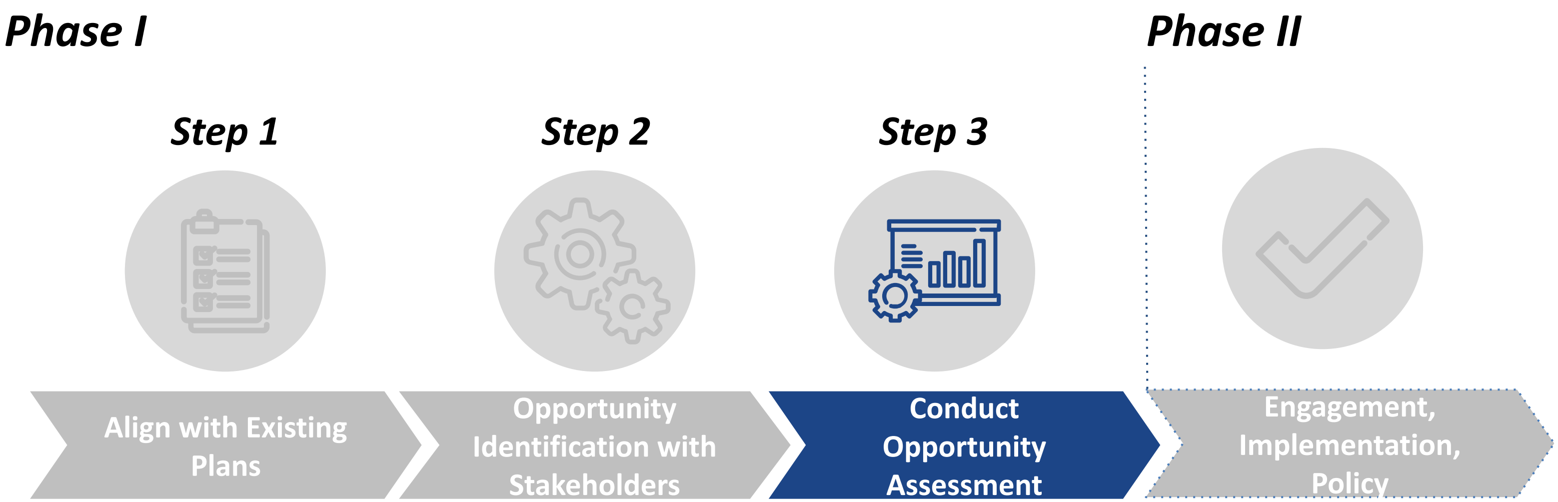
Managing Urban Landscapes for Climate Action

A Strategy Development Guide for Communities & Local Governments to Manage Urban Landscapes & Organic Resources to Achieve Climate Action & Community Resilience Objectives



THE TRUST FOR PUBLIC LAND

University of Colorado Boulder

URBAN DRAWDOWN INITIATIVE
Building Carbon Rich Communities

CITY OF BOULDER

How to Navigate this Strategy Development Guide

This strategy development guide is broken down into four sections - an **Introduction, and Steps 1-3 of Phase I**. In each of the steps, you will find **guidance, templates, and examples**.

Guides hyperlinked below:

Introduction

Phase I

Step 1

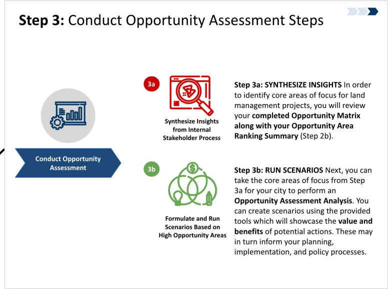
Step 2

Step 3

You are here

Phase II

Forthcoming



Step 3: Conduct Opportunity Assessment Steps

Conduct Opportunity Assessment

3a

Synthesize Insights from Internal Stakeholder Process

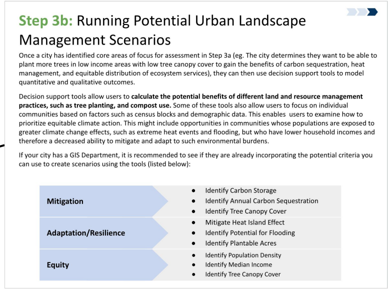
Step 3a: SYNTHESIZE INSIGHTS In order to identify core areas of focus for land management projects, you will review your **completed Opportunity Matrix along with your Opportunity Area Ranking Summary** (Step 2b).

