al., 2016).

A comprehensive plan with a Natural Resources Inventory (NRI) and a well-crafted zoning ordinance can help identify sensitive environmental areas and keep development away from them. The idea of humans living in balance with ecosystems is important for sustainable environmental planning. It is also important for sustainable economic development (Daniels & Daniels, 2003).

In 2012, the American Planning Association's Sustaining Places Task Force defined planning for sustaining places as: "A dynamic, democratic process through which communities plan to meet the needs of current and future generations without compromising the ecosystems upon which they depend by balancing social, economic, and environmental resources, incorporating resilience, and linking local actions to regional and global concerns (Godschalk et al., 2012)."

Six principles of sustaining places were identified including (Godschalk et al., 2012):

1. Livable built environment – Ensure that all elements of the built environment, including land use, transportation, housing, energy, and infrastructure, work together to provide sustainable, green places for living, working, and recreation, with a high quality of life.

2. Harmony with nature – Ensure that the contributions of natural resources to human well-being are explicitly recognized and valued and that maintaining their health is a primary objective.

3. Resilient economy – Ensure that the community is prepared to deal with both positive and negative changes in its economic health and to initiate sustainable urban development and redevelopment strategies that foster green business growth and build reliance on local assets.

4. Interwoven equity – Ensure fairness and equity in providing for the housing, services, health, safety, and livelihood needs of all citizens and groups.

5. Healthy community – Ensure that public health needs are recognized and addressed through provisions for healthy foods, physical activity, access to recreation, health care, environmental justice, and safe neighborhoods.

6. Responsible regionalism – Ensure that all local proposals account for, connect with, and support the plans of adjacent jurisdictions and the surrounding region.

Key features that must be part of sustainable comprehensive planning and implementation include processes for involving the public and for carrying out plan objectives and proposals.

1. Authentic participation – Ensure that the planning process actively involves all segments of the community in analyzing issues, generating visions, developing plans, and monitoring outcomes.

2. Accountable implementation – Ensure that responsibilities for carrying out the plan are clearly stated, along with metrics for evaluating progress in achieving desired outcomes.

Zoning

Without zoning, essentially any land use could take place anywhere and there is less capacity to manage community

character or public service costs. Done correctly, zoning a jurisdiction based on the suitability of the land to accommodate different land uses can protect natural resources, public health and the economy. However, mid-density residential development (or 1- to 3-acre minimum lot sizes) and large minimum lot sizes from three to 10 acres results in extensive manicured landscaping and inefficient land use. Such patterns fragment habitat and waste water, degrading the network of natural areas on which our communities depend (North Carolina Wildlife Resources Commission, 2013).

Natural resource-based zoning (North Carolina Wildlife Resources Commission, 2013):

- Bases the design of districts and policies on analyses that include conservation data and maps.
- Maintains healthy streams and wetlands and encourages development patterns and standards that conserve upland priority wildlife habitats.
- Encourages more concentrated and high-density growth near existing urban services and public transportation.
- Encourages rural and urban cluster development.

Considerations for effective natural resource-based zoning (North Carolina Wildlife Resources Commission, 2013):

- Enable the highest development density possible in cities and towns.
- Reduce the need to build new roads and utilities.
- Ensure that desired rural areas maintain character and natural resources.
    - » Zone by development units per acre instead of minimum lot size. This allows habitat open space to be clustered (Arendt, 1999). Many jurisdictions take this approach now. If your community and prospective residents value natural area conservation, development density can be lower than development designed for septic utilities (North Carolina Wildlife Resources Commission, 2013).
- In the highest priority wildlife areas, encourage very low overall development density coupled with cluster development (North Carolina Wildlife Resources Commission, 2013).
    - » From an ecological standpoint, it is preferable to cluster houses and leave the undeveloped areas in open space, as opposed to dispersing houses across the entire landscape. With respect to the effect of housing density, most avian densities in a study of songbirds conducted in the Rocky Mountain region did not differ significantly between high- and low-density developments but were statistically different from undeveloped sites (Odell & Knight, 2001).
    - » Trends observed by several studies suggest that the composition of native wildlife will be altered in the vicinity of exurban housing developments. Unlike suburban development, **exurban development** is that which occurs beyond the limits of incorporated towns and cities. In exurban landscapes, the surrounding matrix remains in the original ecosystem type, as opposed to suburban development where the surrounding matrix is urban land use. With cluster development, zones of influence from neighboring homes will overlap, thus minimizing the amount of an area affected by exurban development. When development borders wild or undisturbed lands, a buffer of up to 600 feet around the development should be considered affected habitat (Odell & Knight, 2001).
    - » In rural Massachusetts where forests are being fragmented with development, a decline in the number of forest-interior birds in medium density housing developments is thought to be caused by an increase in nest predators. The predators may be drawn to developments where the forest now looks like the edge habitat where they typically hunt. Also, suburbanization offers food subsidies for some nest predators such as backyard bird feeders available to blue jays over the winter months or garbage available to raccoons (Kluza et al., 2000).
- Conserve and connect habitat and natural resources (North Carolina Wildlife Resources Commission, 2013).
    - » **Natural resources overlay districts** aim to maintain the quality of life and to protect the health, safety, welfare and general well-being of citizens by conserving and connecting the highest priority waterways, forests, and habitat for terrestrial and aquatic native plants and animals while accommodating development and other land uses. They are designed to preserve and protect ecosystems while balancing the need for planned growth. This shall be accomplished by minimizing fragmentation or separation of significant natural resource areas, protecting upland habitats in addition to adjacent waterways and water sources, maintaining plant and animal habitat diversity and specifically protecting unique environmental features identified as integral parts of the designated landscape. This ordinance shall establish standards and procedures for the use

and development of land. The standards and procedures are designed to protect, conserve, enhance, restore, and maintain significant natural resource areas and the ecological connections between them (Pickle et al., n.d.).

» **Feature-based density** is a zoning technique where the permissible density is calculated based on a set of factors contained in the ordinance, as opposed to a uniform standard being applied to all of the land in the zoning district. It is necessary to exclude important habitats in the net site acreage in order to better conserve them (New Hampshire, 2008).

» **Natural resource protection zoning** (NRPZ) emphasizes current, natural-resource-based uses over typical development and there is no "underlying zoning;" NRPZ is the zoning for the selected area. A field report from Massachusetts states that NRPZ can take a number of forms but the essence is to combine low underlying densities with compact patterns of development so that significant areas of land are left permanently undeveloped and available for agriculture, forestry, recreation, watershed, carbon sequestration, and wildlife habitat (Lacy et al., 2010).

Zoning is the exercise of the police powers in which utilization and development of privately owned land is regulated through the division of a community into various districts and the specification of permitted and prohibited uses for each district (Washtenaw County, MI as cited by Davidson & Dolnick, 2004). Zoning is the mechanism through which cities regulate the location, size and use of properties and buildings. These regulations are designed to promote the health, safety, morals or general welfare of the community; to lessen congestion in streets; to prevent the overcrowding of land; to avoid undue concentration of population; and to facilitate the adequate provision of transportation, water, sewage, schools, parks and other public requirements (Kansas City, 2006). The **zoning code** is the duly approved, enacted, and amended ordinance that controls and regulates land use in the city (Maryland Heights, MO as cited by Davidson & Dolnick, 2004).

Types of zoning a community may adopt include:

- **Euclidean zoning** – A convenient nickname for traditional as-of-right or self-executing zoning in which: district regulations are explicit; residential, commercial, and industrial uses are segregated; districts are cumulative; and bulk and height controls are imposed. Commentary: The term is derived from Euclid (Ohio) vs. Ambler Realty Co., the 1926 U.S. Supreme Court decision to affirm the validity of comprehensive zoning. The term has nothing to do with geometry; Euclid could just as well have been Cleveland (Davidson & Dolnick, 2004).

- **Form-based zoning** – Allows market demand to determine the mix of uses within the constraints of building type set by the community. The community establishes zones of building type and allows building owners to determine the uses. The look and layout of a street is carefully controlled to reflect neighborhood scale, parking standards, and pedestrian accessibility, but building owners and occupants are allowed maximum flexibility to determine how the buildings will be used (U.S. EPA as cited by Davidson & Dolnick, 2004).

- **Incentive zoning** – The granting by the approving authority of additional development capacity in exchange for a public benefit or amenity. A quid pro quo—more development for a benefit, the need for which may not necessarily be created by the development itself (Clarkdale, AZ as cited by Davidson & Dolnick, 2004).

- **Performance zoning** – Specifies standards of land-use intensity that are acceptable in each district. Performance zoning focuses on the performance of the parcel and how it impacts adjacent lands and public facilities, not on the use of the land. This gives municipalities and developers more flexibility in designing projects, because the use of a property is not restricted as long as the impacts to the surrounding land are not negative (as defined in the specific regulation) (Tompkins County, NY as cited by Davidson & Dolnick, 2004).

Zoning district – A section of the city in which zoning regulations and standards are uniform (Wood River, IL as cited by Davidson & Dolnick, 2004).

- **Agricultural protection zoning** – A zoning classification that protects the agricultural land base by limiting nonfarm uses, prohibiting high-density development, requiring houses to be built on small lots, and restricting subdivision of land into parcels that are too small to farm (American Farmland Trust as cited by Davidson & Dolnick, 2004).

- **Cluster zoning** (see also open space development) – A zoning classification that allows for a development approach in which building lots may be reduced in size and buildings sited closer together, usually in groups or clusters, provided that the total development density does not exceed that which could be constructed on the site under conventional zoning and subdivision regulations. The additional land that remains undeveloped is then preserved as open space and recreational land (Christian County, 2010).

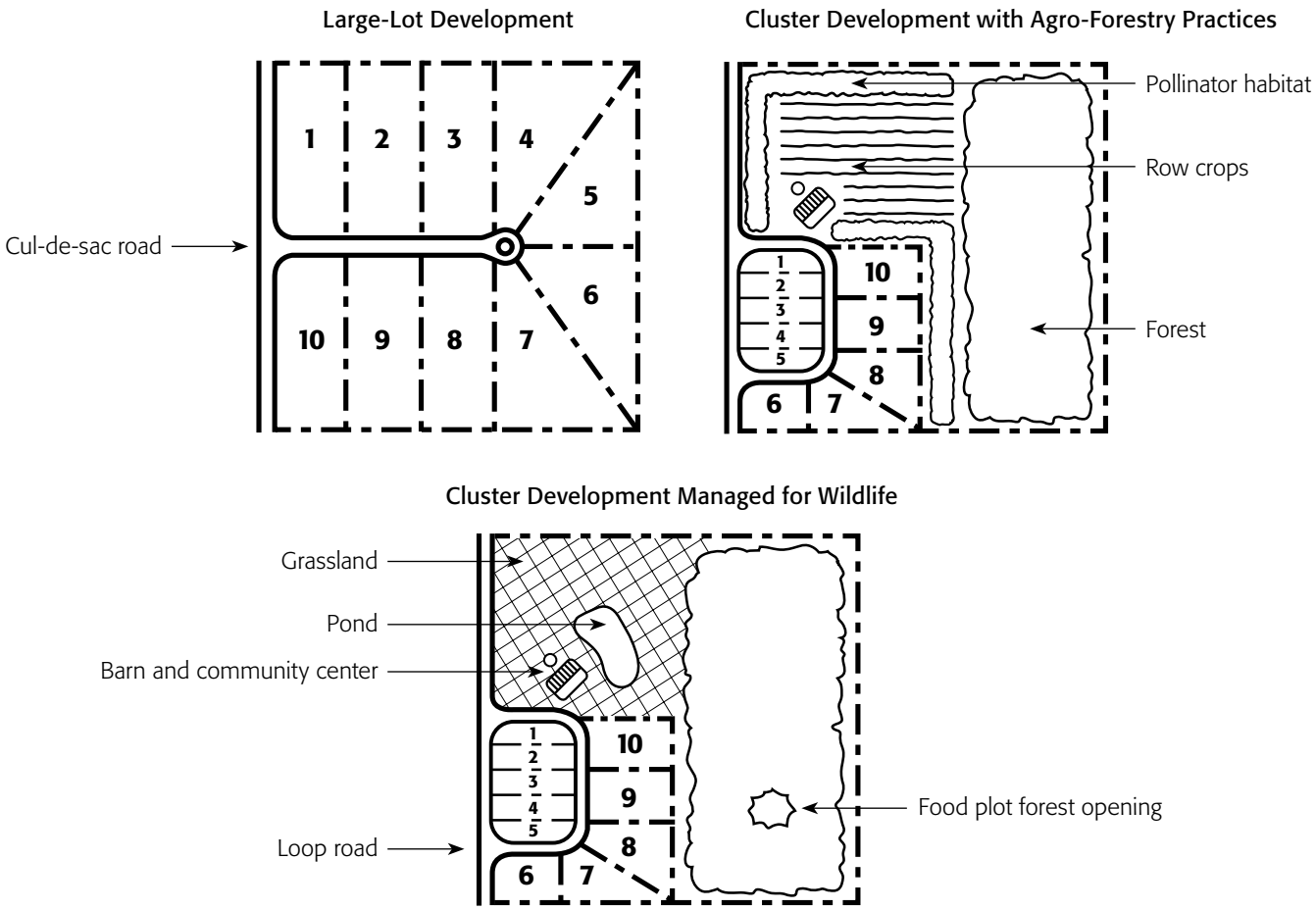


Figure 11. Large-lot rural residential zoning vs. cluster zoning with the open space managed for agro-forestry and for wildlife habitat.
(Ronda Burnett, MDC)

In the figure below, A and B have the same development density, but in image B the lots are clustered and roads are designed to avoid habitat fragmentation (North Carolina Wildlife Resources Commission, 2013).

A. Less habitat conserved – Habitat fragmentation created by large lot zoning and no clustering. This also increases impervious surfaces and stormwater runoff due to longer driveways.

B. More habitat conserved – Clustered development outside sensitive areas and near the main road conserves wider connected habitat.

Figure 12. Cluster developments and habitat fragmentation.
(Images courtesy of Benjamin Pennington, 1000 Friends of Florida)

- **Conservation zoning** – A zoning classification that protect lands that are of high ecological (e.g., wetlands, floodplains, steep slopes, wildlife habitat) or resource (e.g., productive agricultural or forest land) value by limiting development to uses compatible with natural resource conservation and land management goals (Morley et al., 2016).

- **Conservation subdivision zoning** – A zoning classification used to encourage residential subdivision design that improves the preservation of sensitive environmental resources and community character. Conservation subdivision design results in numerous benefits, including the preservation of local biodiversity, retention of existing agriculture/farmland, increased watershed protection, improved recreational opportunities, reduced infrastructure costs, and improved fire protection for residential developments (San Diego County, n.d.).

- **Floodplain zoning** – A zoning classification that implements public health and safety objectives by preventing development in areas where flooding would cause damage to life and property (Mandelker, 1997). A **floodplain** is the strip of nearly level to gently sloping land adjacent to a stream or river channel, built of sediment deposited during overflow and lateral migration of the stream and subject to periodic flooding (Nelson, 2005).

- **Forestry zoning** – A zoning classification that protects a critical mass of commercial timberland and that separates forestry operations from conflicting non-forestry land uses (Daniels, 1999).

- **Mixed-use zoning** – A zoning classification that allows for land uses that are typically located in separate districts to adjoin each other, either horizontally on adjacent parcels or vertically in the same structure. A mixed-use zoning district can be designated within the community or a mixed-use overlay district can be applied to multiple base districts. Traditional zoning was developed during a time when factories and many commercial uses were noisy, odorous, and/or hazardous to the public. To protect public health and residential property values, early zoning focused on separating different uses and buffering them from each other to minimize nuisances. Today, much commercial development is environmentally benign and there are often advantages to locating different uses in close proximity. Mixed use concentrated development, preferably near transit, is seen as a key "smart growth" tool to reduce auto dependence and preserve green space and natural resources. Thus, many communities are turning to "mixed use," which generally refers to a deliberate mix of housing, civic uses, and commercial uses, including retail, restaurants, and offices (Metropolitan Area Planning Council, n.d.).

- **Open space zoning** – A zoning classification that limits the allowable uses to agriculture, recreation, parks, reservoirs, and water supply lands. Open space districts are most commonly used for publicly owned lands, but they are also used in areas subject to flooding (floodplain zones) and other natural hazards (Handbook for Planning Commissioners in Missouri as cited by Davidson & Dolnick, 2004).

- **Watershed-based zoning** – Achieves watershed protection goals by creating a watershed development plan, using zoning as the basis (flexible density and subdivision layout specifications), that falls within the range of density and imperviousness allowable for the watershed to prevent environmental impacts. Watershed-based zoning usually employs a mixture of zoning practices (Smart Growth Network as cited by Davidson & Dolnick, 2004).

Overlay zoning districts – A **base zoning district** is a standard zoning district classification that can be combined with an overlay district for purposes of development regulation specificity. The base (underlying) district regulations shall apply unless expressly superseded by overlay district provisions (Concord, NC as cited by Davidson & Dolnick, 2004). An **overlay zoning district** is a special district or zone which addresses special land use circumstances or environmental safeguards and is superimposed over the underlying existing zoning districts. Permitted uses in the underlying zoning district shall continue subject to compliance with the regulations of the overlay district (Merrimack, NH as cited by Davidson & Dolnick, 2004).

- **Green infrastructure overlay district** – A type of overlay zoning district that imposes additional regulations related to establishing, enhancing, or protecting green infrastructure in order to implement a green infrastructure network vision. Like all zoning overlays, it modifies, but does not replace, base zoning district standards. The distinguishing characteristic of a green infrastructure overlay is that it is explicitly concerned with establishing or enhancing a green infrastructure network, rather than protecting discrete natural features (Morley et al., 2016).

- **Wildlife habitat overlay district** – A tool that can be used to reduce habitat fragmentation resulting from residential development and division of land. It is intended to work in concert with a town's underlying subdivision ordinance and to provide additional guidance for open space approaches to subdivision layout. Although the goal of this tool is to reduce habitat fragmentation and uses unfragmented blocks of forest and connecting overland corridors as its focus, the overlay district approach can readily be adapted to apply to other resource types. In fact, an overlay district can be applied to any well-defined (spatially

specific) resource, such as a lake, large field, rare natural community, deer wintering area, etc., that can be accurately delineated and represented on a local zoning map as a distinct area. Overlay districts are intended to work in concert with the town's underlying zoning and subdivision ordinances and to supplement the underlying zones with additional performance standards. Overlay zoning is useful in enabling a municipality to impose additional standards on specific areas without amending the basic zoning ordinance defining uses or allowed densities for the district or districts overlapped with the overlay zone. This approach is useful in protecting landscape elements that cross underlying district lines and can be the most useful tool in protecting long-term habitat contiguity and connectedness (Beginning With Habitat, 2003).

- **Case study: Town of Skaneateles, NY – Lake Watershed Overlay District** – The community of Skaneateles finds that Skaneateles Lake represents a priceless economic, environmental, aesthetic and recreational resource. The comprehensive plan and supporting studies of lake water quality issues establish a sound justification and framework for protecting the quality of the lake's water. It is the purpose of this section to establish regulations on land uses within the watershed to assure the protection of the quality of the lake's water resources from nonpoint and point-source pollution, while allowing flexibility of land use consistent with maintaining such quality. Within the district, maximum impermeable surface coverage shall not exceed 10 percent (Skaneateles, 2005).

- **Case study: Burlington, VT – Natural Resource Protection Overlay District** – The Burlington Comprehensive Development Ordinance establishes a series of four Natural Resource Protection Overlay districts as follows: Riparian and Littoral Conservation Zone; Wetland Protection Zone; Natural Areas Zone; and Flood Protection Area. Purposes of these districts include: Protect surface waters and wetlands from encroachment by development and from sources of nonpoint pollution; Protect the functions and values of Burlington's wetlands; Protect and enhance water quality near public beaches and other water-based recreation areas from sources of nonpoint pollution; Preserve natural features and communities, geologic features and cultural sites for education and research; Provide opportunities for public access where feasible and appropriate; and Facilitate connections and corridors for wildlife between areas of publicly protected sites (Burlington, 2016).

- **Case study: Park City, UT – Sensitive Area Overlay Zone** – Regulations require protection of steep slopes and ridgelines as part of a broader set of overlay zones that also encourage preservation of wildlife habitat and wetlands (Park City, n.d.).

