Trees Role in Stormwater Mitigation and Management

Planting Recommendations and Report
City of Ottawa, Kansas

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Introduction

Rock Creek, Nugent Creek, Skunk Run Creek and the Marais des Cygnes River flow through the City of Ottawa. Ottawa is in a natural basin with high groundwater levels that limit soil absorption during rain events. When severe or extended rainfall events cause streams and the river to overflow and the stormwater system exceeds capacity, flooding occurs. The frequency and severity of flooding has increased the past several years, causing tens of thousands of dollars in damage and inconvenience to city residents and visitors. This tree planting recommendation is intended to inform Ottawa residents, city staff and leadership of the stormwater benefits provided by trees and their role in stormwater mitigation and management.

In addition to flooding, contaminants flow from landscapes and impervious surfaces like roads, parking lots, sidewalks and roofs to local streams, creeks and rivers during rainfall events. When contaminants enter waterways, they can negatively affect drinking water quality, aquatic life and recreational opportunities. Trees provide critical ecological benefits when their canopies intercept rainfall and their roots intercept contaminants and hold soil in place.

The city has developed and implemented a comprehensive stormwater management program aimed towards improving water quality and lessening flooding occurrence. Ottawa is a 21-year Tree City USA community so utilizing trees as a tool in stormwater mitigation and management is a logical connection.

Trees Reduce Stormwater Runoff and Improve Hydrology

The ability of trees to intercept rainfall and reduce stormwater runoff is dependent on the tree canopy and bark texture. Trees help reduce runoff in multiple ways, according to the U.S. Forest Service's *Lower Midwest Community Tree Guide:*

- Leaves and branch surfaces intercept and store rainfall, thereby reducing runoff volumes and delaying the onset of peak flows.
- Roots reduce soil compaction, increasing the rate at which rainfall infiltrates soil and the capacity of soil to store water, reducing overland flow.
- Tree canopies reduce soil erosion by diminishing the impact of raindrops on barren surfaces.
- Transpiration through tree leaves reduces moisture levels in the soil, increasing the soil's capacity to store rainfall.

Intercepted rainfall is defined as rainfall that is stored temporarily on canopy leaf and bark surfaces. Rainfall that lands on leafy surfaces evaporates, drips from those surfaces and flows down stem surfaces to the ground. Saturation of tree surfaces generally occurs after 1 to 2 inches of rainfall. The interception benefit provided by trees is the amount of rainfall that does not reach the ground because it evaporates from the crown. When this happens, runoff volumes are reduced, and peak flow is delayed. When water movement is slowed, erosion of waterways is also reduced.

Water quality is protected by trees when runoff is reduced during small rainfall events, when most pollutants are washed off. Characteristics of tree crowns that influence rainfall interception are trunk, stem and surface areas; textures (coarse vs. smooth), gaps in the canopy, whether leaves are present or not (deciduous or evergreen) and the height and diameter of the tree. Large trees usually intercept more rainfall than small trees because larger surface areas evaporate at a higher rate. Good condition trees with full crowns intercept more rainfall than fair and poor trees with canopy gaps. Deciduous trees intercept more rainfall during the growing season than the dormant season whereas, evergreen trees intercept rainfall year-round. Where possible, a landscape with both deciduous and evergreen trees will yield increased stormwater benefits.

Threats to Ottawa's Community Forest

An urban tree canopy study conducted by the Kansas Forest Service indicates tree cover in Ottawa to be 25%. This estimate includes trees on private and public properties. An inventory in 2019 found 398 ash trees growing in the street right-of-way, in parks and Highland cemetery. The emerald ash borer is a future threat to these trees, of which approximately 5% (20) trees may be in good enough condition to warrant treatment. Additional threats to community trees are storms and climatic extremes such as drought and flooding. A national trend is that for every four trees removed, only one is replaced. Between 2017 and 2019, Ottawa planted 16 trees and removed 26 on the property it manages. That is better than the national average but still a net loss of canopy coverage in the community. With the anticipated loss of more than 400 ash trees throughout the city and impacts of storms, flooding and drought to community trees, canopy coverage in Ottawa will continue to decline and along with it, stormwater and ecological benefits provided to city residents and visitors. However, with a focus on the establishment and management of all trees on public properties and encouragement of proper tree planting and care on private properties, the anticipated loss of canopy coverage can be countered with an active planting and maintenance program in the years to come.