3b

Formulate and Run Scenarios Based on High Opportunity Areas

Step 3b: RUN SCENARIOS Next, you can take the core areas of focus from Step 3a for your city to perform an **Opportunity Assessment Analysis**. You can create scenarios using the provided tools which will showcase the **value and benefits** of potential actions. These may in turn inform your planning, implementation, and policy processes.

Guidance



Step 3b: Running Potential Urban Landscape Management Scenarios

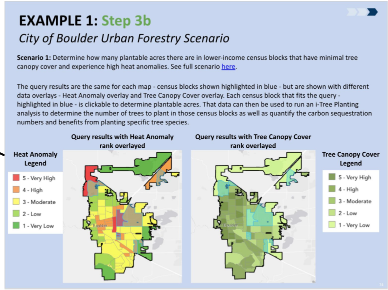
Once a city has identified core areas of focus for assessment in Step 3a (eg. The city determines they want to be able to plant more trees in low income areas with low tree canopy cover to gain the benefits of carbon sequestration, heat management, and equitable distribution of ecosystem services), they can then use decision support tools to model quantitative and qualitative outcomes.

Decision support tools allow users to **calculate the potential benefits of different land and resource management practices, such as tree planting, and compost use.** Some of these tools also allow users to focus on individual communities based on factors such as census blocks and demographic data. This enables users to examine how to prioritize equitable climate action. This might include opportunities in communities whose populations are exposed to greater climate change effects, such as extreme heat events and flooding, but who have lower household incomes and therefore a decreased ability to mitigate and adapt to such environmental burdens.

If your city has a GIS Department, it is recommended to see if they are already incorporating the potential criteria you can use to create scenarios using the tools (listed below):

Mitigation	• Identify Carbon Storage • Identify Annual Carbon Sequestration • Identify Tree Canopy Cover
Adaptation/Resilience	• Mitigate Heat Island Effect • Identify Potential for Flooding • Identify Plantable Acres
Equity	• Identify Population Density • Identify Median Income • Identify Tree Canopy Cover

Templates



EXAMPLE 1: Step 3b

City of Boulder Urban Forestry Scenario

Scenario 1: Determine how many plantable acres there are in lower-income census blocks that have minimal tree canopy cover and experience high heat anomalies. See full scenario here.

The query results are the same for each map - census blocks shown highlighted in blue - but are shown with different data overlays - Heat Anomaly overlay and Tree Canopy Cover overlay. Each census block that fits the query - highlighted in blue - is clickable to determine plantable acres. That data can then be used to run an i-Tree Planting analysis to determine the number of trees to plant in those census blocks as well as quantify the carbon sequestration numbers and benefits from planting specific tree species.

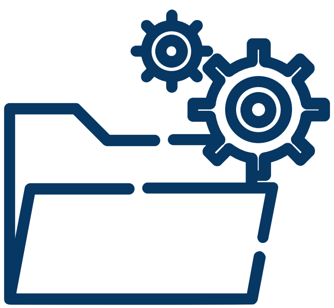
Examples

URBAN DRAWDOWN INITIATIVE

Download Templates Before Proceeding

This opportunity discovery process relies on the use of tools and tables that you may want to fill in or reference as you go along.

All templates referenced in this guide exist on a Google Sheet for you to access and save. There will also be links to the templates throughout this document.



To work in **Google Drive** (recommended):

Click File -> Make a Copy

To work in **Excel**:

Click File -> Download -> Microsoft Excel (.xlsx)

NOTE:

The Introduction to this guide presents a framework (right) for thinking about ecosystems-based climate action. If you have not reviewed the introduction, we suggest that you take a moment to familiarize yourself with the framework as it will make it easier to follow the pages and instructions that follow.

URBAN DRAWDOWN INITIATIVE

Step 3: Conduct Opportunity Assessment

Conduct Opportunity Assessment

QUANTITATIVE AND QUALITATIVE BENEFITS This opportunity assessment is a first order analysis that demonstrates the possible carbon mitigation, adaptation & resilience, and equity benefits that urban landscape management practices can bring to a city.