- **Case study: Falmouth, MA – Wildlife Overlay District** – Given that an enumerated purpose of zoning is the conservation of natural resources and that wildlife is a valued natural resource in Falmouth and finding that the Commonwealth of Massachusetts has established the importance of protecting wildlife through numerous laws, and finding that Falmouth has a significant stock of wildlife which moves through a large, defined area of town, and further finding that development under zoning can be designed to coexist with the wildlife and important habitat areas, the purpose of this Article is to establish and protect permanent and contiguous corridors and special areas for the feeding, breeding and normal home range movement of wildlife through the defined habitat areas. All uses of land within the Wildlife Overlay District as shown on the Official Zoning Map shall be subject to the requirements of these sections (Falmouth, 1988).

- **Case study: Brunswick, ME – Wildlife Habitat Overlay District** – Creates incentives to maintain contiguous blocks of valuable open space during the development process. It provides the basis of a model ordinance found on the Beginning with Habitat website (n.d.).

Ordinances (See Appendix A for a sampling of model ordinances)

Ordinances are laws or regulations set forth and adopted by a governmental authority, usually a city or county (Jefferson County, CO as cited by Davidson & Dolnick, 2004).

Communities around the country have developed ordinances with the goal of protecting important wildlife habitats. However, research by Colorado State University has shown that most ordinances lack measures to encourage habitat continuity and are leading to habitat fragmentation (Wortman-Wunder, 2012). The information in this section aims to provide effective planning methods that conserve habitats and reduce habitat fragmentation (North Carolina Wildlife Resources Commission, 2013).

Clearing/grading/land disturbance ordinances – These ordinances are concerned with removal of vegetation from a site and with the land being reshaped and/or broken. They may overlap with those that focus on tree preservation and/or soil erosion control. The purpose of clearing and grading ordinances may include factors such as: to preserve and enhance the city's physical and aesthetic character by preventing untimely and indiscriminate removal or destruction of trees and ground cover; to minimize surface water runoff and diversion which may contribute to flooding; to reduce siltation in the city's streams, lakes, storm sewer systems and public roadside improvements; to reduce the risk of slides and the creation of unstable building sites; to promote building and site planning practices that are consistent with the city's natural topography, soils, and

vegetative features while at the same time recognizing that certain factors such as disease, danger of fallings, proximity to existing and proposed structures and improvements, interference with utility services, protection of scenic views, and the realization of a reasonable enjoyment of property may require the removal of certain trees and ground cover; etc.

Soil erosion control is any practice or combination of practices to control erosion and attendant pollution (Hopkins, MN; Jordan, MN as cited by Davidson & Dolnick, 2004). A model ordinance for erosion and sediment control on the EPA website includes the following purposes for the ordinance: During the construction process, soil is highly vulnerable to erosion by wind and water. Eroded soil endangers water resources by reducing water quality and causing the siltation of aquatic habitat for fish and other desirable species. Eroded soil also necessitates repair of sewers and ditches and the dredging of lakes. In addition, clearing and grading during construction cause the loss of native vegetation necessary for terrestrial and aquatic habitat. As a result, the purpose of this local regulation is to safeguard people, protect property, and prevent damage to the environment in (municipality). This ordinance will also promote the public welfare by guiding, regulating, and controlling the design, construction, use, and maintenance of any development or other activity that disturbs or breaks the topsoil or results in the movement of earth on land in (municipality) (U.S. EPA, n.d.-a).

Floodplain protection ordinance – The purpose of these standards is generally to reduce the risk of flooding, prevent or reduce risk to human life and property, and maintain the functions and values of floodplains, such as allowing for the storage and conveyance of stream flows through existing and natural flood conveyance systems. A floodplain protection ordinance may also establish a Flood Management Area Overlay Zone and designate uses permitted outright such as planting trees or other vegetation or the restoration/enhancement of floodplains, riparian areas, wetland, upland and streams that meet federal and state standards (Portland, n.d.).

Habitat protection ordinances:

- **Case study: King County, WA – Critical Areas Ordinance** – Requires protection of **Wildlife Habitat Conservation Areas** for species listed in the King County Comprehensive Plan. Protected areas include active wildlife breeding sites and the surrounding area that is necessary to protect breeding activity (King County, 2017).

- **Case study: Tampa, FL – Upland Habitat Protection Ordinance** – Uplands which potentially constitute significant wildlife habitat are mapped on the City of Tampa's Significant Wildlife Habitat Map, dated May 18, 1999 and on file in the office of the city clerk. The map applies to the city's Upland Habitat Overlay District area. Approved upland habitat plans are required before development can occur within the district (Tampa, 2017).

- **Case study: Napa, CA – Riparian Habitat Areas Ordinance** – The following provisions shall apply to all lots which are contiguous with or directly adjoin an intermittent or perennial stream or river identified in and consistent with the conservation element of the general plan. Lots to which the provisions of this section apply shall be indicated on the zoning map as "CR-6." A protective streamside buffer 50 feet in width measured from the top of a stream, creek or riverbank landward shall be observed. A riparian habitat management plan prepared by a registered civil engineer or landscape architect shall be required for development including grading, dredging, and filling within the protective streamside buffer. A riparian habitat management plan shall address the following requirements (Napa, n.d.):

  - Site development shall be fitted to the topography and soil so as to create the least potential for vegetation loss and site disturbance.

  - Vegetation removal shall be limited to that amount necessary for the development of the site. Protection of tree crowns and root zones shall be required for all trees planned for retention.

  - Vegetation indigenous to the site or plan community shall be restored in areas affected by construction activities. Temporary vegetation, sufficient to stabilize the soil, may be required on all disturbed areas as needed to prevent soil erosion. New planting shall be given sufficient water, fertilizer and protection to insure reestablishment. Plants which minimize fire hazards should be utilized adjacent to buildings and structures.

  - If proposed development including grading, dredging and filling within the protective streamside buffer would affect the banks of the stream or river, bank stabilization using techniques acceptable to the public works director shall be required to prevent erosion.

Illicit discharge detection and elimination (IDDE) ordinance – The purpose of this ordinance is to provide for the health, safety, and general welfare of citizens through the regulation of non-storm water discharges to the storm drainage system to the maximum extent practicable as required by federal and state law. This ordinance establishes methods for controlling the introduction of pollutants into the municipal separate storm sewer system (MS4) in order to comply with requirements of the National Pollutant Discharge Elimination System (NPDES) permit process. (U.S. EPA, n.d.-b).

- **Case study: Neosho, MO** – Adopted by the Neosho City Council in 2015, Article VI of the stormwater runoff management code addresses discharge of pollutants and enforcement activities. This ordinance includes provisions for watercourse protection as well as a stream buffer zone that applies to the two major streams in the city: Hickory Creek and Buffalo Creek. The buffer is to consist of undisturbed natural vegetation and be maintained for 25 feet, measured horizontally, on both banks (as applicable) as measured from the top of the stream bank. Within this buffer zone, all impervious cover shall be prohibited and grading, filling and earthmoving shall be minimized (Neosho, 2015).

Karst preservation ordinance – A karst preservation ordinance can be used to establish guidelines to review development plans for projects that encompass or affect karst. The ordinance may include measures to protect groundwater from physical, biological, or chemical pollution. It may also classify groundwater contamination risk based on the type of proposed land use, development density, and area of impervious surface directly draining to and connected with a sinkhole (Currens, 2012).

Karst (aka karst topography, karst geology, karst terrain) refers to features that are the result of the dissolving action of water on carbonate bedrock. Karst features range from sinkholes, vertical shafts, losing streams and springs, to complex underground drainage systems and caves. Underground drainage systems can be extensive; as a result, specific karst features can be impacted by disturbances occurring miles from the affected area. Associated with karst features are unique plants and animals that have at least part, if not all, of their life cycle dependent upon the unique environment of these systems (Missouri Department of Conservation, 2015a). (See Appendix E for descriptions of some karst-related features.)

- **Case study: St. Louis County, MO** – An approximately 4-square-mile area of north St. Louis located in the community of Old Jamestown is characterized by unique karst topography. It has been scientifically identified as the "Florissant Karst" region by the geologic/scientific community as being one of the finest examples of deep funnel-shaped sinkholes in the central United States. Sinkholes, springs, and caves are among the common features in karst areas. This type of topography presents serious constraints to urban development in particular soil creep near sinkhole depressions, localized flooding near sinkholes, and potential groundwater contamination from stormwater runoff and sewage effluent. A primary characteristic of this karst area is the existence of surface sinkholes into which all surface runoff flows. The area is considered to be internally drained, and as a result has no surface channels that convey surface runoff to larger surface streams. Section 1003.109 Karst Preservation District Regulations of the St. Louis County Zoning Ordinance is therefore necessary to protect this significant natural environmental geologic area. It is the purpose of this section to preserve the Florissant Karst area in its natural state, while allowing development at an intensity that can be accommodated within the constraints of the geological features of this unique area (St. Louis County, 2017).

Outdoor lighting ordinance — A regulatory tool for a community to control light pollution, including glare, light trespass and skyglow. Objectives of lighting ordinances may include ecology, energy, human health, public safety, and crime considerations (International Dark-Sky Association, n.d.-c).

Light pollution refers to any nighttime artificial light that shines where it's not needed. This nocturnal brightness can disorient humans and a host of other animals, confounding eyes and biological rhythms that evolved in a world without such light (Scriber, n.d.).

- **Case study: Fort Lauderdale, FL** – The Florida coast is the second-most popular nesting area in the world for loggerhead turtles. Nesting season on Fort Lauderdale's beaches begins in early March with leatherbacks, followed by loggerheads in April, and greens in May and June. Females come up from the water to make their nests and deposit over 100 eggs on average in the sand. Approximately six to eight weeks later, the hatchlings make their way from those nests to the ocean using the reflection of the moon on the water as a guide. Therefore, a common threat to sea turtles is disorientation caused by other sources of light. The City of Fort Lauderdale has adopted Chapter 6, Article III. – Sea Turtles in its Code of Ordinances to help protect threatened and endangered sea turtles that nest and hatch on the beach. This ordinance, "is designed to reduce the impact of artificial lighting on sea turtles by restricting it during both the nesting and hatching season from March 1–October 31 (Fort Lauderdale, n.d.)."

- **Case study: Flagstaff, AZ** – Flagstaff was recognized as the world's first International Dark-Sky City on October 24, 2001, for its pioneering work in the development and implementation of lighting codes that balance the need to preserve Flagstaff's dark sky resource with the need for safe lighting practices. The purpose of the city's code is to help assure that dark skies remain a resource to be enjoyed by the Flagstaff community and its visitors and to provide safe and efficient outdoor lighting regulations that protect Flagstaff's dark skies from careless and wasteful lighting practices. Dark starry nights, like natural landscapes, forests, clean water, wildlife, and clear unpolluted

air are valued in many ways by the residents of this community and they provide the natural resource upon which the city's world-renowned astronomical industry depends. The use of outdoor lighting is often necessary for adequate nighttime safety and utility, but common lighting practices can also interfere with other legitimate public concerns. Principle among these concerns is: (1) The degradation of the nighttime visual environment by production of unsightly and dangerous glare; (2) Lighting practices that produce excessive glare and brightness that interferes with the health and safety of Flagstaff's citizens and visitors; (3) Unnecessary waste of energy and resources in the production of too much light or wasted light; (4) Interference in the use or enjoyment of property that is not intended to be illuminated at night by light trespass, and the loss of the scenic view of the night sky due to increased urban sky-glow; and (5) The impact of inappropriately designed outdoor lighting that disrupts nocturnal animal behavior, particularly migrating birds and other species (Flagstaff, n.d.).

- **Case study: Village of Homer Glen, IL** – On April 8, 2015, Ordinance No. 15-018 established that the corporate authorities recognize the night sky as a natural resource and acknowledged that excessive illumination can have a detrimental effect to wildlife that depend on the natural cycle of day and night for survival (Homer Glen, 2015).

Plant ordinance – A regulatory tool for a community to achieve landscaping objectives, i.e., conserve resources, purify air and water, enhance aesthetics, and preserve a high quality of life.

- **Landscaping** – The area within the boundaries of a given lot that consists of planting materials, including but not limited to trees, shrubs, ground covers, grass, flowers, decorative rock, bark, mulch, and other similar materials (Fayetteville, AR as cited by Davidson & Dolnick, 2004).

- **Nativescaping** – The use of native plant species in a designed landscape. A nativescape is maintained as a conventional, urban landscape and has an ornamental appearance or aesthetic as opposed to a naturescape that has a naturalistic appearance. A nativescape may be part of a green infrastructure system, i.e., street trees, or be employed to seamlessly incorporate rainwater management practices such as rain gardens and bioswales into the urban landscape. Nativescaping is also used to help developments achieve points in green certification programs that consider the water usage of the landscaping as a factor in their rating system.

Figure 13. Nativescaping at a Panera Bread restaurant in Jefferson City, Missouri.

Slope/hillside protection ordinance – Steep slopes are often biologically diverse and support unique plant communities, rock outcrops, cliffs and other important habitat features. When development occurs on or adjacent to steep slopes, sedimentation and erosion can damage important downhill resources and scenic views. Not to mention landslides put people and property at risk. Steep slope protection ordinances can assist in preserving important natural assets by limiting development on certain slopes, landslide prone areas and (North Carolina Wildlife Resources Commission, 2013):

- Areas with important wildlife habitats on, near or downhill.

- Areas above a certain elevation.

- Areas with particularly important views.

- **Case study: Lyme, NH** – The zoning ordinance establishes a **Mountain and Forest Conservation District**. Lands in this district are extremely remote and are reserved for very low intensity land uses. The primary objective is to preserve and protect Lyme's natural heritage of large tracts of undeveloped forest land in the more remote sections of town and thereby serve the following additional objectives: (1) Encourage continuation of large contiguous tracts of forest land in private ownership to provide forest resources and outdoor recreation; (2) Encourage forestry and timber harvesting and permit other compatible uses including very low intensity development that will allow the land to appreciate in value; (3) Protect natural areas; (4) Protect wildlife habitat; (5) Maintain ecological balance; (6) Preserve scenic views; (7) Avoid the burden of unreasonable municipal expenditures for the purpose

of providing municipal services to remote and difficult locations; and (8) Avoid the risk to health and safety of municipal employees and volunteers of providing emergency services to remote and difficult locations. The zoning ordinance also establishes Conservation Districts in order to protect Lyme's natural heritage and agricultural soils and to ensure that land is developed only according to its natural capability. The districts are comprised of (Lyme, 2016):

  - Section 3.27.1 Wetlands Conservation District
  - Section 3.27.2 **Steep Slopes Conservation District** – defined as comprising all areas within which there is an elevation change of 20 feet or more and the average slope is 20 percent or greater.
  - Section 3.27.3 Shoreland Conservation District
  - Section 3.27.4 Agricultural Soils Conservation District
  - Section 3.27.5 Flood Prone Area Conservation District
  - Section 3.27.6 **Ridgeline and Hillside Conservation District** – defined as ridgelines and hillsides within 1000 feet of the ridgelines which could be visible (without trees) from publicly maintained roads and public waterways and including adjacent slopes of 20 percent or greater

- **Case study: Pickens County, GA – Mountain Protection Plan ordinance**, Ch. 26, Article IV, limits development in areas that are 2,200 feet in elevation and on slopes of 25 percent or more (Pickens County, 2017).

Spring recharge zone protection ordinance – A regulation used to protect the quality of rainwater runoff that may infiltrate the ground within the delineated recharge zone of a spring so as to protect groundwater habitat for aquatic wildlife.

Stream set-back ordinance (aka stream buffer ordinance) – A regulation that creates a "buffer zone" between a river, creek, or stream and adjoining land uses, by specifying where construction of buildings and other infrastructure is or is not permitted (King County, n.d.). The buffer zone is located in the stream's riparian area. **Riparian** is pertaining to, living or situated on the banks or active floodplain of streams and rivers (Nelson, 2005).

- **Case study: Kansas City, MO** – Ordinance 080736 was passed by City Council on Aug. 21, 2008. In the Kansas City region and throughout the nation, vegetated stream buffers have been shown to protect stream stability and related infrastructure, improve water quality, conserve wildlife habitat and provide flood water conveyance. The stream buffer standards of the Kansas City ordinance are intended to protect public safety and public infrastructure investments while mitigating the adverse environmental impacts that development can have on streams and associated natural resource areas. More than half of Kansas City is yet to be developed and the ordinance will help avoid future liabilities by protecting new development and infrastructure from flood damage, while saving natural resources that provide multiple benefits. Limiting development near stream banks will also improve Kansas City's water quality, reduce erosion and sedimentation, prevent infrastructure damage, and protect riparian corridor habitat and greenways. The ordinance regulates all streams shown on the Kansas City Natural Resources Protection Map. The Planning and Development Department maintains the map. Setbacks are based on the stream's actual characteristics, including the 100-year floodplain or flood conveyance; adjacent steep slopes (greater than 15 percent grades) and mature, native vegetation (such as woodlands). Three zones (Streamside, Middle, and Outer) are specified, with more restrictions closer to the stream. The floodplain is the core of the "buffer zone" and is a no-build zone. The Outer Zone includes vegetation that protects the stream and provides habitat, if any exists. Conservation residential and non-residential development is guaranteed in the Outer Zone (Kansas City, 2008).

Tree ordinance – A public law developed to organize a municipal urban forestry program, formulate a tree commission, and control the planting, removal, and care of public or private trees (Louisiana State University as cited by Davidson & Dolnick, 2004).

- **Case study: St. Peters, MO** – The municipal tree and landscape regulations of the City of St. Peters include prohibitions on tree topping, requirements for the installation of landscaping on development sites, restrictions on land clearing, requirements for the use of tree protective measures during development, and penalties for trees that die as a result of grading or construction damage. Fines for trees that die are equal to the value of the trees as determined using the International Society of Arboriculture's Guide for Plant Appraisal (St. Peters, 2000).

Tree preservation and protection ordinance – A regulation used for the preservation, planting, maintenance, and removal of trees within a city. This ordinance can be used to prevent removal of trees on undeveloped land prior to a development permit review; to require flexibility in design to protect exceptional trees; to provide the option

of modifying development standards to protect trees over a designated size; to encourage retention of trees over a designated size through the design review and other processes for larger projects; and to protect exceptional trees that because of their unique historical, ecological, or aesthetic value constitute an important community resource (Seattle, 2017).

- **Tree preservation** refers to retaining an existing tree on site (Beaufort, SC as cited by Davidson & Dolnick, 2004). **Tree protection** encompasses all measures taken, i.e., temporary fencing, to protect existing trees from damage or loss during and after project construction (Martin County, FL as cited by Davidson & Dolnick, 2004). The **tree protection zone** is an area surrounding the base of a tree, generally circular in shape, within which neither construction activity nor physical development is permitted (Beaufort, SC as cited by Davidson & Dolnick, 2004). Tree protection zones protect the branches and trunks of trees as well as the underground root system. The **tree root zone** is the area of a tree in which the majority of its roots lie. Often 95 percent of those roots are found in the upper 12 to 18 inches of soil and the majority of the roots supplying nutrients and water are found just below the soil surface. The total amount of a tree's roots is generally proportional to the volume of the tree's canopy and, if the roots only penetrate a thin soil layer, they must spread far from the tree and beyond the canopy (Wayne County, OH as cited by Davidson & Dolnick, 2004). The **tree canopy** is the area within the circumference of the drip line of a tree (Sedona, AZ as cited by Davidson & Dolnick, 2004) and the **tree drip zone** is the area measured from the trunk to the outside reaches of its canopy (Wayne County, OH as cited by Davidson & Dolnick, 2004).

- **Case study: Fayetteville, AR** – It is the purpose of the tree preservation and protection ordinance to preserve and protect the health, safety, and general welfare, and preserve and enhance the natural beauty of Fayetteville by providing for regulations of the preservation, planting, maintenance, and removal of trees within the city in order to accomplish the following objectives: (1) To preserve existing tree canopy; (2) To create a healthy environment for Fayetteville residents, businesses, and industries; (3) To moderate the harmful effects of sun, wind, and temperature changes; (4) To buffer noise, air and visual pollution; (5) To filter pollutants from the air that assist in the generation of oxygen; (6) To reduce storm water runoff and the potential damage it may create; (7) To stabilize soil and prevent erosion, with an emphasis on maintaining tree canopy on hillsides defined as canopied slopes in Chapter 151; (8) To provide habitat for birds and other wildlife; (9) To preserve riparian banks and beds, and prevent sedimentation; (10) To screen incompatible land; (11) To promote energy conservation; and (12) To protect and enhance property values (Fayetteville, 2017).