Trees Are The Answer

So says the bumper sticker. In the following pages, the important role of trees in stormwater mitigation and management is supported by data generated by the i-Tree Planting Calculator. To illustrate the capacity for new trees, maps from i-Tree Design are featured. Both software programs are science-based and peer-reviewed urban forestry analysis and benefit assessment tools that quantify the stormwater, air quality, energy conservation, aesthetic, social, economic and health benefits provided by trees.

In consultation with Stormwater Coordinator Carrie Deitz, three properties were selected to demonstrate stormwater benefits of new trees in Heritage and Kanza Parks and the streetscape on Main between 5th to 17th Streets. The two parks are original stormwater BMP projects along Skunk Run Creek and stormwater drains are abundant along this primary thoroughfare through Ottawa.

Data Results

It should be noted that the following maps are illustrations of where trees can be planted to intercept rainfall and provide benefits to people. More planting locations exist on each site. All ecosystem service values are based on the tree living 60 years in the landscape and reflect the trees being well cared for while they established and grew. Many of the species selected for each site can live much longer than 60 years with good care.

Summaries

Heritage Park - 67 New Trees

- Gallons Rainfall Interception = 3,858,529
- Gallons Avoided Runoff = 382,291.80
- Value Avoided Runoff = $3,416.16

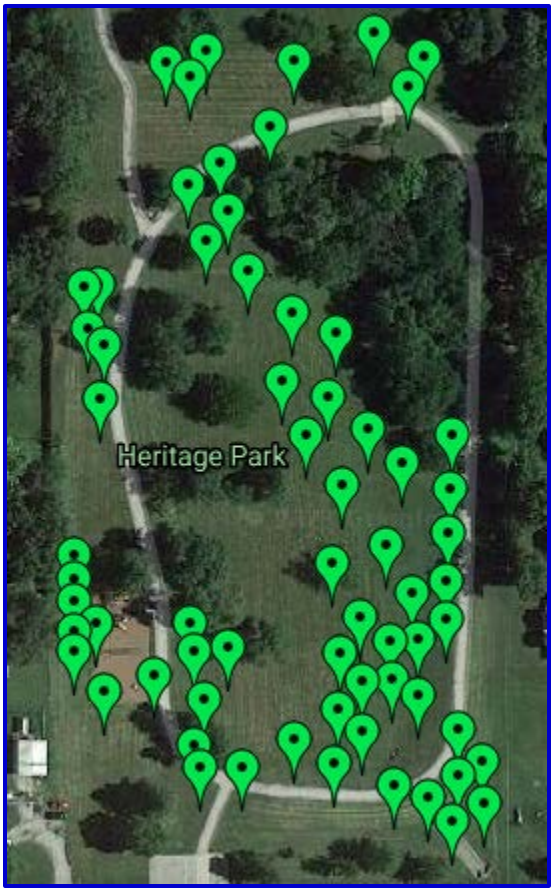
Kanza Park – 330 New Trees

- Gallons Rainfall Interception = 20,351,926.70
- Gallons Avoided Runoff = 2,016,410.30
- Value Avoided Runoff = $18,018.64

Main Street, 5th to 17th Street – 198 New Trees

- Gallons Rainfall Interception = 13,570,021.20
- Gallons Avoided Runoff = 1,344,478.70
- Value Avoided Runoff = $12,014.29

Heritage Park – 67 New Trees



Trees selected for planting in Heritage and Kanza Parks should be tolerant to wet soil conditions and withstand flooding to differing extents. Thirteen different species are plotted in the map to the left. The park contains several poor condition ash trees, so consideration was given for their replacement and shading around the playground, walking trail and park benches. While this recommendation only pertains to trees, shrubs and herbaceous plant materials can also intercept rainfall and avoid runoff and be added where needed.