These benefits include but are not limited to:

- Approximate total of carbon dioxide sequestered and avoided
- Approximate value of ecosystem services provided
- Additional qualitative equity benefits derived within the community

FIRST ORDER ANALYSIS This is not a comprehensive or granular understanding of all benefits but rather **first order estimates** that will inform the efforts of a deeper dive into project planning. The purpose of this analysis is to provide cities and relevant stakeholders the ability to investigate current and future urban landscape management opportunities.

Step 3: Conduct Opportunity Assessment Steps

Conduct Opportunity Assessment

3a

Synthesize Insights from Internal Stakeholder Process

Step 3a: SYNTHESIZE INSIGHTS In order to identify core areas of focus for land management projects, you will review your **completed Opportunity Matrix along with your Opportunity Area Ranking Summary** (Step 2b).

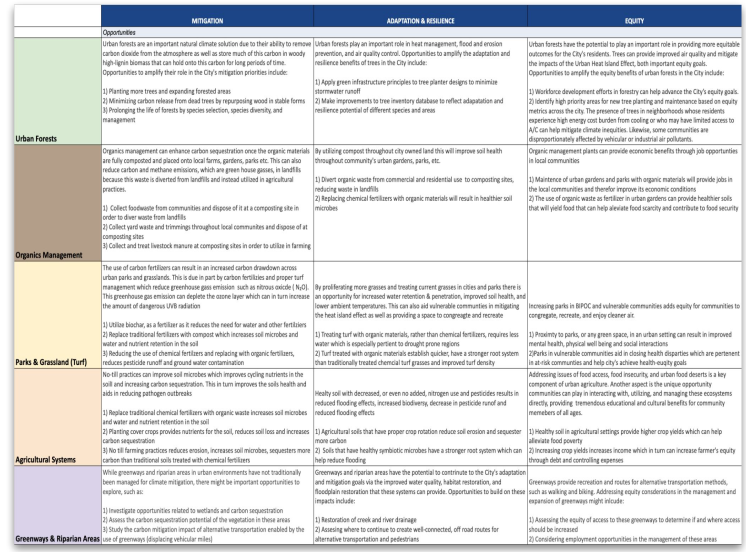
3b

Formulate and Run Scenarios Based on High Opportunity Areas

Step 3b: RUN SCENARIOS Next, you can use the core areas of focus from Step 3a for your city to perform an **Opportunity Assessment Analysis**. You can create scenarios using the provided tools which will showcase the **value and benefits** of potential actions. These may in turn inform your planning, implementation, and policy processes (Phase II).

Step 3a: Identify Core Areas of Focus for Assessment

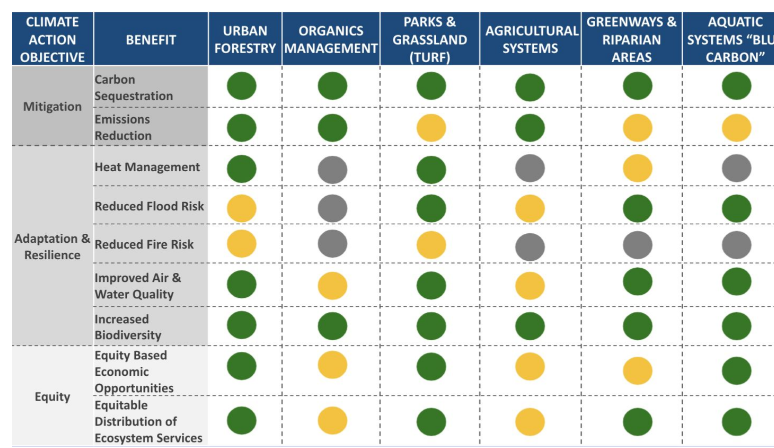
Throughout this step, you can use various tools to conduct a **first-order analysis of the benefits that your municipality might be able to capture from different land and resource management practices.** To initiate this next level of assessment, it is important to distill insights from the Draft Opportunity Matrix and the Ranking exercise from Step 2. To begin, you may consider answering the following questions to prime your thinking:



	MITIGATION	ADAPTATION & RESILIENCE	EQUITY
	Opportunities		
Urban Forests	Urban forests are an important natural climate solution due to their ability to remove carbon dioxide from the atmosphere as well as store much of this carbon in woody high-lignin biomass that can hold onto this carbon for long periods of time. Opportunities to amplify their role in the City's mitigation priorities include: 1) Planting more trees and expanding forested areas 2) Minimizing carbon release from dead trees by repurposing wood in stable forms 3) Prolonging the life of forests by species selection, species diversity, and management	Urban forests play an important role in heat management, flood and erosion prevention, and air quality control. Opportunities to amplify the adaptation and resilience benefits of trees in the City include: 1) Apply green infrastructure principles to tree planter designs to minimize stormwater runoff 2) Make improvements to tree inventory database to reflect adapatation and resilience potential of different species and areas	Urban forests have the potential to play an important role in providing more equitable outcomes for the City's residents. Trees can provide improved air quality and mitigate the impacts of the Urban Heat Island Effect, both important equity goals. Opportunities to amplify the equity benefits of urban forests in the City include: 1) Workforce development efforts in forestry can help advance the City's equity goals. 2) Identify high priority areas for new tree planting and maintenance based on equity metrics across the city. The presence of trees in neighborhoods whose residents experience high energy cost burden from cooling or who may have limited access to A/C can help mitigate climate inequities. Likewise, some communities are disproportionately affected by vehicular or industrial air pollutants.
Organics Management	Organics management can enhance carbon sequestration once the organic materials are fully composted and placed onto local farms, gardens, parks etc. This can also reduce carbon and methane emissions, which are green house gasses, in landfills because this waste is diverted from landfills and instead utilized in agricultural practices. 1) Collect foodwaste from communities and dispose of it at a composting site in order to diver waste from landfills 2) Collect yard waste and trimmings throughout local communites and dispose of at composting sites 3) Collect and treat livestock manure at composting sites in order to utilize in farming	By utilizing compost throughout city owned land this will improve soil health throughout community's urban gardens, parks, etc. 1) Divert organic waste from commercial and residential use to composting sites, reducing waste in landfills 2) Replacing chemical fertilizers with organic materials will result in healthier soil microbes	Organic management plants can provide economic benefits through job opportunties in local communities 1) Maintence of urban gardens and parks with organic materials will provide jobs in the local communities and therefor improve its economic conditions 2) The use of organic waste as fertilizer in urban gardens can provide healthier soils that will yield food that can help aleviate food scarcity and contribute to food security
Parks & Grassland (Turf)	The use of carbon fertilizers can result in an increased carbon drawdown across urban parks and grasslands. This is due in part by carbon fertilizies and proper turf management which reduce greenhouse gass emission such as nitrous oxicde (N_2O). This greenhouse gas emission can deplete the ozone layer which can in turn increase the amount of dangerous UVB radiation 1) Utilize biochar, as a fertilizer as it reduces the need for water and other fertilziers 2) Replace traditional fertilizers with compost which increases soil microbes and water and nutrient retention in the soil 3) Reducing the use of chemical fertilzers and replacing with organic fertilizers, reduces pesticide runoff and ground water contamination	By proliferating more grasses and treating current grasses in cities and parks there is an opportunity for increased water retention & penetration, improved soil health, and lower ambient temperatures. This can also aid vulnerable communties in mitigating the heat island effect as well as providing a space to congreagte and recreate 1) Treating turf with organic materials, rather than chemical fertilizers, requires less water which is especially pertient to drought prone regions 2) Turf treated with organic materials establish quicker, have a stronger root system than traditionally treated chemcial turf grasses and improved turf density	Increasing parks in BIPOC and vulnerable communities adds equity for communities to congregate, recreate, and enjoy cleaner air. 1) Proximty to parks, or any green space, in an urban setting can result in improved mental health, physical well being and social interactions 2)Parks in vulnerable communities aid in closing health disparties which are pertenent in at-risk communties and help city's achieve health-euqity goals
Agricultural Systems	No-till practices can improve soil microbes which improves cycling nutrients in the soill and increasing carbon sequestration. This in turn improves the soils health and aids in reducing pathogen outbreaks 1) Replace traditional chemical fertilizers with organic waste increases soil microbes and water and nutrient retention in the soil 2) Planting cover crops provides nutrients for the soil, reduces soil loss and increases carbon sequestration 3) No till farming practices reduces erosion, increases soil microbes, sequesters more carbon than traditional soils treated with chemical fertilizers	Healty soil with decreased, or even no added, nitrogen use and pesticides results in reduced flooding effects, increased biodiversy, decrease in pesticide runof and reduced flooding effects 1) Agricultural soils that have proper crop rotation reduce soil erosion and sequester more carbon 2) Soils that have healthy symbiotic microbes have a stronger root system which can help reduce flooding	Addressing issues of food access, food insecurity, and urban food deserts is a key component of urban agriculture. Another aspect is the unique opportunity communities can play in interacting with, utilizing, and managing these ecosystems directly, providing tremendous educational and cultural benefits for community memebers of all ages. 1) Healthy soil in agricultural settings provide higher crop yields which can help alleviate food poverty 2) Increasing crop yields increases income which in turn can increase farmer's equity through debt and controlling expenses
Greenways & Riparian Areas	While greenways and riparian areas in urban environments have not traditionally been managed for climate mitigation, there might be important opportunities to explore, such as: 1) Investigate opportunities related to wetlands and carbon sequestration 2) Assess the carbon sequestration potential of the vegetation in these areas 3) Study the carbon mitigation impact of alternative transportation enabled by the use of greenways (displacing vehicular miles)	Greenways and riparian areas have the potential to contrinute to the City's adaptation and mitigation goals via the improved water quality, habitat restoration, and floodplain restoration that these systems can provide. Opportunities to build on these impacts include: 1) Restoration of creek and river drainage 2) Assesing where to continue to create well-connected, off road routes for alternative transportation and pedestrians	Greenways provide recreation and routes for alternative transportation methods, such as walking and biking. Addressing equity consderations in the management and expansion of greenways might inlcude: 1) Assessing the equity of access to these greenways to determine if and where access should be increased 2) Considering employment opportunities in the management of these areas