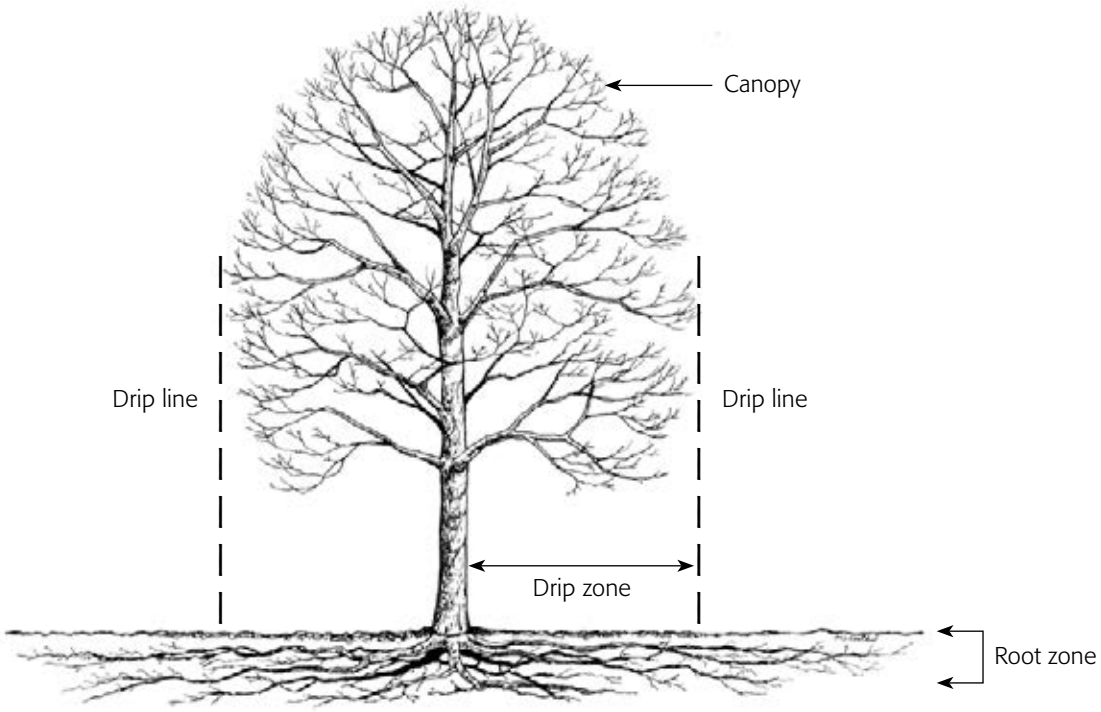


Figure 14. Tree Zones

- **Case study: Brevard County, FL** – Code of Ordinances; Article XIII. Landscaping, Tree Protection, Land Clearing and Land Alteration; Division 2. Sec. 62.4344 – Incentives for increased canopy and tree preservation and increased landscaping. Landscaping and tree planting credits as well as density bonuses are included in the incentives offered by the county (Brevard County, 2017).

Urban hunting ordinance – Regulations addressing the pursuit, harvest, and possession of native Missouri wildlife are set and enforced by the State through the Wildlife Code of Missouri. The rules of the Wildlife Code apply to all areas of Missouri, incorporated and unincorporated, and therefore do not need to be addressed in a municipal ordinance. Municipalities can design firearm and projectile weapon ordinances to allow hunting within their city limits and ensure the safety and well-being of the general public. The ordinance should be written to restrict or permit the use of particular weapons, rather than to directly manage hunting or harvest of wildlife (Missouri Department of Conservation, 2013).

Weed ordinance – A type of plant ordinance that regulates nuisances such as unkempt landscapes and invasive, nonnative plant species. Weed ordinances that restrict natural landscaping (aka naturescaping) have become increasingly outdated as a result of the growing evidence that native landscapes do not contribute to fire risk, vermin, mosquitos or pollen proliferation. Additionally, nuisance ordinances that fail to define a particular vegetation to be controlled have been ruled unconstitutionally vague by some courts (Mid-America Regional Council, 2013).

- **Invasive species** – Those native or nonnative (noxious) species that increase in abundance and cover resulting from accidental or purposeful introduction. These often increase in degraded or disturbed natural communities resulting in disruption of composition and structure and loss of biodiversity (Nelson, 2005).

- **Nonnative species** (aka exotic species) – Those species not native to the existing ecosystems or geographical area. They are often detrimental to native ecosystems, flora, and fauna (Benedict & McMahon, 2006).

- **Naturescaping** – The reconstruction or establishment of a plant community that is associated with a natural community type, i.e., prairie, glade, etc., through the placement of native plant species in a way that achieves a naturalized appearance. Naturescaping is a way to create purposeful wildlife habitat that will attract species of interest, i.e., monarch butterflies, birds, amphibians, etc., to a property or to achieve a nature aesthetic on a landscape. A **plant community** is composed of species that are adapted to growing together (Shaw & Schmidt, 2003). (See Appendix E for a list of the nine terrestrial natural communities of Missouri.)

Figure 15. Naturescaping at Alberici in St. Louis, Missouri.

- **Case study: Cincinnati, OH** – Cincinnati's **weed control ordinance** was updated in 2011 to include exceptions for natural landscaping. Plants in a "Managed Natural Landscape Area" are allowed to exceed the weed and turf grass height restriction of 10 inches provided they are "self-sustaining with minimal resort to artificial methods of plant care." A 3-foot setback is required, but it does not apply to fenced property lines. The ordinance allows only properties containing homes or the adjacent property owned by the same person to be covered by the ordinance. This provision was added to prevent land speculators from using the ordinance to excuse unmanaged growth (Mid-America Regional Council, 2013).

- **Case study: Creve Coeur, MO** – Chapter 220 of the city's code addresses **weeds and vegetation**. Section 220.010 permits use of native plant communities as an alternative in urban landscape design and Section 220.030 establishes exemptions to plant height restrictions for ornamental grasses and native plants in all parks or private property if these grasses do not obstruct sight distance for vehicular, bicycle or pedestrian traffic and are located not less than five (5) feet from an adjacent property owner(s)' boundaries. The Public Works Department maintains a list of permitted ornamental grasses and native plants (Creve Coeur, 2007).

- **Case study: Chesterfield, MO** – Chesterfield's **nuisance ordinance** defines four types of plants: noxious, invasive, nuisance, and native. The ordinance references a plant species list from the U.S. Department of Agriculture for noxious weeds and the Missouri Department of Conservation for invasive and native plants. Native plantings are allowed as long as they are free of turf weeds and grasses, nuisance plants, invasive

plants, and noxious weeds. Native plantings are subject to a 4-foot setback from property boundaries and must not impair sight distance or constitute a hurt, injury, or inconvenience or danger to the health, safety or welfare of the public (Mid-America Regional Council, 2013).

- **Case study: Fayetteville, AR** – Adopted in 2015, Fayetteville's **invasive plant species ordinance** established a list of 18 invasive plants to be restricted from being installed in new developments that require a Landscape Plan Review by the Urban Forester. The list of invasive plants was determined through an open participation process which involved a team of 13 stakeholders. Stakeholders included, nursery owners/managers, landscape architects, academic experts, landscape installers, hobby gardeners, botanists, naturalists, conservationists, City Park Managers and local citizens. The team met to evaluate the economic and environmental harm caused by invasive plants. After recognizing the need for an invasive plant policy, the stakeholder group reviewed other communities' invasive plant species policies and made recommendations to City staff (Fayetteville, n.d.).

Design and Development Codes and Standards

(See Appendix C for more on green standards and rating systems)

Building codes are regulations governing building design, construction, and maintenance (Handbook for Planning Commissioners in Missouri as cited by Davidson & Dolnick, 2004). **Design standards** (aka guidelines) are a set of policy statements used to direct or guide the external features of a development, as well as the relationships within the development site and between the development and adjacent uses, in order to promote quality places (Kansas City, 2006). Design standards can guide a variety of development types including:

- **Conservation subdivision design standards** – Standards that require site developers to design and layout new streets and lots in a way that protects sensitive environmental features and maximizes the amount of site area retained as permanent open space. In practice, localities often incentivize conservation subdivision design by permitting developers to use smaller individual lot sizes and sometimes a greater number of total lots than would otherwise be permitted under conventional residential subdivision design standards (Morley et al., 2016).

- **Green building standards** – Guidelines developed to help increase the energy efficiency of buildings and to reduce the negative impacts of buildings on human health and the natural environment. Some standards were developed as criteria by programs that certify buildings based on how green they are according to the program's own rating system.

- **Green infrastructure design standards** – Guidance to developers or public agencies to help integrate green infrastructure into private development or public construction, landscaping, or maintenance projects. In practice, these standards often supplement development regulations related to natural resource protection or site design, or the procedures manuals of specific local agencies (e.g., an engineering manual used by a local public works or transportation department) (Morley et al., 2016).

- **Landscape design guidelines** – Guidelines that communicate desirable plant selection and design qualities for the planting of trees, shrubs, and other vegetation. In practice, these guidelines typically supplement development regulations related to landscaping or urban forestry, or the procedures manuals of specific local agencies, e.g., a parkland maintenance manual for a local parks department (Morley et al., 2016).

- **Low-impact development (LID) standards** – Standards that require new development to mitigate stormwater impacts through techniques, including rain gardens, bioswales, green roofs, and permeable pavement, which help capture and treat stormwater at its source and mimic predevelopment hydrology (Morley et al., 2016).

- **Natural resource protection standards** – Standards that prohibit or severely limit the disturbance of existing natural features—such as forests, floodplains, stream buffers, steep slopes, wetlands, or shoreline areas—by new development. In practice, localities may impose these standards through one or more zoning overlays or through provisions related to land subdivision or site development (Morley et al., 2016).

- **Site design standards** – Standards that control the design and layout of new streets, lots, and parking areas and establish minimum setbacks or build-to lines for new structures. Through these standards, localities have considerable influence over the amount of impervious cover added by new development. In practice, localities may impose these requirements through provisions related to land subdivision or site development, or through zoning district development standards (Morley et al., 2016).

- **Sustainable site standards** – Guidelines developed to assess the design, construction, and maintenance of landscapes relative to sustainability standards. They are used by landscape architects, designers,

engineers, architects, developers, policy-makers, and others to guide land design and development of sites at various scales, with or without buildings. Project types include: open spaces, streetscapes, commercial and educational/institutional campuses, residential neighborhoods and yards, military, and more. **Sustainability** refers to the practice of making sure present needs are met without compromising the needs of future generations; maintaining resources in such a way that they are able to renew themselves over time (Benedict & McMahon, 2006).

Special Focus on Community Forestry

Community forestry (aka urban forestry) is the art, science, and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic, and aesthetic benefits trees provide society (Helms 1998 as cited in Schwab, 2009).

An important component of the community forest is the street tree system. **Street trees** are located along streets or highways. They can be located on private property or on publicly held land. Street trees are typically planted in a linear fashion and provide spatial enclosure as well as other technical and aesthetic benefits (Wildwood, Missouri as cited by Davidson & Dolnick, 2004). (See Appendix L for benefits of street trees.)

The provision of an adequate amount of soil for urban street trees to grow in is vital for the health of each individual tree and for the combined street tree system's ability to operate as green infrastructure. **Soil volume** is important because a tree's ability to grow and stay healthy is largely dependent on available rooting space. This is particularly evident in highly urbanized areas where many trees exist in small planting spaces with little available soil. Trees in this situation tend to be short-lived (Casey Trees, 2008).

A growing tree will send roots far into the surrounding soil. In uncompacted soil, the roots of a mature tree can spread to more than twice the width of the tree's canopy. Trees get nutrients from soil, but roots also need the air and water that occupy voids between soil particles. In uncompacted soil, these voids are abundant. In dense urban areas where soils are often compacted and covered by pavement, the soil has few voids. Tree roots cannot penetrate highly compacted soil and will not grow in soil that lacks air and water. Roots of street trees frequently grow in the space between the compacted soil and overlying pavement, where air and water are present. As these roots grow, they may lift the pavement and cause sidewalk heaving (Casey Trees, 2008).

Trees growing in typical urban "tree boxes" are usually surrounded by compacted soil. If the tree roots cannot expand into the surrounding soil, they will continue to grow in the tree box until they have filled up the available space. When the needs of the tree exceed the capacity of the soil, the health of the tree will begin to decline and it will eventually die. Trees in typical urban tree boxes rarely reach their full growth potential and cannot provide the wide range of benefits that mature, healthy trees offer.

Published research suggests that trees need 1 to 2 cubic feet of soil volume for every square foot of crown area spread. A tree in a typical 4-foot by 10-foot street tree space has 120 cubic feet of available soil. When the roots cannot grow out of the box, the tree is expected to grow to a canopy spread of 10 feet before declining. Tree spaces with 500 cubic feet of soil will enable trees to grow a canopy of more than 20 feet, and even larger soil volumes will yield larger trees (Casey Trees, 2008).

Development Strategies

- **Compact development** – Pattern of development in which structures and uses are located in close proximity to one another. In areas of the city that are developing, compact development refers to development that is contiguous or adjacent to existing development (Kansas City, 2006).
- **Conservation development** – An approach to the design, construction, and stewardship of a development that achieves functional protection of natural resources, while also providing social and economic benefits to human communities (Colorado State University, 2016).

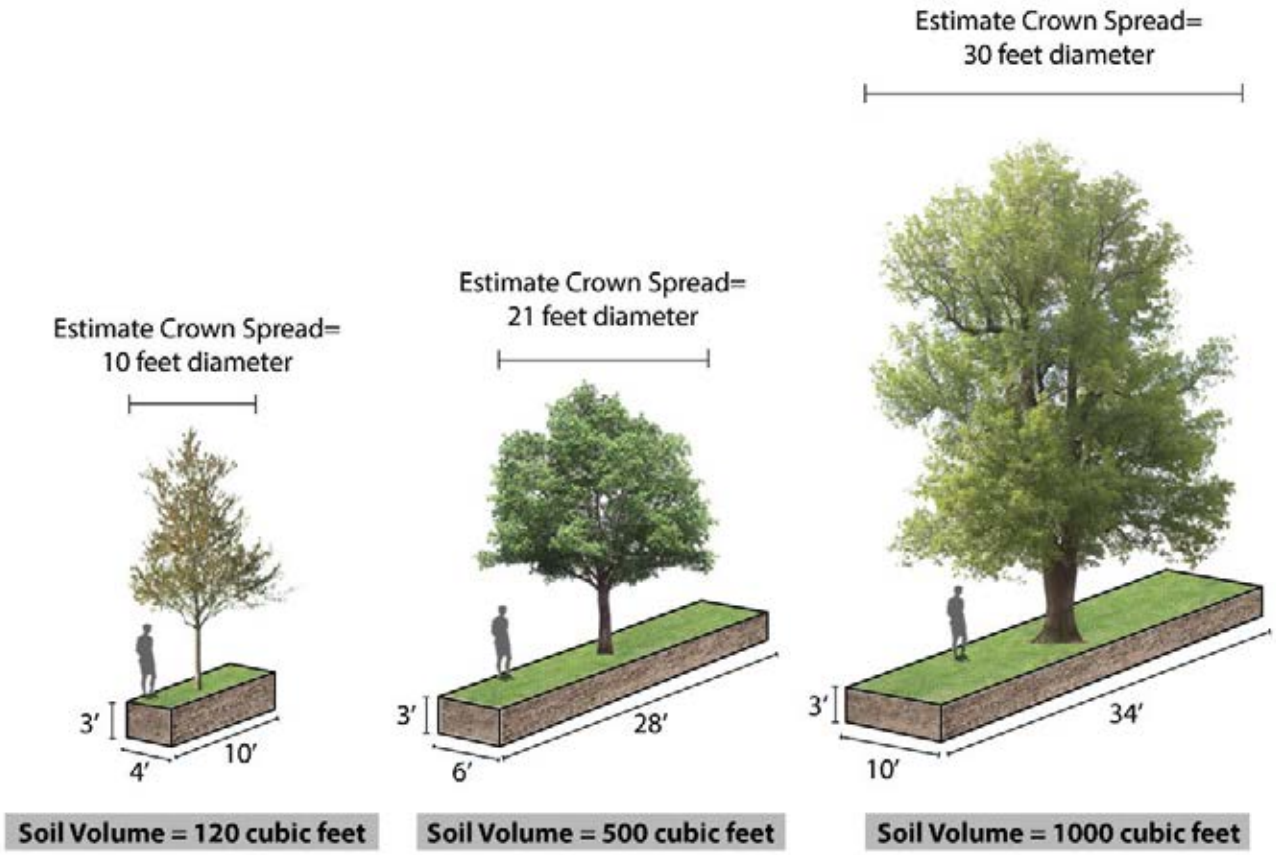


Figure 16. Soil Volume and Tree Growth
(Casey Trees, 2008)

- **Infill development** – The process of developing vacant or under-used parcels within existing urban areas that are already largely developed (Municipal Research and Services Center, 2016).

- **Low-impact development** (LID) (see Appendix C for common obstacles in local codes to LID) – Systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration or use of stormwater to protect water quality and associated aquatic habitat. LID is an approach to land development (or redevelopment) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product (U.S. EPA, 2017c). **Evapotranspiration** is the total water loss from the soil, including that by direct evaporation and that by transpiration from the plant surfaces (Nelson, 2005). **Transpiration** is the process by which water is drawn through plants and returned to the air as water vapor (Chopra et al., 2005).
  - "What if urban stormwater infrastructure enhanced ecological functioning to serve as a civic asset rather than an environmental liability (UACDC, 2010)?" LID is an ecologically based stormwater management approach favoring soft engineering to manage rainfall on site through a vegetated treatment network. The goal of LID is to sustain a site's pre-development hydrologic regime by using techniques that infiltrate, filter, store, and evaporate stormwater runoff close to its source. LID remediates polluted runoff through a network of distributed treatment landscapes, which is contrary to conventional "pipe-and-pond" conveyance infrastructure that channels runoff through pipes, curbs and gutters, and catchment basins (UACDC, 2010).

- **Mixed-use development** – Mixed use is a land use type which recognizes that many land uses and activities are compatible and can be co-mingled to promote physical development at a human scale. Mixed use allows the integration of commercial, retail, office, medium to high density house, and some light industrial land uses. These various land uses can be integrated either horizontally or vertically in a single building or structure, or on a parcel or parcels of land

(Kansas City, 2006). A **mixed-use center** is a node of development and activity that provides a focal point for the surrounding area. This node incorporates mixed uses such as commercial, office, residential, and community serving facilities. The transportation/circulation system in a mixed-use center is designed to accommodate a variety of modes, including pedestrian, transit, bicycle and the automobile. Mixed-use centers are divided according to function and scale into regional, community and neighborhood centers (Kansas City, 2006).

- **Open space development** (see also cluster zoning) – A development approach that preserves ecologically valuable open space and other lands by grouping buildings and other built infrastructure in less environmentally sensitive areas; a site-planning technique in which lot sizes, setbacks, and frontage distances are minimized to allow for open space (Benedict & McMahon, 2006).

- **Pedestrian-oriented development** – Development that provides facilities for walking and encourages pedestrian use, designed to make movement on foot attractive and comfortable and to reduce the dependence on motorized vehicles for short trips (Kansas City, 2006).

- **Planned unit development** (PUD) – A parcel of land planned as a single unit, rather than as an aggregate of individual lots, with design flexibility from traditional siting regulations (such as side yards, setbacks, and height limitations) or land-use restrictions (such as prohibitions against mixing land uses within a development). The greater flexibility in locating buildings and in combining various land uses often makes it possible to achieve certain economics in construction, as well as the preservation of open space and the inclusion of many amenities (Gurnee, IL as cited by Davidson & Dolnick, 2004).

Growth-Management Strategies

Urban growth is development that makes intensive use of land for the location of buildings, other structures, and impermeable surfaces to such a degree as to be incompatible with the primary use of such land for the production of food, fiber, or other agricultural products, or the extraction of mineral resources and that, when allowed to spread over wide areas, typically requires urban services (Growing Smart Legislative Guidebook as cited by Davidson & Dolnick, 2004). **Growth management** is the use by a community of a wide range of techniques in combination to permit it to determine its own amount, type, and rate of growth, and channel it into designated areas (Handbook for Planning Commissioners in Missouri as cited by Davidson & Dolnick, 2004).

Growth management strategies allow a community to grow purposefully and avoid the pitfalls of urban sprawl. **Sprawl** refers to urban development or uses that are located in predominantly rural areas or rural areas interspersed with generally low-intensity or low-density urban uses and which are characterized by one or more of the following conditions: (a) The premature or poorly planned conversion of rural land to other uses; (b) The creation of areas of urban development or uses that are not functionally related to land uses which predominate the adjacent area; or (c) The creation of areas of urban development or uses that fail to maximize the use of existing public facilities or the use of areas within which public services are currently provided. Urban sprawl is typically manifested in one or more of the following land use or development patterns: leapfrog or scattered development; ribbon or strip commercial development; large expanses of predominantly low-intensity, low-density, or single-use development (Martin County, FL as cited by Davidson & Dolnick, 2004). **Leapfrog development** refers to the pattern that is created when new development is separated from existing development by substantial vacant land (Greenbelt Alliance, 2017).