Ecosystem Services of New Trees through 60 Years
**Gallons Rainfall Interception = 3,858,529*
**Gallons Avoided Runoff = 382,291.80*
**Value Avoided Runoff = $3,416.16*
*Pounds Carbon Dioxide Sequestered = 425,906.6
*Value Carbon Dioxide Sequestered = $9,905.26
*Pounds Air Pollutants Removed = 2,642
(Nitrogen Dioxide, Ozone, Sulfur Dioxide and Particulate Matter$_{2.5}$)

When trees are present where people live and work, they provide vital health benefits. Trees absorb the four common pollutants listed above, with the benefit to people being reduced incidences of asthma exacerbation, acute and chronic bronchitis, heart attack, death, respiratory symptoms and emergency room visits. Hospital admissions and days lost at work and school are also avoided.

Kanza Park – 330 New Trees

Twenty different species of trees are plotted in the map to the left. Most are large-growing deciduous trees that will produce large crowns to intercept more rainfall with Norway spruce and eastern redcedar the evergreen choices for year-round function. Consideration was also given for replacement planting and added shade along the walking trail and near the playground. Many more planting locations are available in this park than shown. The age of trees in this and Heritage Park are older than younger so creating uneven-aged stands is critical to have younger trees in place as older trees senesce.

Ecosystem Services of New Trees through 60 Years

**Gallons Rainfall Interception = 20,351,926.70*

**Gallons Avoided Runoff = 2,016,410.30*

**Value Avoided Runoff = $18,018.64*

*Pounds Carbon Dioxide Sequestered = 2,392,869.5

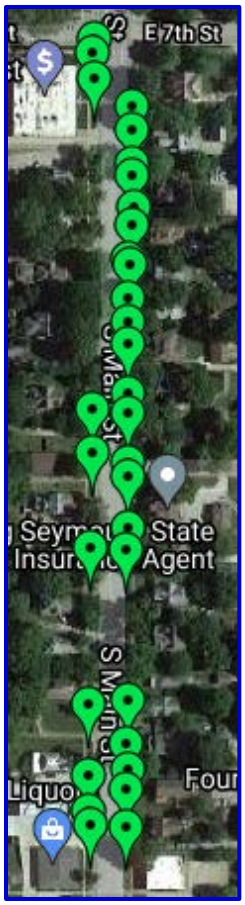
*Value Carbon Dioxide Sequestered = $55,650.75

*Pounds Air Pollutants Removed = 15,435.9

(Nitrogen Dioxide, Ozone, Sulfur Dioxide and Particulate Matter$_{2.5}$)

Main Street, 5th to 17th Street – 198 New Trees

5th to 7th St.

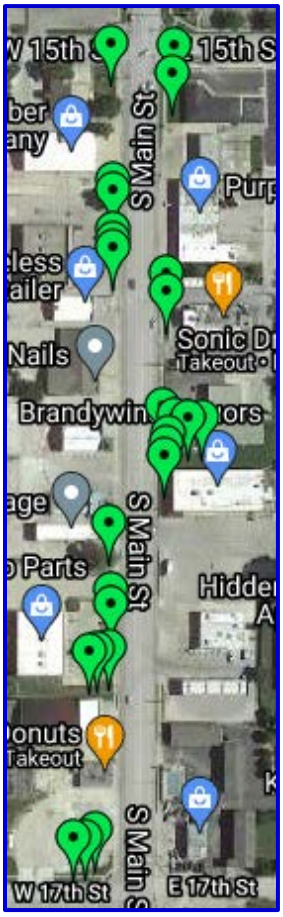


7th to 9th St.

9th to 11th St.

11th to 13th St.

13th to 15th St.



15th to 17th St.

Eighteen species of trees are plotted in these street maps. Most are large-growing deciduous trees but where space is more limited, medium and small-growing trees are utilized. There are many vacant planting locations to establish trees along Main Street. A windshield survey found more than 50 stumps, dying and poor condition trees that need to be removed, providing yet more opportunities to improve canopy coverage along Main Street. Most planting locations shown are publicly owned except at a few commercial locations, where a public/private partnership would be beneficial.