1. *In the **Opportunity Matrix**, which opportunities are the most clearly aligned with the city's existing policy and budget priorities, and have momentum for action?*

2. *In the **Ranking exercise**, what areas of ecosystem services or landscape/resource systems showed the most "high priority area" classification by participants?*



The following slides introduce the assessment tools and present opportunity scenarios that may serve as a jumping off point for your own assessment.

Step 3b: Running Potential Urban Landscape Management Scenarios

Once a city has identified core areas of focus for assessment in Step 3a (e.g., the city determines they want to be able to plant more trees in low-income areas with low tree canopy cover to gain the benefits of carbon sequestration, heat management, and equitable distribution of ecosystem services), they can then use decision support tools to model quantitative and qualitative outcomes. It is also advised to check-in with your city's GIS department if applicable as they may have data sets and tools that are directly applicable to urban landscape management.

Decision support tools, such as the ones introduced in the next page, allow users to **calculate the potential benefits of different land and resource management practices such as tree planting and compost use.** Some of these tools also allow users to focus on individual communities based on factors such as census blocks and demographic data. This enables users to examine how to prioritize equitable climate action. This might include opportunities in communities whose populations are exposed to greater climate change effects (eg. extreme heat events and flooding) but who have lower household incomes and therefore a decreased ability to mitigate and adapt to such environmental burdens.

Mitigation	• Identify Carbon Storage • Identify Annual Carbon Sequestration • Identify Tree Canopy Cover
Adaptation/Resilience	• Mitigate Heat Island Effect • Identify Potential for Flooding • Identify Plantable Acres
Equity	• Identify Population Density • Identify Median Income • Identify Tree Canopy Cover

Step 3b: Decision Support Tools Overview

The decision support tool created by the Urban Drawdown Initiative (UDI) and the Trust for Public Land (TPL), in combination with the i-Tree Planting tool (described below), allows users to **identify, analyze, and quantify carbon sequestration and storage as well as ecosystem service benefits** across areas of mitigation, adaptation & resilience, and equity. The features and applications of these tools are showcased in the following slides.

While not covered in this guide, the American Forest Tree Equity Tool allows for further exploration into **equity gaps and opportunities within cities in the U.S.** This includes data on tree canopy cover, temperatures, and demographic data that can guide tree planting projects.

i-Tree Planting provides data on **carbon sequestration and other forest canopy benefits from new tree planting projects**. This tool will be covered in greater detail in the coming slides.

i-Tree Landscape is a tool that shows **current tree canopy cover, carbon stocks, forest canopy benefits,** and other additional land use data for cities that are interested in exploring their current urban forest. **Note:** this tool is different from the i-Tree Planting tool.