Growth management strategies include:

- **Greenbelt** – A linked network of protected natural or working lands that surrounds a city and buffers areas beyond the city from urban and suburban growth (Benedict & McMahon, 2006).

- **Land banking** – The purchase of land by a local government for use or resale at a later date. Banked lands have been used for development of low- and moderate-income housing, expansion of parks, and development of industrial and commercial centers. Federal rail-banking law allows railroads to bank unused rail corridors for future rail use while allowing interim use as trails (Greenbelt Alliance, 2017).

- **New urbanism** (aka neo-traditional development) – A planning and development approach based on the principles of how cities and towns had been built for the last several centuries: walkable blocks and streets, housing and shopping in close proximity, and accessible public spaces. In other words: new urbanism focuses on human-scaled urban design (Congress for the New Urbanism, n.d.).

- **Nodal development** – A pattern of development in which the most intense uses are located at the intersection of major streets, roadways, and transit corridors and in areas surrounding a transit station or transit stop (Kansas City, 2006).

- **Smart decline** – Focuses on strategies that improve the lives of existing residents rather than exhaust city resources through hopeless efforts to increase population (Heins, 2012). One tool used by communities that actively manage for decline is a **vacant property**

pattern book, which describes potential greening or reuse alternatives for vacant lots in weak-market neighborhoods with low potential for conventional residential, commercial, or industrial redevelopment. In practice, these pattern books often supplement public and private vacant land management and neighborhood revitalization efforts and the goals often include aesthetic improvement, green stormwater management, and food or energy production (Morley et al., 2016).

  - » **Case study** – The Green Pattern Book is the Growing Green Initiative tool used to guide the greening of vacant land in Baltimore, Maryland, by City agencies, NGOs, community-based organizations, and individual residents. The Green Pattern Book can spur creative ideas and help different groups that work with vacant lots understand how they can effectively partner with each other. The Green Pattern Book features eight green project types or patterns including community managed open space and urban forest/buffer (Baltimore Office of Sustainability, 2017).

- **Smart growth** – Strategies for planning development in ways that are economically sound, environmentally friendly, supportive of community livability, and that enhance quality of life (Benedict & McMahon, 2006).

- **Transit-oriented development** (TOD) – A form of development that maximizes investment in transit infrastructure by concentrating the most intense types of development around transit stations and along transit lines; development in such areas is designed to make transit use as convenient as possible (Palo Alto, CA as cited by Davidson & Dolnick, 2004). **Transit** (aka mass transit) is a term used in reference to public transportation, including buses, light rail, commuter rail, and others (Kansas City, 2006).

- **Urban growth area** – An area delineated in an adopted regional or county comprehensive plan, prepared pursuant to [ordinance or law section] within which urban development is encouraged by delineation of the area, compatible future land-use designations, and implementing actions in a local comprehensive plan, and outside of which urban development is discouraged. An urban growth area shall allow existing or proposed land uses at minimum densities and intensities sufficient to permit urban growth that is projected for the region or county for the succeeding 20-year period and existing or proposed urban services to adequately support that urban growth (Growing Smart Legislative Guidebook as cited by Davidson & Dolnick, 2004). An **urban growth boundary** is a perimeter drawn around an urban growth area (Growing Smart Legislative Guidebook as cited by Davidson & Dolnick, 2004).

- **Urban services area** – A defined area, not always coincidental with a municipality's corporate boundaries, that defines the geographical limits of government-supplied public facilities and services (Elbert County, CO as cited by Davidson & Dolnick, 2004). **Urban services** are those activities, facilities, and utilities that are provided to urban-level densities and intensities to meet public demand or need and that, together, are not normally associated with nonurban areas. Urban services may include, but are not limited to: the provision of sanitary sewers and the collection and treatment of sewage; the provision of water lines and the pumping and treatment of water; fire protection; parks, recreation, and open space; streets and roads; mass transit; and other activities, facilities, and utilities of an urban nature, such as stormwater management or flood control (Growing Smart Legislative Guidebook as cited by Davidson & Dolnick, 2004).

Management Plans

- **Integrated water resource management plan** – An emerging practice to plan for water in a comprehensive manner by considering all components of water – supply, wastewater, stormwater, and water quality – and their relationships to each other as well as other aspects of the environment, both natural and man-made (Cesanek & Wordlaw, 2015).

"Planners must look comprehensively at all aspects of water-related decisions from comprehensive plans to zoning maps and ordinance requirements to subdivision and land development ordinance standards and land development decisions to stormwater management to floodplain management and develop collaborative partnerships with conservation agencies and watershed associations."

— Jerry S. Walls, FAICP, Chair of the Susquehanna Greenway Partnership Board, Montoursville, PA (Walls, 2016)

- **Invasive species management plan** – Invasive species are those that spread at such a rate that they cause harm to human health, the environment, and/or the economy (Portland, 2008). Invasive species management plans contain an inventory and assessment of invasive species found within a selected

geography, along with recommendations for how to control or eradicate them.

  - **Case study: Portland, OR** – In 2008, the City of Portland adopted an Invasive Plants Strategy with the goal of reducing invasive plant coverage within the City. The strategy provides a guide for how to integrate invasive plant management into existing City programs and includes proposed policy changes as well as cost estimates (Portland, 2008).

- **Risk assessment and hazard mitigation plan** (aka climate adaptation plan) – Functional plans that present goals and recommendations related to reducing risk from identified natural hazards. Under the Disaster Mitigation Act of 2000, local governments must adopt hazard mitigation plans in order to access federal disaster mitigation funds (Morley et al., 2016).

  Healthy ecosystems, compact development patterns, and wildlife friendly development practices protect communities from storms, floods, drought, and wildfire. Actions a community takes to conserve wildlife and habitat will reduce the risk of natural disasters. Plan components should (North Carolina Wildlife Resources Commission, 2013):

  - Address the importance of supporting prescribed fire on managed areas through land-use planning.

  - Encourage fire-wise design and keep intensely developed areas far from large natural areas and working lands.

  - Discuss the benefits of conserving floodplain forests, large and small wetland communities, and large blocks of forest.

  - Identify ordinances that could protect natural resources and habitat.

- **Stormwater quality protection plan** – A plan that provides guidance for land development practices within a specific geography. It provides developers, engineers and planners with flexible tools to reduce the volume of stormwater discharge while conserving water quality at the same time. Such plans provide specific guidance for planning and implementing best management practices (BMPs) and describe how to assess alternative site-design approaches to maximize the benefits for individual sites. They can also provide performance goals for site development and describe methods for determining development impacts (Mid-America Regional Council, 2017c).

  - **Case study: Mid-America Regional Council (MARC) and the Kansas City Metro Chapter of the American Public Works Association (APWA) Manual of BMPs for Stormwater Quality** – A guide for applying stormwater BMPs to land development within the Kansas City Metropolitan Area and the MARC planning region. The manual addresses the need to control the volume and quality of stormwater discharges from developed sites, both of which are crucial requirements for protecting human life and property, maintaining overall water quality, and for creating more environmentally sensitive site designs. It describes state-of-the-art stormwater management practices that can meet water quality regulations such as the NPDES Phase II requirements, reduce flooding, conserve water, protect wildlife habitat, and create community amenities (Mid-America Regional Council, 2017c).

- **Viewshed management plan** – A **viewshed** is the area within view from a defined observation point (California Planning Roundtable as cited by Davidson & Dolnick, 2004). Viewsheds can be mapped and any proposed development evaluated according to its impact on scenic views (Daniels, 1999). The mapping of viewsheds is achieved through a process that includes a visual assessment of a community and a survey of residents and businesses to determine which views are important to them. Viewshed management is particularly beneficial in communities that wish to protect aspects of their cultural heritage, i.e., rural scenery, or protect scenic views that are vital to an established ecotourism industry. **Ecotourism** is tourism based principally upon natural and archaeological/historical resources. It is the segment of tourism that involves traveling to relatively undisturbed or uncontaminated natural areas with the specific object of admiring, studying, and enjoying the scenery and its wild plants and animals, as well as any existing cultural features, both past and present; ecotourism approaches often focus on preserving the integrity of the location and the land (Benedict & McMahon, 2006).

  - **Case study: Branson, MO** – Community Plan 2030: Visual Assessment Survey of Hillsides. The community expressed an interest in protecting natural, highly visible sensitive lands from future development. Steep slopes and visible hillsides have not historically been protected from development in Branson and there is a strong desire within the community to protect them. When asked if hillsides that are visible from major streets should remain undeveloped, 65 percent of survey respondents said "yes." The following strategy and actions were established: *Preserve the area's natural beauty by enhancing, protecting and preserving Branson's sensitive lands, including steep slopes, waterways, floodplains, and biodiversity corridors.*

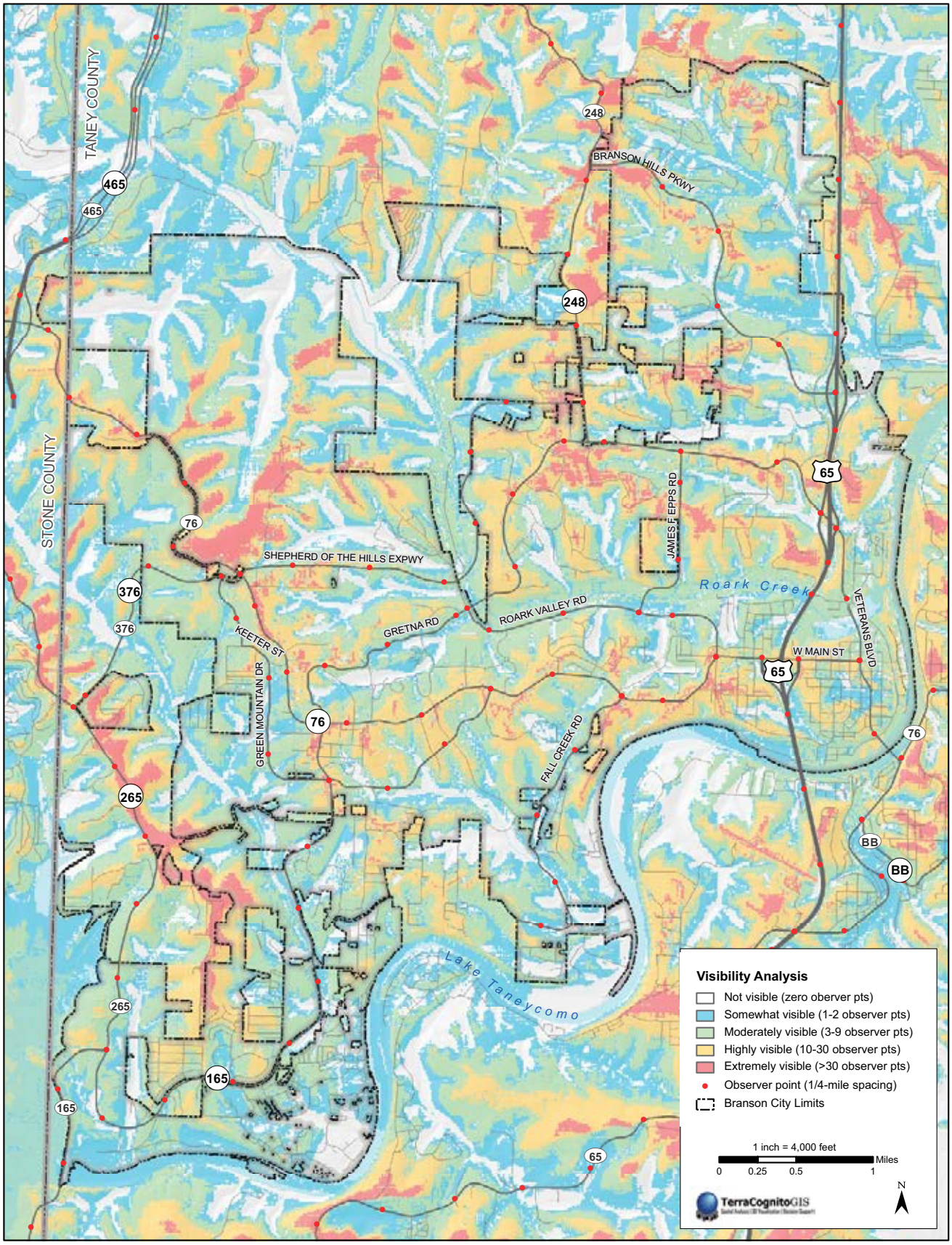


Figure 17. Visual-Assessment Survey Results Map for Branson, Missouri
(Map courtesy of the City of Branson.)

- Develop regulations for lands with a 30 percent slope and greater.
- Develop criteria for sensitive land classification (i.e., percent slope, visible hillsides, 100- or 500-year floodplain, etc.).
- Identify and map the sensitive lands as defined by the community and various stakeholders using GIS.
- Provide regulations and standards for development within the identified sensitive lands via a zoning amendment.
- Research additional methods for protecting sensitive lands and implement the most suitable initiatives and incentives.
- Work with local agencies to identify, purchase and rehabilitate sensitive lands.

- **Watershed management plan** – A strategy and/or work plan for achieving water resource goals that provides assessment and management information for a geographically defined watershed. It includes analysis, actions and resources related to its implementation and development (U.S. EPA, 2017b).
  - A **watershed** (aka catchment basin) is the land area that drains into a particular watercourse or body of water (Chopra et al., 2005). The line between watersheds, called a divide, is the highest ground between two streams. Towns are often situated on watershed divides and roads often run along them where the divides have formed wide, flat ridges. Watersheds are classified by size and assigned a Hydrologic Unit Code (HUC). This is a national system used to communicate the size and relationship of natural stream systems. Every hydrologic unit is identified by a unique HUC, a number containing two to 12 digits. The bigger the HUC number, the smaller the watershed (Missouri Department of Natural Resources, n.d.-d). Major rivers in Missouri are classified at the HUC-8 level (see Figure 16).

A city or county may draft a watershed management plan for the basins they occupy, but the plans for the large rivers that cross multiple jurisdictions are commonly written and implemented by either nongovernmental, nonprofit organizations or by regional planning councils/commissions. A regional planning council (RPC), aka **council of governments**, is a regional board consisting of elected officials from member cities and counties. RPCs deal with issues mainly concerning transportation, planning and housing (Greenbelt Alliance, 2017). There are 19 RPCs in Missouri and together they form the Missouri Association of Councils of Government (2017).

Plan components should (North Carolina Wildlife Resources Commission, 2013):

- Address the importance of conserving high-quality streams proactively.
- Emphasize conservation of stream buffers. Restoration is much costlier than preserving riparian buffers to maintain water quality and healthy streams.
- Encourage the use of wildlife-friendly low-impact development (LID) and management practices to minimize stormwater runoff polluted with nutrients, sediment, heat, etc.
- Identify wildlife and habitat conservation priority areas that overlap with watershed priorities.

"Such pondering on the facts of gravity and the fluidity of water shows us that the golden rule speaks to a condition of absolute interdependency and obligation. People who live on rivers – or, in fact, anywhere in a watershed – might rephrase the rule this way: Do unto those downstream as you'd have those upstream do unto you."

— Wendell Berry

Property Rights

Property rights are privileges, often imagined as a "bundle of sticks," that are associated with land ownership and are balanced with state and local governments' obligation to protect the health, safety, and general welfare of citizens. Property rights include the right to occupy and use property for an economically productive purpose, to exclude others, to convey title or ownership interests, and to convey by will the property to others (Porter, 1997). Property rights grant landowners the right to specific uses, perhaps including exchange in a market, of ecosystems and their services (Chopra et al., 2005).

Landowner property management options include:

- **Conservation easement** – A voluntary legal agreement between a landowner and a land trust or

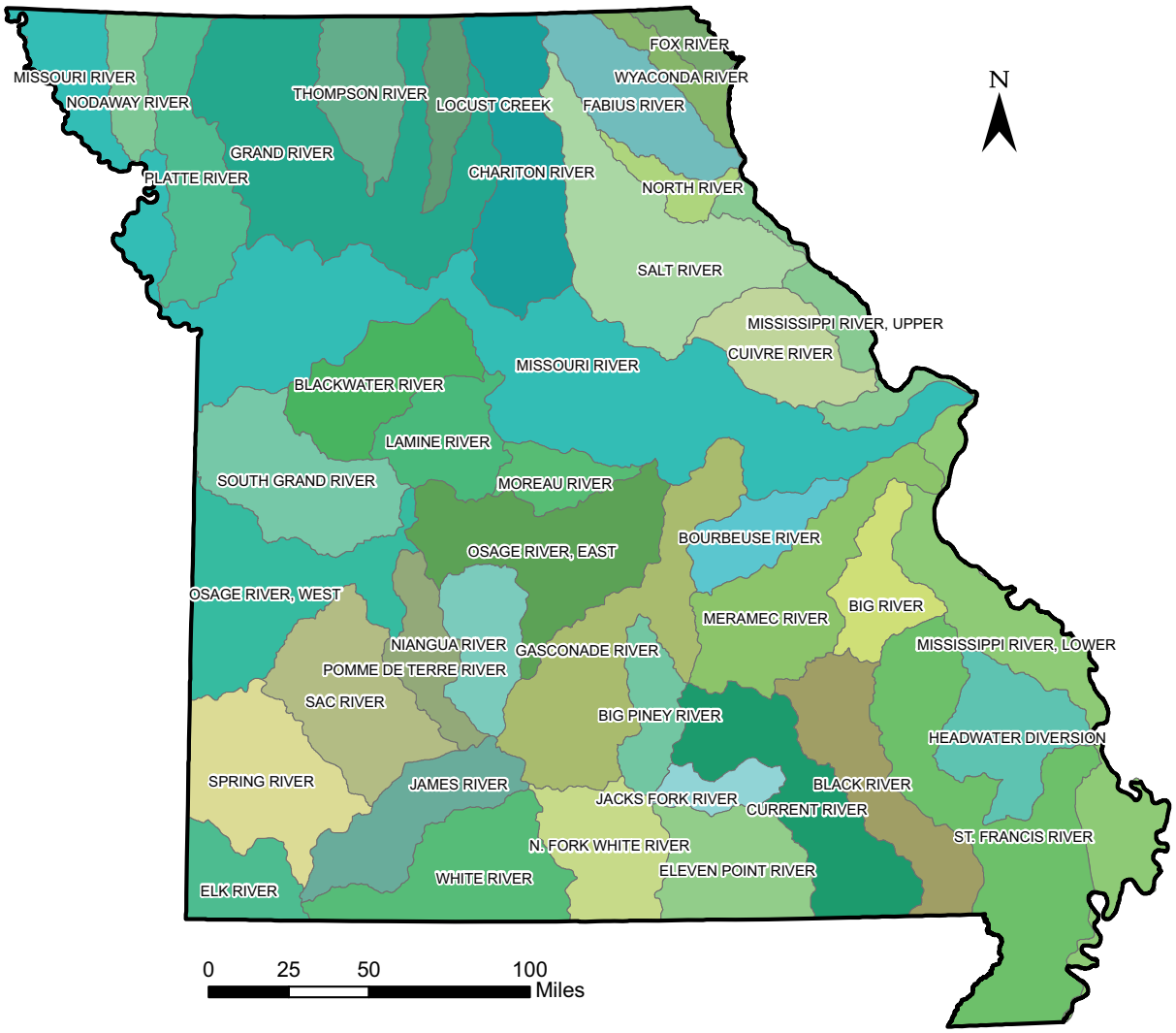


Figure 18. HUC-8 Watersheds in Missouri
(Cartography by Ronda Burnett, MDC)

government agency that permanently limits uses of the land in order to protect its conservation values. Landowners retain many of their rights, including the right to own and use the land, sell it and pass it on to their heirs (Land Trust Alliance, n.d.).

- **Mitigation banking** – Preserving and/or restoring large natural systems or areas for the purpose of mitigating in advance the adverse effects of development or other land alteration activities; mitigation banks allow developers and landowners with eligible sites to transfer mitigation responsibility to multi-acre "bank" sites of degraded lands that bank operators enhance or restore to carry out their clients' mitigation responsibilities (Benedict & McMahon, 2006).

- **Trading program, carbon credits** – Carbon storage or "sequestration" helps reduce carbon dioxide emissions. As forests grow, the trees absorb CO_2 from the atmosphere through photosynthesis and store it within their growing biomass (trunk, branches, leaves and root systems). A "forest carbon offset," is a metric ton of carbon dioxide equivalent (CO2e)—the emission of which is avoided or newly stored—that is purchased by greenhouse gas emitters to compensate for emissions occurring elsewhere. Offsets may be developed under voluntary market standards or compliance market standards, each of which has specific carbon accounting and eligibility rules (Yankel, 2014).