Ecosystem Services of New Trees through 60 Years

**Gallons Rainfall Interception = 13,570,021.20*
**Gallons Avoided Runoff = 1,344,478.70*
**Value Avoided Runoff = $12,014.29*
*Pounds Carbon Dioxide Sequestered = 1,756,015.20
*Value Carbon Dioxide Sequestered = $40,839.53
*Pounds Carbon Dioxide Avoided = 2,929,061.60
*Value Carbon Dioxide Avoided = $68,120.94
*kWh Electricity Saved = 933,153.7
*Value Electricity Saved = $121,496.62
*MMBtu Fuel Saved = 6.071.6
*Value Fuel Saved = $68,878.93
*Pounds Air Pollutants Removed = 9,166.6
(Nitrogen Dioxide, Ozone, Sulfur Dioxide and Particulate Matter$_{2.5}$)
*Pounds Air Pollutants Avoided = 4,733.2
(Nitrogen Dioxide, Sulfur Dioxide, Particulate Matter$_{2.5}$, VOC)

In addition to intercepting rainfall and reducing runoff to stormwater systems, trees along city streets provide many other benefits, especially to people. Trees absorb pollutants from tailpipe emissions and reduce residential energy costs. Trees cool heat islands created by unshaded roads, sidewalks and parking lots. Ozone levels are reduced when streets and parking lots are shaded. People walk and recreate more when the surrounding environment is shaded; temperatures between shaded and unshaded sidewalks can be as much as 15 degrees cooler. Incidences of skin cancer may be reduced where good canopy cover exists. Shaded business districts are more desirable to shoppers and more profitable for merchants. The list is long for how trees improve the community and benefit people when trees are properly placed, planted and well cared for along streets and by parking areas, walking trails, playgrounds, concrete areas as well as in parks and open spaces.

Numerous planting locations exist in residential and commercial areas in Ottawa.
Image Source: Google Maps

A feature of i-Tree Design is to model the growth of tree canopies over time. With this project, 60 years was the chosen time span of growth. As visible in the image to the left, just 28 trees between 15th and 17th Street can provide a significant amount of relief from heat, tailpipe emissions and stormwater runoff. Below is the model for Heritage Park.

Management Recommendations

It is acknowledged that this recommendation is very ambitious. Nonetheless, it is offered to illustrate the powerful ability of trees to help solve community issues. Trees will benefit other priority stormwater areas where rainfall interception, reduced runoff and erosion control is needed and provide for a healthy community. Partnerships with organizations that emphasize clean air and water, and community health could be beneficial to pursue.

Specifically, it is recommended to:

- Create short and long-term planting initiatives with correlating maintenance programs.
- Conduct a 100% inventory of street, park and cemetery trees and/or of vacant planting locations.
- Take back management of the street tree resource. Not all residents have the interest or financial means to properly maintain and remove trees. Inventory data from other cities that require the adjacent landowner to pay for maintenance of street trees show a poorer condition resource than cities that maintain their own street trees.
- Forge partnerships with commercial entities to establish trees on private properties to shade parking lots and other impervious areas.
- Encourage residents to establish trees to shade their impervious surfaces and reduce their energy costs.
- Undertake an educational program to promote the benefits of trees to the community, including the reduction of flooding and improvement of water quality.

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Resources:

USDA Forest Service, Pacific Southwest Research Station. *Lower Midwest Community Tree Guide*. 2009. Found online at https://www.fs.fed.us/psw/publications/documents/psw_gtr219/psw_gtr219.pdf

i-Tree Planting Calculator and i-Tree Design. Found at https://www.itreetools.org

Burden, D. *Urban Street Trees: 22 Benefits*. 2006. Found online at https://www.vibrantcitieslab.com/resources/22-benefits-of-street-trees

Vibrant Cities Lab. Multiple resources about how trees benefit people and communities. Found online at https://www.vibrantcitieslab.com