- **Trading program, water quality credits** – The U.S. Department of Agriculture (USDA) and the Environmental Protection Agency (EPA) are working to expand markets for water quality benefits generated on farms, ranches and forest lands. Water quality trading is a market-based system that uses pollutant reduction credits to improve compliance with Clean Water Act requirements. It is an innovative approach to reduce pollution and efficiently achieve water quality

goals. Trading is based on the fact that sources in a watershed can face very different costs to control the same pollutant. Trading programs allow facilities facing higher pollution control costs to meet their regulatory obligations by purchasing environmentally equivalent (or superior) pollution reductions from another source at lower cost, thus achieving the same water quality improvement at lower overall cost (U.S. Department of Agriculture, 2015).

- **Transfer of development rights** (TDR) – This is a voluntary, incentive-based program that allows landowners to sell development rights from their land to a developer or other interested party who then can use these rights to increase the density of development at another designated location. While the seller of development rights still owns the land and can continue using it, an easement is placed on the property that prevents further development. A TDR program protects land resources and, at the same time, provides additional income to both the landowner and the holder of the development rights (University of Wisconsin, 2005).

- At a community level, a TDR program can be used to relocate potential development from a "donor or sending" site where proposed land use or environmental impacts are considered undesirable to a "receiver" site chosen on the basis of its ability to accommodate additional units of development beyond that for which it was zoned, with minimal environmental, social, and aesthetic impacts (California Planning Roundtable as cited by Davidson & Dolnick, 2004). In practice, localities may use TDR for natural resource, historic, or agricultural preservation (Morley et al., 2016).

  - **Case study: Lenexa, KS** – The Unified Development Code of the City of Lenexa contains the property development regulations for the City in Section 4-1-B-26. A type of TDR is established therein whereby property owners who dedicate land to the City or other City approved public trust to further the City's goals and objectives for riparian corridor protection or for other City approved watershed purposes shall be permitted to use the land so dedicated to apply to the requirements set forth regarding open space and setback calculations on the remaining adjacent property from which such dedication was made. Such dedications may also be used for density calculations on the remaining adjacent property, subject to the provisions of Section 4-1-B-27G(4)(e), provided that the remaining adjacent area from which the dedication was made remains under single ownership.

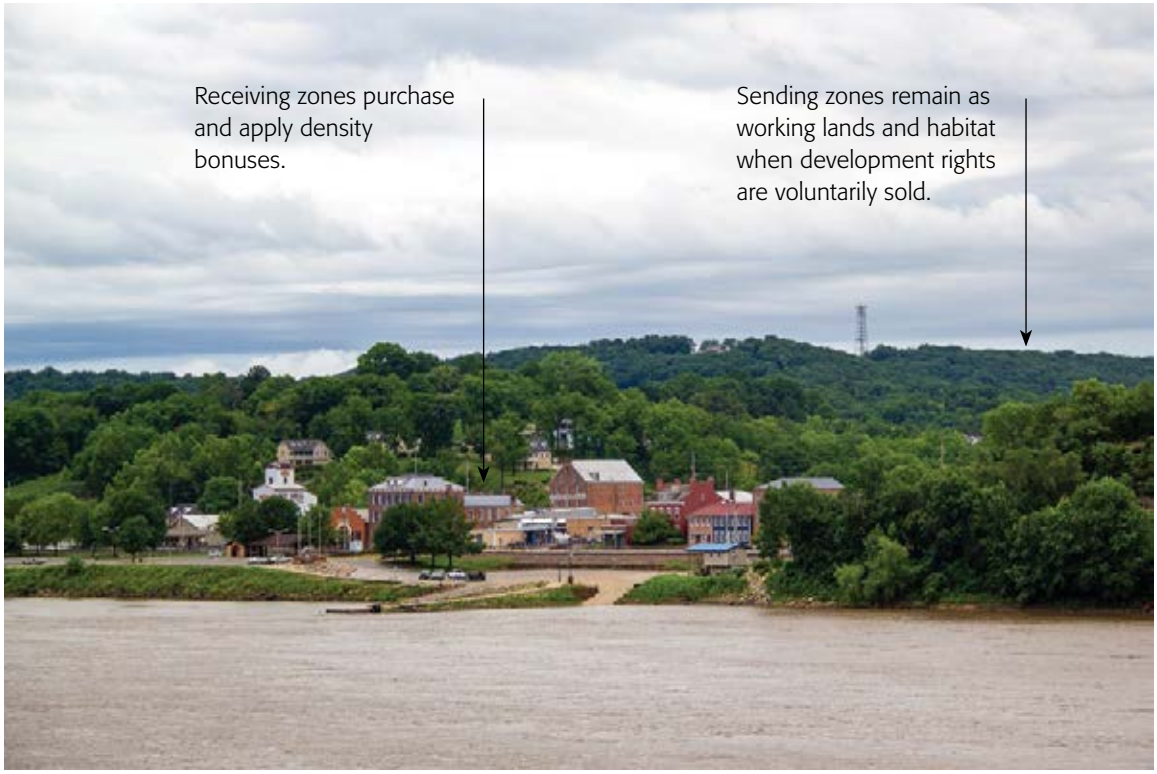


Figure 19. Designated sending and receiving zones for transfer of development credits.

Appendix

Appendix A: Model Ordinances

Model ordinance for bird-friendly construction (American Bird Conservancy, 2015)

[ORDINANCE NAME]
Sponsored by: [list names]

WHEREAS, birds provide valuable and important ecological services,

WHEREAS, [location] has recorded [ ] species of resident and migratory bird species,

WHEREAS, birding is a hobby enjoyed by 64 million Americans and generates more than $40 billion a year in economic activity in the United States,

WHEREAS, as many as one billion birds may be killed by collisions with windows every year in the United States,

WHEREAS, reducing light pollution has been shown to reduce bird deaths from collisions with windows,

WHEREAS, new buildings can be designed to reduce bird deaths from collisions without additional cost,

WHEREAS there exist strategies to mitigate collisions on existing buildings,

WHEREAS more than 30 percent glass on a façade usually increased costs for heating and cooling

WHEREAS, bird-friendly practices often go hand-in hand with energy efficiency improvements,

And WHEREAS [any additions specific to the particular location]

NOW, THEREFORE, BE IT ORDAINED,
by [acting agency]

[Title of legislation and other necessary language]

(a) In this section the term "Leadership in Energy and Environmental Design (LEED)" means a green building rating system promulgated by the United States Green Building Council (USGBC) that provides specific principles and practices, some mandatory but the majority discretionary, that may be applied during the design, construction, and operation phases, which enable the building to be awarded points from reaching present standards of environmental efficiency so that it may achieve LEED certification from the USGBC as a "green" building,

(b) [acting agency] does hereby order [acting department] to take the steps necessary to assure that all newly constructed buildings and all buildings scheduled for capital improvement are designed, built, and operated in accordance with the standards and requirements of the LEED Green Building Rating System Pilot Credit #55: Reducing Bird Collisions.

(c) The USGBC releases revised versions of the LEED Green Building Rating System on a regular basis; and [acting department] shall refer to the most current version of the LEED when beginning a new building construction permit project or renovation.

(d) New construction and major renovation projects shall incorporate bird-friendly building materials and design features, including, but not limited to, those recommended by the American Bird Conservancy publication *Bird-friendly Building Design.*

(e) [acting department] shall make existing buildings bird-friendly where practicable.

Model ordinance for community deer management (Missouri Department of Conservation, 2013)

Summary

Regulations addressing the pursuit, harvest, and possession of native Missouri wildlife, including white-tailed deer, are set and enforced by the State through the Wildlife Code of Missouri. The rules of the Wildlife Code apply to all areas of Missouri, incorporated and unincorporated, and therefore do not need to be addressed in a municipal ordinance.

Municipalities can design firearm and projectile weapon ordinances to allow hunting within their city limits and ensure the safety and well-being of the general public. Projectile ordinances that permit the use of certain types of weapons to harvest wildlife should include some basic language defining weapons and specific rules regarding the discharge of weapons by private citizens. The ordinance should be written to restrict or permit the use of particular weapons, rather than to directly manage hunting or harvest of wildlife.

The following components of an ordinance are intended to be building blocks for a community to tailor an ordinance to fit residents' needs and desires. Few or all of the items may be included to manage more specific elements of weapons use related to wildlife harvest.

The contents of this document are intended to specifically guide the lawful discharge of weapons within city limits. It is not intended to address other typical components of a community weapons ordinance including: carrying concealed weapons; possession, manufacture, transport, repair or sale of certain weapons; exceptions for police officers, military, or other licensed security agents; defacing a firearm or possession of a defaced firearm; unlawful transfer of weapons, or penalties for violations.

Weapons definitions

Air gun: Any device designed to fire or discharge a projectile using compressed air or gas.

Atlatl: A rod or narrow board-like device used to launch, through a throwing motion of the arm, a dart five to eight feet (5–8') in length.

Archery device: Any long bow or compound bow.

Crossbow: Any device designed to discharge a bolt, formed as a bow set crosswise on a stock, usually drawn by means of a mechanism and discharged by release of a trigger.

Firearm: Any rifle, shotgun, pistol, muzzleloader or any similar device or mechanism by whatever name known which is designed to expel a projectile or projectiles by the action of an explosive.

Muzzleloader: A firearm that is loaded from the muzzle capable of firing a single discharge each time it is loaded.

Shotgun: Any firearm designed to fire a number of shot or a single projectile through a barrel by a single function of the trigger.

Discharge of weapons, general provisions

The following is an example of language that permits the use of projectile weapons on private property which would allow for the harvest of wildlife such as deer:

1. All current laws of the Wildlife Code of Missouri shall be obeyed within the corporate limits of [Community].

2. This Section permits the use of the following weapons [list here] on private property, with the express consent of such property owner(s), so long as the path of the projectile and the impact area remains within the confines of said property, provided that such equipment is being used in a manner which will protect all persons against bodily injury, as well as protect property, public and private, from damage.

Discharge of weapons, specific provisions

The following are examples of ordinance provisions that can be applied to further restrict the use of weapons if a community so desires:

1. Discharge of weapons will only be allowed on land consisting of [insert number] acres or more.

2. Contiguous landowners may combine properties to fulfill the acreage requirement listed in paragraph 1.

3. Discharge of weapons will only be allowed from an elevated tree stand.

4. Operators of [permitted weapons] are required to have taken a Missouri Department of Conservation-approved hunter education course.

5. Operators of archery and/ or crossbow equipment are required to mark individual arrows with their nine-digit Missouri Conservation Identification Number.

6. No discharge of weapons shall be permitted without the written permission of the landowner or lessee of the property in question, which must be in the possession of the hunter while hunting, or be in the actual presence of the landowner or lessee.

7. No discharge of weapons shall be permitted within [insert distance] feet of any road, residential structure or place where domestic animals are kept except with written permission of the landowner or lessee of the property in question.

8. No weapon shall be discharged in the direction of any human, roadway, structure or domestic animals within reasonable range of the weapon at an angle which might allow the projectile to strike at, or dangerously near, these objects.

9. Any managed hunts permitted by the Missouri Department of Conservation or Department, Missouri Department of Natural Resources or the County Parks Department shall be permitted under this Section after obtaining approval of the City Council of the City of Community.

Model ordinance for native plants in the urban landscape (GN, 2013)

A MODEL MUNICIPAL ORDINANCE ENCOURAGING THE USE OF NATIVE PLANTS AND NATIVE PLANT COMMUNITIES AS AN ALTERNATIVE IN URBAN LANDSCAPE DESIGN

The Common Council of the City of _____ do ordain as follows:

SECTION 1. Legislative Purpose: A variety of landscapes adds diversity and richness to the quality of life in _____ . There are, nonetheless, reasonable expectations regarding the city's landscapes which, if not met, may decrease the value of nearby properties, degrade the natural environment, or threaten the public health and safety. It is therefore in the public interest, and within the purview of this legislation, to provide standards for the development and maintenance of the city's landscapes, whether corporate, private, or public.

WHEREAS, the city recognizes the landowners' interest in having managed turf grass landscapes. At the same time, the city encourages the preservation, restoration, and management of native plant communities and wildlife habitats within the city limits. The city recognizes that the use of wildflowers and other native plants in home, school, corporate, municipal, or other managed landscapes is economical, reduces maintenance, effectively conserves water, soil, and other elements of the natural community. Moreover, landscaping with native plants and the preservation, restoration, and management of native plant communities and wildlife habitats may preclude the introduction of toxic pesticides, herbicides, fertilizers, and other pollutants into the environment.

WHEREAS, the city further acknowledges the need to enjoy and benefit from the variety, beauty, and practical values of natural landscapes, and seeks to guarantee citizens the freedom to employ varying degrees of natural landscaping as viable and desirable alternatives to other conventional modes of landscaping.

WHEREAS, the city seeks to encourage each landowner to create and sustain a condition of ecological stability on his or her land, that is, a state of good health and vigor, as opposed to one of impairment and decline. It is not the intent of this legislation to allow vegetated areas to be unmanaged or overgrown in ways that may adversely affect human health or safety or pose a threat to agricultural activity.

WHEREAS, it is the express intent of this city that it shall be lawful to grow native plants, including, but not limited to ferns, grasses, forbs, aquatic plants, trees, and shrubs in a landscape when these plants were obtained not in violation of local, state, or federal laws.

SECTION 2. Definitions: The following terms shall have the stated meanings.

(a) Landowner. One who owns or controls land within the city, including the city itself.

(b) Turf Grass. Grass commonly used in regularly cut lawns or play areas, such as, but not limited to bluegrass, fescue, and ryegrass blends.

(c) Preservation, or Restoration Area. Any lands managed to preserve or restore native Missouri grasses and forbs, native trees, shrubs, wildflowers, and aquatic plants; an oldfield succession of native and nonnative plants; or, a combination of these.

(d) Weeds. The following plant species are defined as "noxious weeds" under Missouri law (RSMo Chapter 263 Insect Pests and Weeds, Section 263.190, August 28, 2012): Canada thistle (Cirsium arvense L. Scop.), musk thistle (Carduus nutans L.), Scotch thistle (Onopordum acanthium L.), common teasel (Dipsacus fullonum L.), cutleaf teasel (Dipsacus laciniatus L.), field bindweed (Convolvulus arvensis L.), kudzu (Pueraria montana [Lour.] Merr.), Johnson grass (Sorghum halepense L.), marijuana (Cannabis sativa L.), multiflora rose (Rosa multiflora Thunb. ex Murr.), purple loosestrife (Lythrum salicaria L. and any hybrids thereof), spotted knapweed (Centaurea stoebe L., including all subspecies).

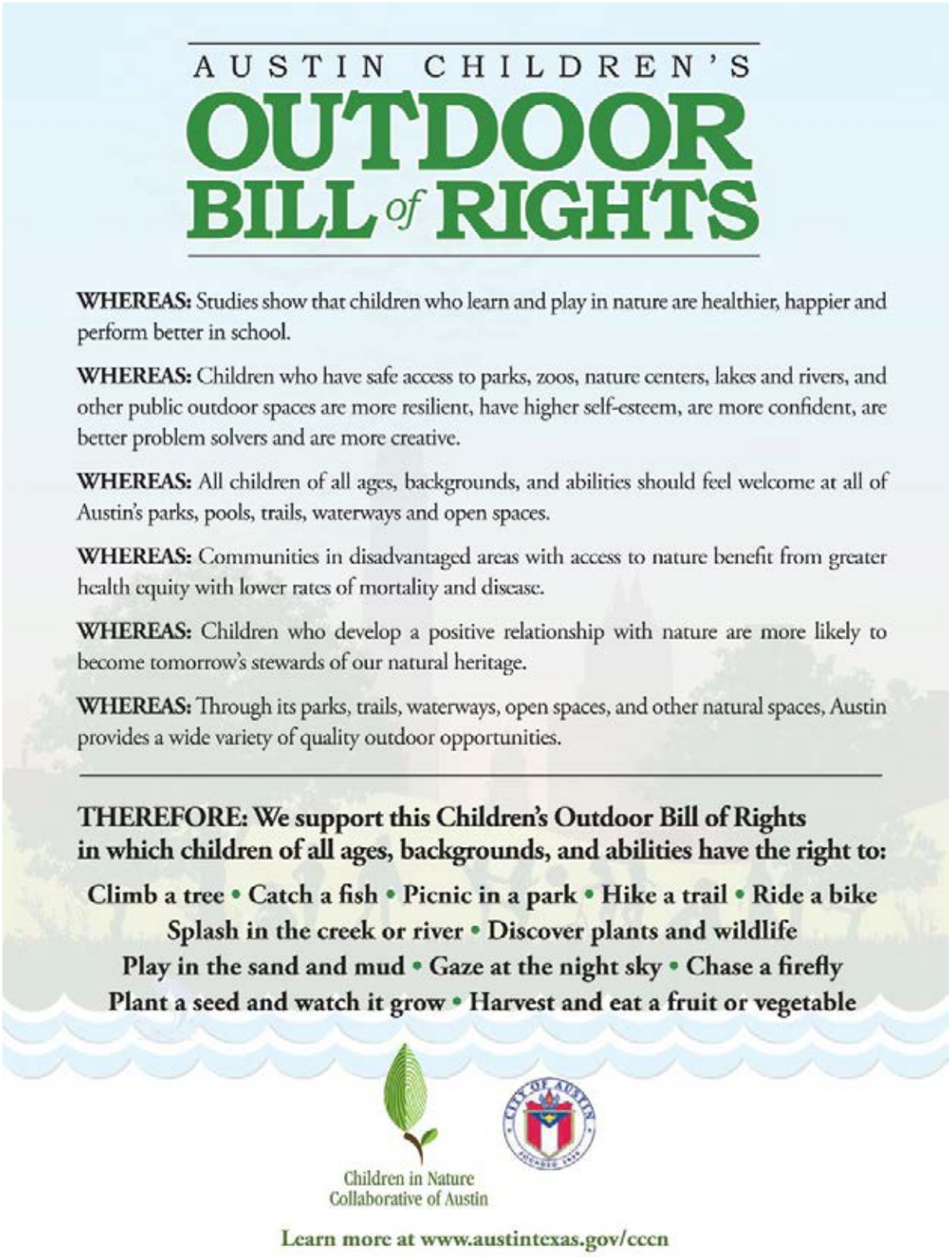
(e) Destruction, or Destroy. The complete killing of plants, or effectually preventing such plants from maturing to the bloom or flower stage.

SECTION 3. Landowners' Rights and Responsibilities: (a) This ordinance shall apply to all landowners. (b) Turf grass shall not exceed eight inches. (c) Noxious weeds shall be destroyed by the Landowners on whose land they grow. (d) The City may control turf grass in excess of _____ inches and noxious weeds as set forth in Section 4 below.

SECTION 4. Controls: The city may not damage, remove, burn, or cut vegetation of any landowner for which the city does not have management responsibilities, except following a hearing at which it is established (1) that noxious weeds specifically named in the landscape ordinance exist in the landscape; or (2) that a condition creating a clear and present hazard to public health or safety exists; or (3) that the condition is a threat to the agricultural economy; or (4) that the conditions of Section 3, entitled Landowners' Rights and Responsibilities, have not been met. A court order under these subsections shall provide that the destruction, cutting, or removal of the offending vegetation shall be selective so as not to harm that vegetation which is compliant with the law.

This model ordinance was prepared under the auspices of The Native Plant Preservation Coalition of Wisconsin, in cooperation with the Milwaukee Chapter of the National Audubon Society, and adapted slightly by the Grow Native! Committee of the Missouri Prairie Foundation, 2013.

Appendix B: Municipal Proclamations



AUSTIN CHILDREN'S

OUTDOOR BILL of RIGHTS

WHEREAS: Studies show that children who learn and play in nature are healthier, happier and perform better in school.

WHEREAS: Children who have safe access to parks, zoos, nature centers, lakes and rivers, and other public outdoor spaces are more resilient, have higher self-esteem, are more confident, are better problem solvers and are more creative.

WHEREAS: All children of all ages, backgrounds, and abilities should feel welcome at all of Austin's parks, pools, trails, waterways and open spaces.

WHEREAS: Communities in disadvantaged areas with access to nature benefit from greater health equity with lower rates of mortality and disease.

WHEREAS: Children who develop a positive relationship with nature are more likely to become tomorrow's stewards of our natural heritage.

WHEREAS: Through its parks, trails, waterways, open spaces, and other natural spaces, Austin provides a wide variety of quality outdoor opportunities.

THEREFORE: We support this Children's Outdoor Bill of Rights in which children of all ages, backgrounds, and abilities have the right to:

Climb a tree • Catch a fish • Picnic in a park • Hike a trail • Ride a bike
Splash in the creek or river • Discover plants and wildlife
Play in the sand and mud • Gaze at the night sky • Chase a firefly
Plant a seed and watch it grow • Harvest and eat a fruit or vegetable

Children in Nature Collaborative of Austin

Learn more at www.austintexas.gov/cccn

(Austin, 2016)

Mayors' Monarch Pledge

The monarch butterfly is an iconic North American species whose multigenerational migration and metamorphosis from caterpillar to butterfly has captured the imagination of millions of Americans.

We, the undersigned mayors and local or tribal government chief executives, are deeply concerned about the decline of the monarch butterfly population. Twenty years ago, more than one billion eastern monarch butterflies migrated to Mexico. In the winter of 2014, only 60 million made the trip. The North American monarch population has declined by more than 90 percent in the past two decades. Monarch scientists attribute the decline to degradation and loss of summer breeding habitat in the U.S., and loss of winter habitat in Mexico. Western populations of monarch butterflies that overwinter in California are also in decline.

Cities, towns and counties have a critical role to play to help save the monarch butterfly. Municipalities in particular can provide habitat at public parks, median strips, community gardens, and municipal buildings that serve as community hubs such as recreation centers and libraries. Schools, homes, and businesses can all provide essential habitat for monarchs too. Simple changes in landscaping ordinances or school policies can make a big difference for the monarch. Educating citizens about how and where to grow milkweed is also a key piece of the puzzle. Creating habitat and educating citizens will benefit other pollinators that need healthy habitat as well.

When mayors speak up and take a stand, citizens notice. Therefore, we hereby commit to help restore habitat for the monarch and encourage our citizens to do the same, so that these magnificent butterflies will once again flourish across the continent.

Sign the pledge at www.nwf.org/mayorsmonarchpledge

(NWF, 2017)

ExploreBranson.com

Proclamation

OFFICE OF THE MAYOR
BRANSON, MISSOURI

Whereas, the monarch butterfly is an American icon whose multigenerational migration and metamorphosis from caterpillar to butterfly has captured the imagination of generations of Americans; and

WHEREAS, twenty years ago, more than one billion eastern monarch butterflies migrated to Mexico but that population has declined by more than ninety percent in the past two decades, down to only 60 million in 2014; and

WHEREAS, the monarch butterfly is an important pollinator for plants; and

WHEREAS, Branson is in the center of the Monarch Flyway, a vital breeding ground of the monarch butterflies traveling to Mexico; and

WHEREAS, cities, towns, and counties have a critical role to play to help save the monarch butterfly, and the City of Branson can play a leadership role by launching, "Milkweed for Monarchs: Bringing Butterflies Back to Branson," and

WHEREAS, every business, public leader and citizen can make a difference for the monarch by planting native Missouri milkweed and nectar plants to provide habitat for the monarch pollinators in locations where citizens and visitors live, work, play, and worship; and

WHEREAS, on behalf of the people of Branson who have already joined me in creating healthy habitat for these magnificent butterflies, I am honored to lead the way by signing the National Wildlife Federation's Mayors' Monarch Pledge; and I encourage other city officials across our great nation to take a stand with me so that the monarch butterfly will once again flourish across the continent.

NOW, THEREFORE, I, Karen Best, Mayor of the City of Branson, do hereby proclaim in the City of Branson, Missouri, October 3, 2016 as

MAYORS' MONARCH PLEDGE DAY

In testimony thereof, I have hereunto set my hand and caused to be affixed the seal of the City of Branson, Missouri this 3rd day of October, 2016.

—Karen Best, Mayor

Appendix C: A Sampling of Green Standards and Rating Systems

The following text is by Stephanie Vierra, Assoc. AIA, LEED AP BD+C as posted on the Whole Building Design Guide page of the National Institute of Building Sciences website.

Introduction

Buildings have extensive direct and indirect impacts on the environment. During their construction, occupancy, renovation, repurposing, and demolition, buildings use energy, water, and raw materials, generate waste, and emit potentially harmful atmospheric emissions. These facts have prompted the creation of green building standards, certifications, and rating systems aimed at mitigating the impact of buildings on the natural environment through sustainable design (Vierra, 2016).

The push toward sustainable design increased in the 1990s with the creation of Building Research Establishment's Environmental Assessment Method (BREEAM), the first green building rating system in the U.K. In 2000, the U.S. Green Building Council (USGBC) followed suit and developed and released criteria also aimed at improving the environmental performance of buildings through its Leadership in Energy and Environmental Design (LEED) rating system for new construction. Since that first release, LEED has continued to grow in prominence and to include rating systems for existing buildings and entire neighborhoods. Others also responded to the growing interest and demand for sustainable design including the Green Building Initiative (GBI), which was created to assist the National Association of Homebuilders (NAHB) in promoting its Green Building Guidelines for Residential Structures. Although originally developed for Canada, GBI helped to make Green Globes available for use in the U.S. in 2005. Additional rating systems have been developed that were influenced by these early programs but are tailored to their own national priorities and requirements or seek to go beyond the limits of current policy and building practices to address broader issues of sustainability or evolving concepts such as net-zero energy and living and restorative building concepts that improve the natural environment, or those that model nature's processes (Vierra, 2016).

Building Standards

A standard is a set of guidelines and criteria against which a product can be judged. Common standards related to building practices are created through consensus processes by organizations such as the American National Standards Institute (ANSI) or the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE). Supporting the governance of standards and certifications is the International Standards Organization (ISO), which defines and develops worldwide standards that frequently become law or form the basis of industry norms (Vierra, 2016).

Green Codes

Green building codes continue to be developed and adopted in the U.S. and abroad that seek to push the standard of building design and construction to new levels of sustainability and performance. Codes come in two basic formats: prescriptive and performance, with outcome-based becoming a developing third option. A prescriptive path is a fast, definitive, and conservative approach to code compliance. Materials and equipment must meet certain levels of stringency, which are quantified in tables. Performance-based codes are designed to achieve particular results, rather than meeting prescribed requirements for individual building components. Outcome-based codes for example, establish a target energy use level and provide for measurement and reporting of energy use to assure that the completed building performs at the established level (Vierra, 2016).

The unique difference between codes and building rating systems is that codes are mandatory. If green codes become adopted on a wide spread basis, their impact can change the building environment rapidly and extensively (Vierra, 2016).

The International Green Construction Code (IgCC) provides a comprehensive set of requirements intended to reduce the negative impact of buildings on the natural environment. It is a document which can be readily used by manufacturers, design professionals and contractors; but what sets it apart in the world of green building is that it was created with the intent to be administered by code officials and adopted by governmental units at any level as a tool to drive green building beyond the market segment that has been transformed by voluntary rating systems (Vierra, 2016).

Green Product Certifications

A certification is a confirmation that a product meets defined criteria of a standard. ISO defines certification as: "any activity concerned with determining directly or indirectly that relevant requirements are fulfilled (Vierra, 2016)."

Green product certifications are intended to outline and confirm that a product meets a particular standard and offers an environmental benefit. Many product labels and

certification programs certify products based on life-cycle parameters, making them multi-attribute programs. These parameters include energy use, recycled content, and air and water emissions from manufacturing, disposal, and use. Others focus on a single attribute, such as water, energy, or chemical emissions that directly impact indoor environmental quality (Vierra, 2016).

A green product certification is considered most respected when an independent third party is responsible for conducting the product testing and awarding the certification. Third-party means they are independent of the product manufacturer, contractor, designer, and specifier. Third-party labels and green product certification programs can be helpful in evaluating the attributes of green products because they validate that the product meets certain industry-independent standards. They can also offer greater assurance to consumers, designers, specifiers, and others that a product's marketing claims accurately reflect its green attributes. Many product certifications are also recognized within comprehensive green building rating systems such as LEED, Green Globes, and the National Green Building Standard. As a result, green product certifications are on the rise as market conditions change and the demand for greener products continues to increase. It is important to note that greenwashing, which is defined as the use of green claims that are not true or are unverifiable but used to sell products or a corporate image, has become commonplace as companies try to stay competitive in the green marketplace (Vierra, 2016).

Green Building Rating and Certification Systems

Rating systems are a type of building certification system that rates or rewards relative levels of compliance or performance with specific environmental goals and requirements. Rating systems and certification systems are frequently used interchangeably (Vierra, 2016).

Green building rating and certification systems require an integrated design process to create projects that are environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. A few of these programs are single-attribute, focusing solely on water or energy, while others are multi-attribute addressing emissions, toxicity, and overall environmental performance in addition to water and energy. While the philosophy, approach, and certification method vary across these systems, a common objective is that projects awarded or certified within these programs are designed to reduce the overall impact of the built environment on human health and the natural environment (Vierra, 2016).

Green building rating systems exist to address every project type from single-family houses and commercial buildings to entire neighborhoods. There are rating systems available for new construction, which focus on decisions made in the planning and design process and actions taken through construction, as well as for existing buildings, which focus on operations and maintenance throughout the life of the building. A primary reason for the creation of rating systems is the need to more clearly define, implement, and measure green. Federal, state, and municipal agencies across the country such as the General Services Administration (GSA), Department of Energy, Department of Health and Human Services, and the Environmental Protection Agency, have taken an early lead in incorporating energy efficiency and sustainability by following green building guidelines in the design, construction, and renovation of Federal facilities. Most states and many major cities have also incorporated green into their internal building requirements for new construction (Vierra, 2016).

Buildings

- **ANSI/ASHRAE/USGBC/IES Standard 189.1-2014** – Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings (ASHRAE 189.1)

  - Provides total building sustainability guidance for designing, building, and operating high-performance green buildings. From site location to energy use to recycling, this standard sets the foundation for green buildings by addressing site sustainability, water use efficiency, energy efficiency, indoor environmental quality, and the building's impact on the atmosphere, materials and resources. The standard provides minimum requirements for siting, design, construction, and operation of high-performance green buildings to (1) balance environmental responsibility, resource efficiency, occupant comfort and well-being, and community sensitivity; and (2) support the goal of development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Standard 189.1 is a compliance option of IgCC (ASHRAE, n.d.).

- **Green Globes™**

  - An online green building rating and certification tool that is used primarily in Canada and the USA. In 2004, the Green Building Initiative acquired the U.S. rights to the Green Globes building assessment and certification program and adapted it for the U.S. market as an alternative to the LEED building rating system. In 2013, the U.S. General Services Administration (GSA) recommended

Green Globes and LEED as the two certification options for federal government construction projects. This recommendation followed a review of all major certification systems, as required by the 2007 Energy Independence and Security Act (Green Globes, n.d.).

- **ICC/ASHRAE 700-2015 National Green Building Standard™**
  - This residential green building standard has undergone the full consensus process and received approval from ANSI. First developed in 2008, NAHB, the International Code Council (ICC) and ASHRAE have partnered to develop the third edition of the nationally recognized standard. IgCC allows compliance with ICC 700 National Green Building Standard as an alternate compliance path for residential buildings more than four stories in height (National Association of Home Builders, 2017).
- **International Living Future Institute (ILFI)** – Living Building Challenge™, version 3.1
  - The Living Building Challenge is a performance standard for buildings that endeavors to make the world a better place with every single act of design and construction. It established a regenerative design framework to create spaces that give more than they take (ILFI, 2017a).
- **National Association of Home Builders** – Model Green Home Building Guidelines
  - Guidelines that were designed to highlight ways in which a mainstream home builder can effectively and holistically weave environmental concerns into a new home and to provide a tool for local associations to create a green home building program (National Association of Home Builders, 2006).
- **US Green Building Council (USGBC)** – Leadership in Energy and Environmental Design (LEED), version 4
  - LEED is changing the way we think about how buildings and communities are planned, constructed, maintained and operated. Leaders around the world have made LEED the most widely used third-party verification for green buildings, with around 1.85 million square feet being certified daily. LEED works for all buildings at all phases of development. Projects pursuing LEED certification earn points across several areas that address sustainability issues. Based on the number of points achieved, a project then receives one of four LEED rating levels: Certified, Silver, Gold, and Platinum. LEED-certified buildings are resource efficient. They use less water and energy and reduce greenhouse gas emissions. As an added bonus, they save money. Green Business Certification Inc. (GBCI) is the certification body for the LEED green building program (U.S. GBC, 2017a).
  - **American Bird Conservancy** – Bird-Friendly Building Standard
    - In 2011, USGBC added Pilot Credit 55: Bird Collision Deterrence to its Pilot Credit Library. The credit was drafted by the ABC, members of the Bird-Safe Glass Foundation, and the USGBC Sustainable Sites Technical Advisory Group. Building developers who wish to earn this credit must quantify the threat level to birds posed by various materials and design details. The credit also requires adopting interior and exterior lighting plans and post-construction monitoring. The revised version of the credit, posted in 2015, expands its availability to all LEED rating systems except "neighborhoods" (American Bird Conservancy, 2017).
- **US Resiliency Council (USRC)** – USRC Building Rating System for Earthquake Preparedness
  - The USRC building rating system identifies expected consequences of an earthquake affecting buildings. The rating considers the performance of a building's structure, its mechanical, electrical and plumbing systems, and architectural components such as cladding, windows, partitions, and ceilings. The performance of these elements affects occupant safety, the cost and time to carry out necessary repairs, and when you can begin using the building following an event. USRC's approach provides consistency, usefulness and transparency to increase free market demand for better performing buildings (U.S. Resiliency Council, 2017).

Communities and Sites

- **American Society of Landscape Architects Fund, The Lady Bird Johnson Wildflower Center at The University of Texas at Austin, and the United States Botanic Garden** – Sustainable Site Initiative™ (SITES®), version 2
  - SITES is used by landscape architects, designers, engineers, architects, developers, policy-makers and others to align land development

and management with innovative sustainable design. Land is a crucial component of the built environment and can be planned, designed, developed and maintained to protect and enhance the benefits we derive from healthy functioning landscapes. SITES helps create ecologically resilient communities and benefits the environment, property owners, and local and regional communities and economies. Administered by Green Business Certification Inc. (GBCI), SITES offers a comprehensive rating system designed to distinguish sustainable landscapes, measure their performance and elevate their value. SITES certification is for development projects located on sites with or without buildings—ranging from national parks to corporate campuses and from streetscapes to homes (The Sustainable SITES Initiative, 2017).

- **International Living Future Institute** – Living Community Challenge™, version 1.1 (2016)

  - The Living Community Challenge is a framework for master planning, design, and construction. It is a tool to create a symbiotic relationship between people and all aspects of the built environment. The program is a call to action to governments, developers, and planners to create communities that operate like forests (ILFI, 2017-b).

- **STAR Communities** – STAR Community Rating System (STAR)

  - STAR Communities is a nonprofit organization that works to evaluate, improve, and certify sustainable communities. It helps cities and counties achieve a healthy environment, a strong economy, and well-being for their residents. Sustainability means different things to different people, so STAR provides a clear, data-driven approach to assessing communities' sustainability efforts. The STAR framework helps communities assess their efforts in seven key areas and define sustainability for themselves. This robust framework is necessary for communities to credibly track their progress toward overall sustainability objectives and to allow communities to compare progress with each other. The STAR Community Rating System was initiated and supported by founding partners ICLEI-Local Governments for Sustainability USA, the U.S. Green Building Council, National League of Cities and the Center for American Progress (Star Communities, 2017).

- **US Green Building Council** – Leadership in Energy and Environmental Design for Neighborhood Development (LEED ND), version 4 (2016)

  - LEED ND was engineered to inspire and help create better, more sustainable, well-connected neighborhoods. It looks beyond the scale of buildings to consider entire communities. There are two certification options that reflect important project milestones. Plan certification is available for a neighborhood-scale project if it's currently in any phase of planning and design. Plan certification helps developers market and fund projects among prospective tenants, financiers, and public officials by affirming their intended sustainability strategies. Built project certification is designed for neighborhood-scale projects that are near completion or were completed within the last three years (U.S. GBC, 2017-b).

Transportation Infrastructure

- **Greenroads Rating System®**

  - Greenroads International is an independent 501(c)(3) nonprofit corporation which advances sustainability education and initiatives for transportation infrastructure. As the developer of the Greenroads Rating System®, the Foundation manages the certification process for sustainable transportation development projects in the U.S. and internationally (Greenroads, 2017).

- **Institute for Sustainable Infrastructure: Envision**

  - Envision is a groundbreaking resource for professionals involved in planning, designing, building, and maintaining civil infrastructure. As a rating system for sustainable infrastructure, Envision is supported by a wide array of organizations involved in infrastructure design, construction, and operation (ISI, 2017).

- **North American Sustainable Transportation Council** – Sustainable Transportation Analysis and Rating System (STARS)

  - STARS is an integrated planning framework for transportation plans and projects. STARS helps communities evaluate the impacts of transportation plans and projects, identify innovative strategies, and improve decision-making. Many rating systems evaluate the design and construction of transportation projects, but not their future use. Yet the use of a transportation project (that is, the people, goods and vehicles moving along it over many years) often has bigger impacts than its construction. The decision of what to build can therefore be much more important than how to build it. STARS evaluates improved access rather than simply improved mobility. That is, STARS

recognizes the value in people having access to work, school, goods and services, even if they do not have to travel far to do so. Travelling, or mobility, is a means to accessing these places, not an end in itself. A focus on access enables STARS users to find solutions to transportation problems that might otherwise be overlooked with a traditional focus on moving more people farther, faster (North American Sustainable Transportation Council, n.d.).

- **U.S. Department of Transportation-Federal Highway Administration** – Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects

  - The Eco-Logical approach organizes current methods for addressing natural resource identification, avoidance, minimization and mitigation into a systematic, step-wise process that starts at the beginning of the transportation planning process and concludes with establishing programmatic approaches to recurring natural resource issues that are implemented at the project level (U.S. Department of Transportation, n.d.-b).

- **U.S. Department of Transportation-Federal Highway Administration** – Infrastructure Voluntary Evaluation Sustainability Tool (INVEST), version 1.2 (2015)

  - A web-based self-evaluation tool comprised of voluntary sustainability best practices, which cover the full lifecycle of transportation services including system planning, project planning, design, construction, operations, and maintenance. FHWA developed INVEST for voluntary use by transportation agencies to assess and enhance the sustainability of their projects and programs (U.S. Department of Transportation, n.d.-c).

Appendix D: Common Obstacles in Local Codes to LID Practices (UACDC, 2010)

1. **BUILDING CODES**

   A. Prohibition of graywater recycling for household use

   B. Prohibition of rainwater recycling for household use

   C. Requirement for gutters

   D. Sprawling building footprints

2. **PROPERTY CODES**

   A. Lack of requirements regulating soil compaction

   B. Lack of requirements for maintaining pre-development hydrologic regimes

   C. Turf specifications

   D. Excessive setback distances in residential districts

   E. Lack of requirements for protecting LID facilities

   F. Prohibition of permeable surfaces for parking

   G. Excessive automobile parking requirements

   H. Lack of requirements to keep stormwater runoff on-site

   I. Lack of tree protection requirements

   J. Lack of proper wetland mitigation

   K. Sidewalk material restrictions

   L. Universal requirements for sidewalks

   M. Prohibition of vegetation near an intersection

   N. Prohibition of LID facilities in the public right-of-way

   O. Prohibition of pervious materials in public right-of-way

   P. Prohibition of runoff conveyance in public right-of-way

   Q. Minimum street widths

   R. Requirements for low-density land uses

   S. Requirement for street curbs

   T. Arterial highway statutes prohibiting landscape materials

   U. Excessive cul-de-sac requirements

   V. Lack of requirements for street trees

3. **OPEN SPACE REGULATIONS**

   A. Lack of development transfer rights

   B. Lack of hillside and tree ordinances

   C. Lack of waterbody buffers

   D. Lack of conservation requirements

4. **ACROSS THE TRANSECT**

   A. LID as non-conforming infrastructure

Appendix E: A Sampling of Incentives and Other Funding Mechanisms

Incentive – Inducement provided by government to encourage development of a certain type or in a certain area. Examples include tax abatement, tax reduction, power to condemn and acquire property, density bonuses, etc. (Kansas City, 2006). **Density** is the term used to describe the amount or intensity of development on a tract of land. It is generally measured in two ways: as the ratio of housing units to total land area (e.g., dwelling units per acre) or as the **Floor Area Ratio** (FAR) (Kansas City, 2006). FAR is the ratio of a building's total floor area to the area of the lot on which the building stands. The gross floor area permitted on a site divided by the total net area of the site, expressed in decimals to one or two places. For example, on a site with 10,000 net square feet of land area, a floor area ratio of 1.0 will allow a maximum of 10,000 gross square feet of building floor area to be built. On the same site, an FAR of 1.5 would allow 15,000 square feet of floor area; an FAR of 2.0 would allow 20,000 square feet; and an FAR of 0.5 would allow only 5,000 square feet (Greenbelt Alliance, 2017). A **density bonus** is the allowance of a development to surpass allowable FAR, often under the condition of providing community benefits either at the same site or another location (Greenbelt Alliance 2017).

Grants

- **319 nonpoint source project grants** – Grants available to public institutions of higher education, units of government and nonprofit organizations with 501(c)(3) status for projects that prevent, control or abate nonpoint source water pollution (Missouri Department of Natural Resources, 2014).

- **604b water quality management planning grants** – Grants available to assist state, regional public comprehensive planning organizations, and interstate organizations carry out water quality management planning. Funds are used to determine the nature and extent of point and nonpoint source pollution and to develop management plans to address them with an emphasis on a watershed approach (Missouri Department of Natural Resources, 2014).

- **Community development block grant (CDBG)** – A federal funding program that provides annual funding to eligible local governments for housing, community revitalization, development programs and social services, particularly in low- and moderate- income areas (Kansas City, 2006).

- **Five-star wetland and urban waters restoration grant program** – The program seeks to develop nationwide community stewardship of local natural resources, preserving these resources for future generations and enhancing habitat for local wildlife. It focuses on the stewardship and restoration of coastal, wetland, and riparian ecosystems across the country. Major funding is provided by the National Fish and Wildlife Foundation's partnerships with the U.S. EPA, the U.S. Forest Service, the U.S. Fish and Wildlife Service, Southern Company, FedEx, Alcoa Foundation, and Pacific Gas and Electric Company (National Fish and Wildlife Foundation, 2017).

- **Land and water conservation fund** – Federally funded grants are available to local government and school districts to be used for renovation, development of outdoor recreation facilities and land acquisition. Project sites will be held in perpetuity to be used for public outdoor recreation use (Missouri Department of Natural Resources, 2014).

- **Recreational trails program** – Federally funded grants are available to trail organizations, local governments, schools, businesses and for-profit/nonprofit organizations for trail construction, maintenance and education (Missouri Department of Natural Resources, 2014).

- **Surface transportation block grant program** (aka TA Set-Aside) – The Fixing America's Surface Transportation (FAST) Act replaced the former Transportation Alternatives Program (TAP) with a set-aside of funds under the Surface Transportation Block Grant Program. The TA Set-Aside authorizes funding for programs and projects defined as transportation alternatives, including on- and off-road pedestrian and bicycle facilities, infrastructure projects for improving non-driver access to public transportation and enhanced mobility, community improvement activities such as historic preservation and vegetation management, and environmental mitigation related to stormwater and habitat connectivity; recreational trail projects; safe routes to school projects; and projects for planning, designing, or constructing boulevards and other roadways largely in the right-of-way of former divided highways (U.S. Department of Transportation, 2017).

  - Wheaton, Missouri received funding for a greenway trail through this program in 2017 (Missouri Department of Transportation, 2017).

- **Urban waters small grants program** – Healthy and accessible urban waters can help grow local businesses and enhance educational, recreational, social, and employment opportunities in nearby communities. These federally funded grants expand the ability of communities to engage in activities that both improve water quality and advance community priorities. Grants are funded on a two-year cycle (U.S. EPA, 2017d).
    - » Saint Louis University received funding in 2015 for a project in the St. Louis Region
    - » Blue River Watershed Association received funding in 2013 for a project in the Kansas City Metro Area
    - » Heartland Conservation Alliance, Inc. received funding in 2011 and 2013 for a project in Kansas City
    - » Southern Illinois University–Edwardsville received funding in 2011 for a project in St. Louis

Improvement districts

- **Community improvement district (CID)** – A district established to allow private parties, by vote of a majority of property owners within the district, to assess a special tax on themselves for improvements and services that benefit the entire community (Kansas City, 2006).
- **Neighborhood improvement district** – A district established to allow private parties, by vote of a majority of landowners within the district, to assess a special tax on themselves for improvements and services that benefit the entire community (Kansas City, 2006).

Revolving loan funds

- **Brownfields revolving loan fund** – In cooperation with the Missouri Department of Natural Resources Brownfields Voluntary Cleanup Program, the Environmental Improvement and Energy Resources Authority (EIERA) supports cleanup activities. In 2005, EIERA was awarded a $1 million grant to capitalize a revolving loan fund from which the EIERA will provide loans and sub-grants to support cleanup activities for sites contaminated with petroleum, hazardous controlled substances, and mine-scarred lands (Environmental Improvement and Energy Resources Authority, n.d.).
- **Clean water state revolving loan funds** – Communities that have brownfields and suffer from water quality impairment may be able to access and use money from Clean Water State Revolving Funds (CWSRFs) to correct or prevent water quality problems at such properties. Through the CWSRF program, states maintain a revolving loan fund to provide low-cost financing for a wide range of water quality infrastructure projects. Nationally, interest rates for CWSRF loans average 1.7 percent compared to market rates that average 3.8 percent. States have the flexibility to target resources to their particular environmental needs, including brownfields remediation, treatment of contaminated runoff from urban and agricultural areas, wetland restoration, estuary management, and wastewater treatment. Construction of wetlands to use as a filtering mechanism is an allowed use of this program (U.S. EPA, 2017a).
- **Tax incentives** – Tools and mechanisms that convey one or several financial advantages to a particular employer, developer, or homeowner for a specific period of time. Incentive programs include Tax Abatement, the forgiving of a portion or all taxes due (Kansas City, 2006).
- **Historic preservation tax credit program** – An incentive program offered by the Missouri Department of Economic Development for the redevelopment of commercial and residential historic structures in Missouri (Missouri Department of Economic Development, 2014).
- **Historic building rehabilitation tax credits** – An incentive adopted by Congress to discourage unnecessary demolition of sound older buildings and to slow the loss of businesses from older urban areas. The tax credits encourage private investment in the cleanup and rehabilitation of historical properties. The National Park Service administers the program in partnership with the Internal Revenue Service and State Historic Preservation Offices (U.S. EPA, 2017a).
- **New markets tax credit (NMTC) program** – Designed to stimulate the economies of distressed urban and rural communities and create jobs in low-income communities by expanding the availability of credit, investment capital, and financial services. The NMTC program was created through the Community Renewal Act of 2000. The program is administered by the Community Development Financial Institutions (CDFI) Fund within the U.S. Department of the Treasury. Each year, tax credits are allocated through the CDFI Fund and distributed to qualified Community Development Entities (CDEs). CDEs include a range of for-profit and nonprofit organizations, such as community development corporations, CDFIs, organizations that administer community development venture capital funds or community loan funds, small business development corporations, and specialized small business investment companies. There are nearly 6,000 organizations are certified as CDEs and

approximately 1,000 certified CDFIs (U.S. EPA, 2017a).

- **Tax increment financing (TIF)** – A state legislated incentive mechanism whereby certain redevelopment project expenses are financed by Payments in Lieu of Taxes (PILOTS) and a portion of Economic Activity Taxes (EATS) resulting from the redevelopment project. PILOTS are equal to the tax revenue that would accrue from the increase in assessed property valuation in the project area. EATS are composed of taxes generated by economic activities within the project area, including sales taxes, utility taxes, and earnings taxes. The project must be located in a blighted area, a conservation [i.e., historic] area, or an economic development area, and it must be determined that without TIF assistance, redevelopment would not occur. A TIF plan must comply with the general development plan of the municipality (Kansas City, 2006).

Technical assistance programs

- **Partnership for sustainable communities** – An interagency collaboration between the U.S. Environmental Protection Agency, the U.S. Department of Housing and Urban Development, and the U.S. Department of Transportation to coordinate federal investments in infrastructure, facilities, and services in order to get better results for communities and use taxpayer money more efficiently (U.S. Department of Housing, US-DOT, & U.S. EPA, n.d.).

  - **Building blocks for sustainable communities program**

    - Columbia, Missouri received this assistance in 2014 via grant-recipient Smart Growth America
    - St. Louis, Missouri received this assistance in 2015 via grant-recipient Global Green USA

  - **Green infrastructure community assistance program**

    - Neosho, Missouri received this assistance in 2012 via grant-recipient the Low-Impact Development Center

- **Strong cities, strong communities initiative** – Established in 2012, the White House Council on Strong Cities, Strong Communities (SC2) brings together 19 federal agencies to work together in partnership with city leaders as they implement locally driven economic visions. SC2 is an innovative approach for supporting cities experiencing population and job loss, persistent poverty, capacity constraints, and similar challenges in an era of ever-dwindling resources. SC2 consists of four components: SC2 Deployed Federal Community Solutions Teams; SC2 National Resource Network; SC2 Fellows and AmeriCorps VISTA volunteers; and the SC2 Economic Visioning Challenge (U.S. Department of Housing, n.d.).

  - Kansas City, Missouri, participates in the SC2 National Resource Network component
  - Springfield, Missouri, participates in the SC2 National Resource Network component
  - St. Louis, Missouri, participates in the SC2 Deployed Federal Community Solutions Team component

Appendix F: Terrestrial Natural Communities of Missouri

Natural communities are distinct assemblages of native plants, animals and microorganisms that occur in repeatable patterns across the landscape and through time. These assemblages of biota occupy definable physical environments, which in turn influence the structure and composition of natural communities (Nelson, 2005).

1. ***Cave** – A naturally formed void in the earth, generally large enough for a person to enter and that is long enough to have an area of total darkness.

2. **Cliff** – Any high, very steep to perpendicular or overhanging face of rock or earth; a precipice. Talus – Rock fragments of any size and shape derived from and lying at the base of a cliff or very steep, rock slope.

3. **Forest** – An area dominated by trees forming a closed canopy and interspersed with multilayered shade-tolerant subcanopy trees, shrubs, vines, ferns and herbs. Trees attain heights of 60 to over 100 feet. The ground flora is rich in spring ephemerals.

4. **Glade** – Open, exposed bedrock areas dominated by drought-adapted herbs and grasses in an otherwise woodland or forest matrix.

5. **Prairie** – Native grasslands in Missouri dominated by warm-season grasses and perennial herbs with very few trees (<10 percent cover).

6. **Savanna** – Native grasslands interspersed with open-grown scattered trees or groupings of trees. They are strongly associated with prairies and are dominated by prairie grasses and forbs. Canopy cover is usually <30 percent.

7. **Stream edge** – A riparian natural community type occurring along and in streams where flooding constantly shapes the soil or parent materials.

8. **Wetland** – Natural communities resulting from inundation or saturation by surface or groundwater creating hydric soil conditions favoring the development of hydrophytic vegetation.

9. **Woodland** – A natural community with a canopy of trees ranging from 30–100 percent canopy closure with a sparse understory and a dense ground layer rich in forbs, grasses and sedges. Canopy height ranges from 20–90 feet depending on site conditions.

*Caves and the following features are associated with karst geology:

Losing stream (aka sinking stream) – A surface-flowing stream that disappears underground (Currens, 2012).

Sinkhole – A depressed area usually formed by solution of surficial bedrock or collapse of underlying caves. The surface expression of a sinkhole is typically a conical depression or area of internal drainage (Missouri Department of Natural Resources, n.d.-c). Sinkhole depressions may be gradual or abrupt; they may or may not have a well-defined eye. While most sinkholes can be defined as the area within a "closed contour," some sinkholes, such as those located on the sides of hills and in stream valleys, may not. All sinkholes provide discreet points of recharge to groundwater (Greene County, 1999).

Sinkhole eye – Generally, a visible opening, cavity or cave in the bottom of a sinkhole, sometimes referred to as a swallow hole (Greene County, 1999).

Spring – A continual or intermittent natural flow of water from the ground following a rather well-defined channel (Nelson, 2005).

Swallow hole – A place where water disappears underground into a hole in a stream bed or sinkhole (Currens, 2012).

Appendix G: Soil Characteristics

SOIL MOISTURE (DRAINAGE) CLASS – The descriptive terms applied to natural communities in distinguishing soil moisture based on frequency and duration of hydrologic conditions similar to those under which the soil developed. The classes are based on runoff, permeability, and internal drainage characteristics (Nelson, 2005).

The classes are as follows (Nelson, 2005):

- **Xeric:** Excessively drained
  - » Soils are very rapidly drained; water is removed from the soil very rapidly because sloping bedrock or gravel is at or near the surface.
- **Dry:** Somewhat excessively drained
  - » Soils are excessively to somewhat excessively drained or shallow.
- **Dry-mesic:** Well drained
  - » Soil that is well drained; water is removed from the soil readily but not rapidly.
- **Mesic:** Moderately well drained
  - » Soil that is moderately well drained; water is removed from the soil somewhat slowly so that the profile is wet for a small but significant part of the time.
- **Wet-mesic:** Somewhat poorly drained
  - » Soil that is somewhat poorly to poorly drained; the soil is wet at shallow depths for significant periods during the growing season.
- **Wet:** Poorly drained
  - » Soil that is very poorly drained; water is removed from the soil so slowly that the water table is at or above the surface most of the time.
- **Hydric:** Very poorly drained
  - » Soil that is very poorly drained; the water table is at or above the surface most of the time.

SOIL TEXTURE – Soil texture is defined as the percentage by weight of sand, silt and clay in the mineral fraction of soils (Nelson, 2005). Three broadly defined categories and 12 specific categories occur (Nelson, 2005):

- **Coarse-textured soils:** sand, loamy sand, sandy loam.
- **Medium-textured soils:** loam, silt loam, silt.
- **Fine-textured soils:** sandy clay, silty clay, clay, clay loam, sandy clay loam, silty clay loam.

Appendix H: Plant Community Characteristics and Plant Types

PLANT COMMUNITY – Species adapted to growing together (Shaw & Schmidt, 2003).

- Plant communities in a forest or woodland can be divided into vertical layers (Nelson, 2005):
  - **Ground layer** (aka groundcover) – A vegetation layer, generally less than 3.5 feet tall of herbaceous plants, bryophytes, and woody plant seedlings and saplings.
  - **Understory** – Collective term for the small trees and shrubs growing beneath the canopy in a forest or woodland.
  - **Canopy** – Generally the tallest (tree) layer in a natural community. Canopy plants receive direct sunlight and occur in patches or continuous cover of individuals with similar heights.
- Plant communities can be grouped according to zones that change with elevation. Hydrological plant community zones include (Shaw & Schmidt, 2003):
  - **Zone 1.** Submergent zone – 1.5 to 6 feet of water
  - **Zone 2.** Emergent zone – 0 to 18 inches of water
  - **Zone 3.** Wet meadow zone – Permanent moisture
  - **Zone 4.** Floodplain zone – Flooded during snowmelt and large storms
  - **Zone 5.** Upland zone – Seldom or never inundated (includes prairie and forest plant communities)
- Plant communities can also be grouped according to the indicator status of plants. A positive (+) sign indicates that the species is more likely to be found in wetlands and a negative (-) sign indicates that it is less likely to be found in wetlands (Shaw & Schmidt, 2003).
- **FAC (Facultative)** – Equally likely to occur in wetlands or non-wetlands (estimated probability 67–99 percent).
  - **FACU (Facultative Upland)** – Usually occurs in non-wetlands (estimated probability 67–99 percent), but is occasionally found in wetlands (estimated probability 1–33 percent).
  - **FACW (Facultative Wetland)** – Usually occurs in wetlands (estimated probability 67–99 percent), but is occasionally found in non-wetlands.
  - **OBL (Obligate Wetland)** – Under natural conditions, occurs almost always (estimated probability > 99 percent) in wetlands.
  - **UPL (Obligate Upland)** – Occurs in wetlands in another region but occurs almost always (estimated probability > 99 percent) under natural conditions in non-wetlands in the region specified.
- **Growing cycles:**
  - **Annuals** – Plants that complete their growth from seed to maturity within one growing season.
    - Summer annuals germinate in the spring and complete their growth in late summer to early fall

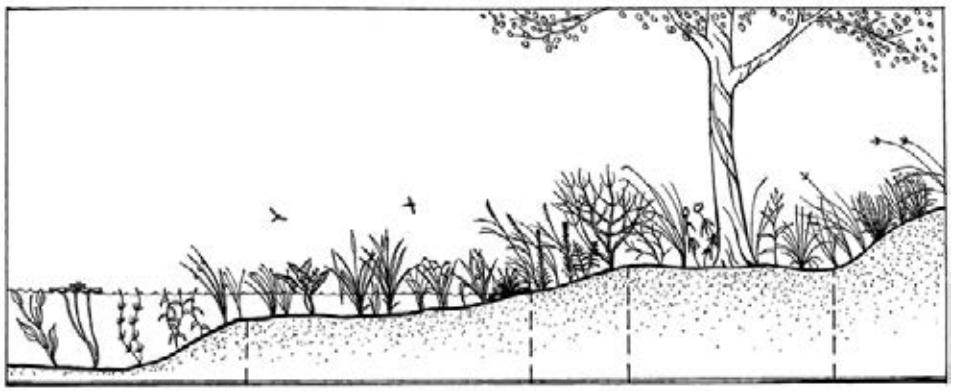


Figure 20. Hydrological Plant Community Zones (Shaw & Schmidt, 2003)

    - Winter annuals germinate in the fall or late winter and complete their growth in the spring to early summer (Bradley & Fishel, 2010).

  - **Biennial** – A plant that lives for two years, usually reproducing only in the second year before dying (New England Wild Flower Society, 2017a).

  - **Perennial** – A plant species with a life cycle that lasts at least two growing seasons (Nelson, 2005).

- **Plant types include:**

  - **Ferns** – Non-flowering plants that produce spores, which themselves germinate to form sexual plantlets whose offspring in turn become the spore-bearing plant (New England Wild Flower Society, 2017b).

  - **Forbs** (aka wildflowers) – Broadleaved herbaceous plants (Nelson, 2005).

    - Legumes – Forbs in the pea family. Legumes help make nitrogen available in the soil for other plants to use.

  - **Grasses** – Plants in the family Poaceae. Grasses are annual, biennial, or perennial plants that are usually herbaceous but may be woody in some genera. They may be terrestrial or aquatic. These very common plants are variable in height and form but most have hollow, circular stems with alternate, narrow leaves that have parallel veins. The lower portion of the leaf consists of a tubular sheath that surrounds the stem. At the base of the sheath is the point where the leaf connects to the stem; this point is called the node and is often swollen (New England Wild Flower Society, 2017b).

    - Cool-season grasses grow best in spring and fall.

    - Warm-season grasses grow best in summer.

  - **Rushes** (also bulrushes, cattails, and other narrow-leaved plants) – A broad variety of plants with long, narrow leaves that sheath the stem, some of which may be hollow or have compartments with air spaces. They may resemble grasses or sedges, but do not have a perigynium like sedges, or flowers arranged in spikelets as in true grasses (New England Wild Flower Society, 2017b).

  - **Sedges** – Plants in the genus Carex (Cyperaceae) (Nelson, 2005). The stems of sedges are usually triangular in cross-section.

  - **Shrubs** – Multi-stemmed woody plants generally < 15 feet in height at maturity under good growing conditions (Nelson, 2005).

  - **Spring ephemeral** – A plant that completes its reproductive cycle early in the growing season, typically before or during the period in which trees leaf out; such species usually die back and become dormant during summer months when habitats are characterized by high temperatures and deep shade (Nelson, 2005).

  - **Trees** – Single-stemmed woody plants generally > 15 feet in height at maturity under good growing conditions (Nelson, 2005).

Appendix I: Native Plant Resources

Grow Native! (GN!)

http://grownative.org/

A native plant marketing and education program of the Missouri Prairie Foundation, GN! helps protect and restore biodiversity by increasing conservation awareness of native plants and their effective use in urban, suburban, and rural developed landscapes. Through collaboration with consumers, private industry, nonprofit organizations, and government agencies, GN! aims to significantly increase the demand and use of native plants in the lower Midwest.

- **Native plant database:** http://grownative.org/native-plant-info/plant-picker/
- **Directory of design consultants, contractors, native plant nurseries, and more:** http://grownative.org/resource-guide/

Missouri Botanical Garden

http://www.missouribotanicalgarden.org/

Founded in 1859, the Missouri Botanical Garden is the nation's oldest botanical garden in continuous operation and a National Historic Landmark. Its mission is, "To discover and share knowledge about plants and their environment in order to preserve and enrich life."

- ***The Flora of Missouri Project*** has been gathering information on the vascular plants growing outside of cultivation in Missouri since 1987. It is a collaboration between the Missouri Botanical Garden and the Missouri Department of Conservation. Among its products is the "Catalogue of the Flora of Missouri" (1990), available from the Missouri Botanical Garden Press. http://www.mobot.org/mobot/missouri/
- **Plant finder:** http://www.missouribotanicalgarden.org/plantfinder/plantfindersearch.aspx
- **Native landscaping manual:** http://www.missouribotanicalgarden.org/visit/family-of-attractions/shaw-nature-reserve/gardens-gardening-at-shaw-nature-reserve/native-landscaping-for-the-home-gardener/native-landscaping-manual.aspx
- **Stormwater management landscaping guide:** http://www.missouribotanicalgarden.org/visit/family-of-attractions/shaw-nature-reserve/gardens-gardening-at-shaw-nature-reserve/native-landscaping-for-professionals/stormwater-solutions.aspx
- **LILY database:** The 2,400-acre Shaw Nature Reserve in Gray Summit, Missouri, was established in 1925 to protect the Missouri Botanical Garden's plant collection from the smoke pollution of the 1920's. Although originally planned as a refuge, it has become a premier educational, research, and habitat restoration and reconstruction site. The LILY database includes information regarding what wildlife species are attracted to particular native plants (http://eol.org/collections/104829, 03/02/17).

Missouri Department of Conservation

Two books by Don Kurz, *Trees of Missouri and Shrubs and Woody Vines of Missouri,* map the native range of plants to the county level.

Missouri Native Plant Society

http://monativeplants.org/

Founded in 1979, the Missouri Native Plant Society (MONPS) is a nonprofit 501(c)(3) organization devoted to the enjoyment, preservation, conservation, restoration, and study of the flora native to Missouri.

- **Publications:** http://monativeplants.org/publications/

Missouri Native Seed Association

http://www.monativeseed.org/

The Missouri Native Seed Association is an organization of Missouri native seed producers and native seed collectors, state and federal government agencies and other partners. The organizers strive to create fair and prosperous marketing opportunities for Missouri native seed producers and collectors.

Appendix J: Stormwater Management Practices and Native Plants

Native plants, exclusively, are recommended for use in vegetated stormwater management practices due to their hardiness and the wide variety of functions they provide. The beneficial functions plants perform in the landscape are varied and complex and range from providing habitat for beneficial microbes to physically inhibiting the flow of stormwater. The ability of plants to intercept and hold rainwater and to decrease water flow with stalks, stems, branches, and foliage is one of the better-recognized functions of vegetation, but there are many others. In many stormwater systems, native vegetation provides habitat for amphibians, reptiles, birds, and insects. Native plants also take nutrients into their tissues, and their roots provide a substrate for growth of bacteria and algae, which are responsible for nutrient cycling and organic degradation. They contribute to the water cycle by returning water to the atmosphere through evapotranspiration. In stormwater management practices such as vegetated filter strips, the roots of native species increase soil stability (Shaw & Schmidt, 2003).

Vegetated stormwater management practices include (Shaw & Schmidt, 2003):

- **RETENTION** – Systems of extended detention designed to utilize the retention of water to improve water quality.
  - **Wet ponds** – Designed to retain a permanent pool of water. The primary function of wet ponds is sedimentation, which removes metals, nutrients, sediment and organics from stormwater. Wet ponds are suitable for sites with high nutrient loads. Benches are often incorporated into wet ponds to add areas for plant growth which aid in sedimentation, evapotranspiration and provide wildlife habitat.
- **EXTENDED STORAGE PONDS** – Similar to wet ponds but are generally designed to provide temporary storage of stormwater. As a result, extended storage ponds are designed to fill quickly and then slowly decrease in water level. Since both wet and extended storage ponds may experience significant water fluctuations after storms, plants must be chosen that can handle these conditions. Many urban wetlands and lakes that receive stormwater experience environmental conditions similar to wet ponds. Floodplain species may be well-suited for extended storage ponds that flood and then become dry. Plant species suitable for ponds can be grouped according to zones that change with elevation.

Figures 21a.–21e. Stormwater Management Practices Using Native Plants

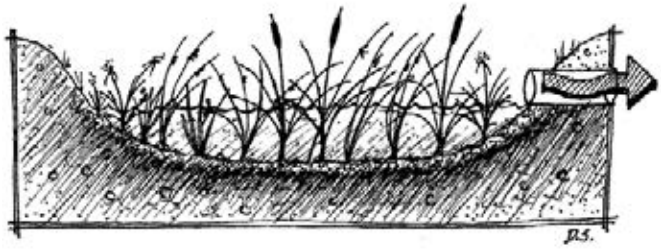


Figure 21a. Retention Basin

- **DETENTION** – Practices designed to filter and slow stormwater.
  - **Dry pond** (aka detention basin) – Designed to reduce stormwater velocity. Dry ponds typically empty completely between storms so they provide limited pollution removal. Plants in dry ponds must be able to handle flooding and subsequent dry conditions. Several floodplain-forest and wet-prairie species are adapted to these conditions.

Figure 21b. Detention Basin

  - **Dry swales** (aka ditches) – Open, vegetated channels that are designed to filter and slow stormwater. Check dams or berms are often used to hold water and settle pollutants. Grasses are generally chosen for dry swales because they have many stems to slow water flow.
- **INFILTRATION** – Practices designed to infiltrate stormwater into the soil and that often utilize plants to provide filtration and evapotranspiration.

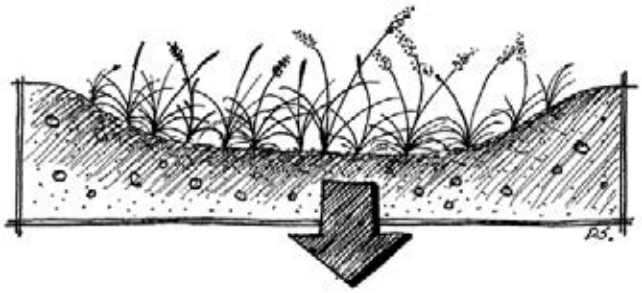


Figure 21c. Infiltration Practice

- **Rain gardens** – Small depressions that are ideal for residential and small commercial sites. They are most effective in areas where soils have good infiltration capacity. Since these systems are designed to drain relatively quickly, a large variety of shrubs, perennial grasses and flowers can be planted. Dry- and mesic-prairie species are well suited to the side slopes or rain gardens while wet meadow species are well suited to the lower portions.

- **Infiltration basin** – Like rain gardens, infiltration basins are designed to infiltrate stormwater relatively quickly, but they are larger and receive stormwater from a greater area via pipes or swales. Deep-rooted plants are most effective in these systems as they increase the rate of infiltration and prevent erosion.

- **WETLANDS** (constructed) – Practices designed for flood control and the removal of pollutants from stormwater.

  - **Stormwater wetland** – Like natural wetlands, stormwater wetlands have the capacity to improve water quality through microbial breakdown of pollutants, plant uptake, retention of stormwater, settling and adsorption. Sediment forebays and micropools are often designed as part of stormwater wetlands to prevent sediment from filling the wetland. Stormwater from large areas can be diverted into these wetlands. Stormwater wetlands will have zones and plants similar to wet ponds. They may have less fluctuation, though, and can maintain higher diversity.

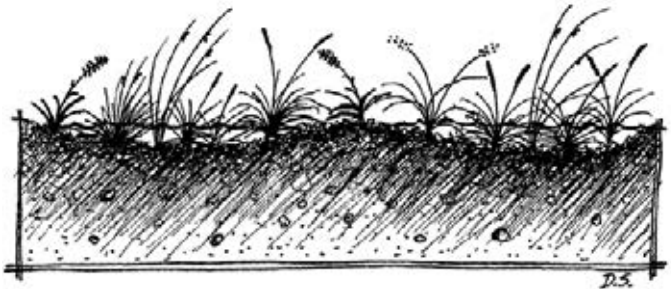


Figure 21d. Wetland

  - **Wet swales** – Consist of broad, open channels, used to temporarily store water. Wet swales are constructed on existing soils and are often at or slightly above the water table. As a result, they can incorporate a wide variety of wetland and wet-meadow shrub, grass and flower species. The primary purpose of wet swales is to improve water quality and to slow runoff velocity. Check dams and berms are often used to slow and retain water.

- **FILTRATION** – Practices that remain dry between storm events and are designed to remove pollutants from stormwater.

  - **Bioretention basins** – Like rain gardens and infiltration basins, bioretention basins rely on plants to function effectively. Bioretention basins can be designed for infiltration, but often have longer detention times and are often built with soils that have less infiltration capacity. Generally, the same species used for rain gardens and infiltration basins can be used for bioretention areas.

  - **Filter strips** – Filter strips are densely graded and uniformly vegetated areas designed to treat sheet flow. They differ from natural buffers in that they are generally designed specifically for pollutant removal. In filter strips, native vegetation slows runoff, collects sediment and allows some infiltration. Dry- and mesic-prairie species, especially deep-rooted grasses, are well suited for filter strips. They produce many stems that slow water flow and have deep roots that increase infiltration and absorption. Tree and shrub species can be planted among the prairie species also, but they will inhibit growth of the prairie species if the shade they produce is dense. Dense stands of vegetation are required for filter strips to function effectively. Excessive accumulation of sediment can affect plant growth and should be removed.

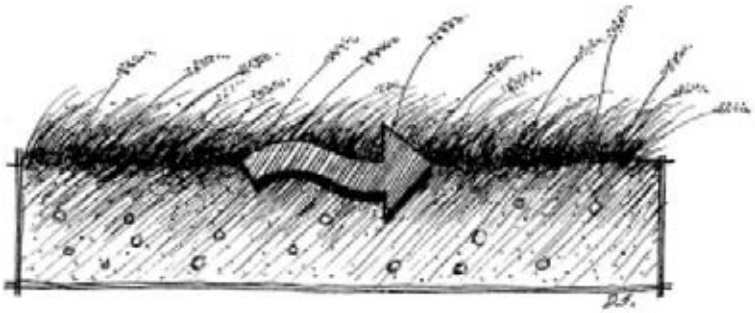


Figure 21e. Filtration Practice

Appendix K: Streams and Riparian Corridors

A **stream** is a body of water flowing in a natural surface channel. Flow may be continuous or only during wet periods (Indian Trail, NC as cited by Davidson & Dolnick, 2004). The **stream channel** consists of the area between both stream banks (Missouri Department of Conservation, 2014b). The active channel and the adjacent high-flow channel convey all non-flood stream flows and a portion of flow during flood events.

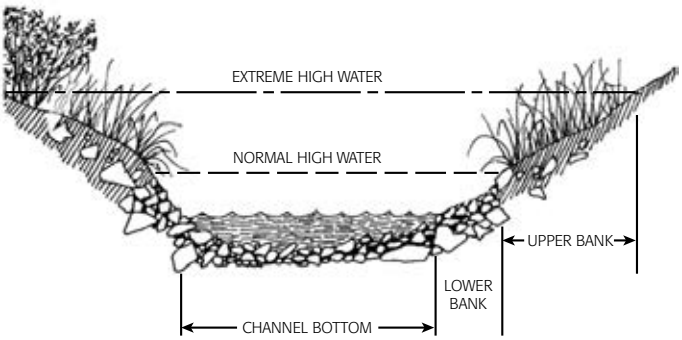


Figure 22. Stream Channel

Stream types are often classified by their flow, which is determined by their groundwater connection.

- **Perennial streams** – Flow year-round and have well-defined banks and natural channels; the water table is above the streambed (Missouri Department of Conservation, 2014b).
- **Intermittent streams** – Only flow during wet seasons but still have well-defined banks and natural channels. They may contain seasonal pools during dry periods; the water table is above the streambed at certain times but not always (Missouri Department of Conservation, 2014b).
- **Ephemeral streams** (aka stormwater courses or wet weather streams) – Only flow with runoff from rain or snowmelt. The water table never reaches the streambed of these streams (Missouri Department of Conservation, 2014b).
- **Losing stream** – A surface stream that loses a significant amount of its flow to the subsurface through bedrock openings. (Missouri Department of Natural Resources, n.d.-b)

A **riparian corridor** is the part of the floodplain closest to the channel and is greatly influenced by the stream. A well-vegetated riparian corridor dissipates the power and erosive force of overbank floods, captures sediment and woody debris carried by the stream during high flows and provides high quality habitats for a variety of wildlife species. Riparian corridors that are forested or covered with native, unmowed grasses not used for grazing can serve as a buffer for the stream by trapping sediment and pollutants carried in surface runoff before they enter the stream. The four most important water quality components affected by the riparian corridor are nutrient loading, sediment loading, water temperature, and dissolved oxygen levels in the water (Lobb & Femmer, n.d.).

Stream buffers to protect water quality for aquatic life – Based on an extensive review of the scientific literature for wildlife in the southeastern U.S. by the North Carolina Wildlife Commission, the following buffer widths are found to minimize negative impacts to aquatic species such as fish and mussels (North Carolina Wildlife Resources Commission, 2013):

- In subwatersheds without federally listed aquatic species:
  - » Preserve 100-foot native, forested buffers on each side of perennial streams
  - » Preserve 50-foot native, forested buffers on each side of intermittent streams.
- In subwatersheds that contain federally listed aquatic species:
  - » Preserve 200-foot native, forested buffers on each side of perennial streams.
  - » Preserve 100-foot native, forested buffers on each side of intermittent streams.

Riparian buffers for protection of biodiversity – Of the many species of wildlife dependent on riparian habitats for various life-history functions (e.g., breeding, foraging, overwintering), amphibians are far more threatened than either birds or mammals. This is because many amphibians require both aquatic and terrestrial habitats to complete their life cycles and therefore are especially susceptible to the loss and degradation of either habitat. Salamanders generally comprise the greatest biomass of any vertebrates in forested ecosystems and thus are of vital importance to the ecosystem as a whole because they consume invertebrates and serve as prey for other vertebrates (Crawford & Semlitsch, 2007).

To protect stream amphibians and other wildlife dependent on riparian areas, land managers and policy makers must consider conserving more than aquatic resources alone. Developing core terrestrial habitat estimates and buffer zone widths for wildlife populations is a critical first step in the conservation of many semiaquatic organisms and protecting biodiversity. Core habitat is important for population persistence and buffers around the core are necessary in order to reduce potential edge effects that can penetrate great distances into forested habitats (Crawford & Semlitsch, 2007).

Research focused on salamanders in southern Appalachian streams that was conducted by the Division of Biological Sciences at the University of Missouri found that a core terrestrial habitat of 140 feet and an overall buffer width of 300 feet was needed to protect all of the species included in that study (Crawford & Semlitsch, 2007).

Riparian corridor vegetation – The natural community type that a stream is flowing through is going to determine what plants are growing next to it. Broadly speaking, a riparian corridor will be vegetated with either grassland species or forestland species.

Planting schemes next to urban streams are informed by project goals and long-term management plans in addition to existing site conditions. Native plants specified for use within a riparian corridor or the adjacent floodplain may be called upon to perform an array of ecosystem services including:

- Enhance the resiliency of a community in the face of major storms
- Provide habitat for wildlife and pollinators
- Help a community meet its urban forestry goals including a minimum percentage of tree canopy coverage
- Remediate contaminated soils so that brownfields can be reclaimed as open space for public use
- Remove pollutants, including heat transferred from hot pavement, from rainwater runoff before it drains into the stream and degrades aquatic habitat
- Decrease flash flooding events through a reduction in the volume of rainwater runoff that enters the stream
- Stabilize streambanks damaged from high velocity rainwater runoff
- Protect soil from sediment erosion caused by high velocity rainwater runoff
    - » As a general rule, seedlings planted to provide erosion control should be spaced 3–6 feet apart (Missouri Department of Conservation, 2017).

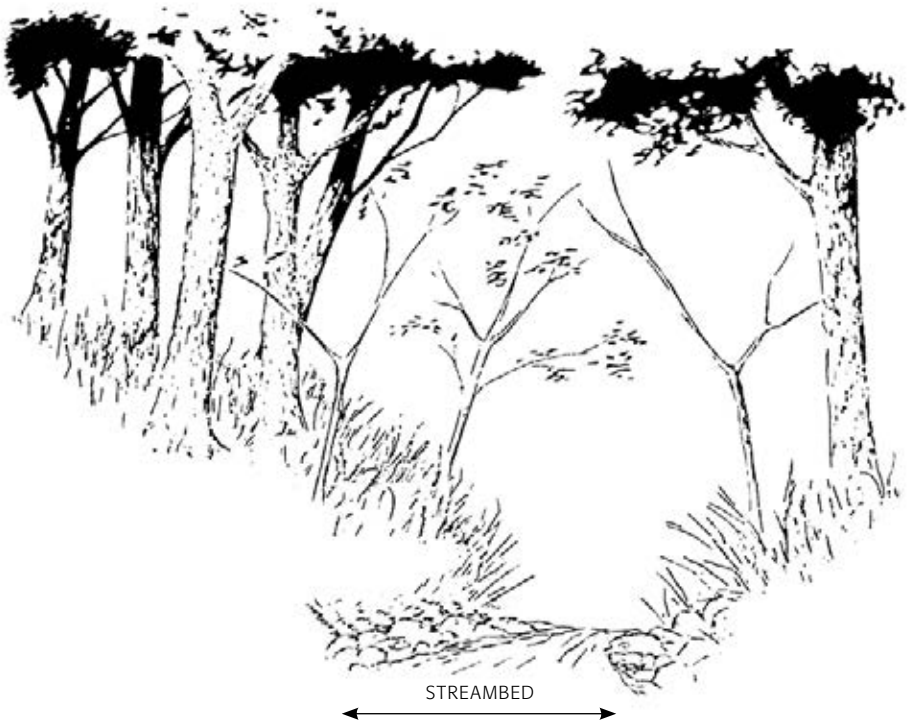


Figure 23. Riparian Corridor

Appendix L: Benefits of Street Trees
(Burden & Jackson, 2006)

Properly placed and spaced urban street trees:

1. **Increase motorized traffic and pedestrian safety.**

    A. Urban street trees create vertical walls that frame streets and define an edge, helping motorists guide their movement and assess their speed (leading to overall speed reductions and more appropriate urban traffic speed). This also creates safer walking environments as motorists are able to better distinguish between their environment and one shared with people.

    B. Trees call for planting strips, which further separate motorists from pedestrians and buildings.

2. **Increase security.** Trees create more pleasant walking environments, bringing about increased walking, talking, pride, care of place, association and therefore actual ownership and surveillance of homes, blocks, neighborhoods plazas, businesses and other civic spaces.

3. **Improve business.** Businesses on treescaped streets show 20 percent higher income streams, which is often the essential competitive edge needed for main street store success, versus competition from plaza discount stores.

4. **Lessen drainage infrastructure needs.** Trees absorb the first 30 percent of most precipitation through their leaf systems, allowing evaporation back into the atmosphere. This moisture never hits the ground. Another up to 30 percent of precipitation is absorbed into the ground, taken in by roots, and then absorbed and transpired back to the air. Stormwater runoff and flooding potential to urban properties is therefore reduced.

5. **Provide rain, sun, heat and skin protection.** For light or moderate rains, pedestrians find less need for rain protection. In cities with good tree coverage there is less need for chemical sun blocking agents. Temperature differentials of 5–15 degrees are felt when walking under tree canopied streets.

6. **Reduce harm from tailpipe emissions.** Increases in urban street temperatures that hover directly above asphalt where tailpipe emissions occur dramatically increase creation of harmful ozone. Tailpipe emissions also add to asthma and other health impacts. Impacts are reduced significantly from proximity to trees.

7. **Increase gas transformation efficiency.** Trees in street proximity absorb nine times more pollutants than more distant trees, converting harmful gases back into oxygen and other useful and natural gases.

8. **Lower urban air temperatures.** Asphalt and concrete pavements can increase urban temperatures 3–7 degrees. These temperature increases significantly impact energy costs to homeowners and consumers. A properly shaded neighborhood, mostly from urban street trees, can reduce energy bills for a household 15–35 percent.

9. **Soften the appearance of and make streets, parking lots, and blank walls more aesthetically pleasing.**

10. **Soften and screen vertical street features such as utility and light poles.**

11. **Reduce blood pressure and improve overall emotional and psychological health.**

12. **Reduce road rage.**

13. **Improve operations potential.** When properly positioned and maintained, the backdrop of street trees allow those features that should be dominant to be better seen, such as vital traffic regulatory signs.

14. **Add value to adjacent homes, businesses, and tax base.** Realtor-based estimates of street tree versus non-street tree comparable streets relate a $15–25,000 increase in home or business value.

15. **Provide a lawn for a splash and spray zone, storage of snow, driveway elevation transition and more.** Tree lawns are an essential part of the operational side of a street.

16. **Increase pavement life.** The shade of urban street trees can add from 40–60 percent more life to costly asphalt. This factor is based on reduced daily heating and cooling (expansion/contraction) of asphalt.

17. **Connect people to nature.**

Index of Terms

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