The COMET Farm tool provides f**armers and ranchers with the ability to calculate their 'carbon footprint'** and determine ways to sequester more carbon through a greenhouse gas and carbon accounting system.

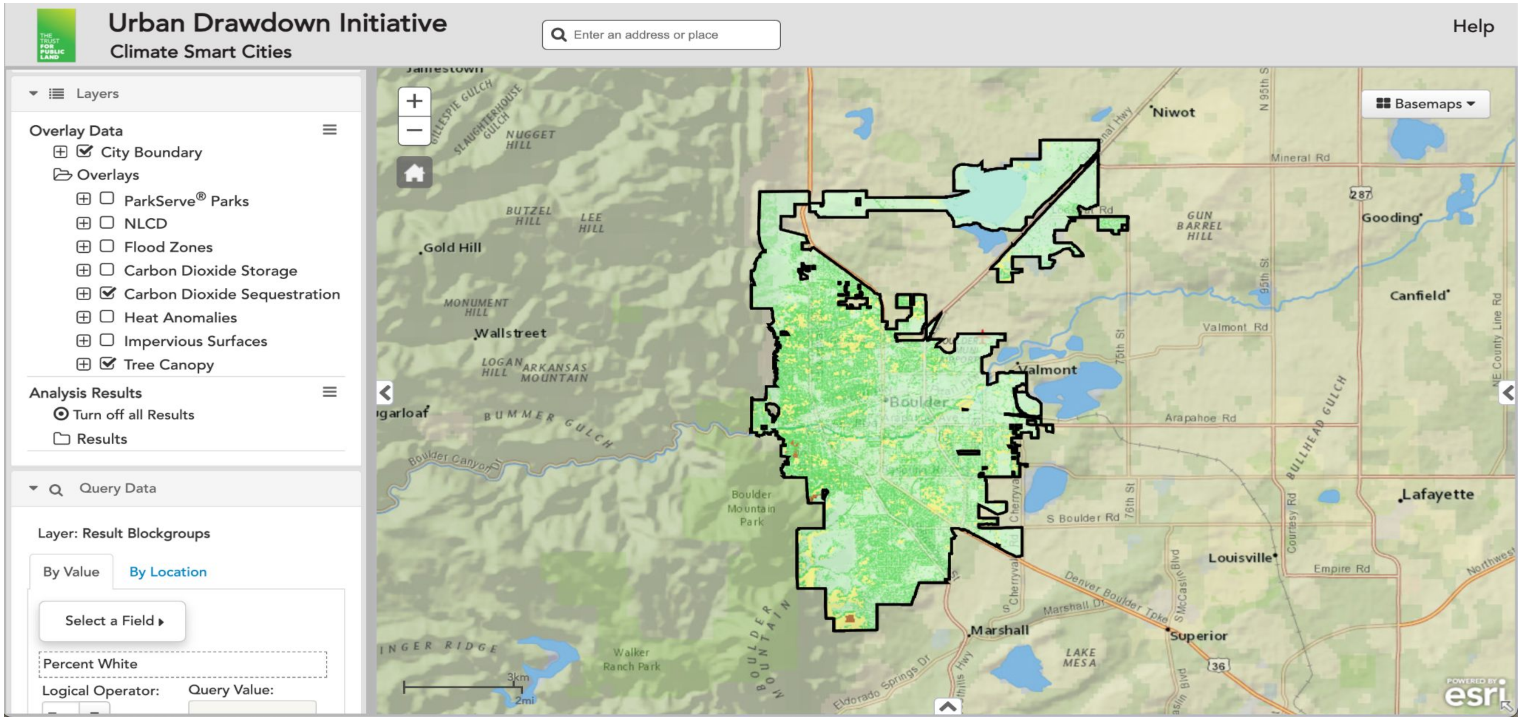
Step 3b: Decision Support Tools

UDI TPL Tool

The UDI TPL Tool is a geographic information system (GIS) tool that aids municipalities in specific carbon drawdown related matters. Some examples of data that can be used to visualize and query in order to analyze opportunities are: **demographic information, tree canopy information, flood zones, and heat islands**.

Comparing data with and across census blocks* can aid cities with identifying potential high priority areas that cities can invest time and resources into for the greatest impact for climate action. The tool also includes a carbon calculator to give baseline estimates of the **carbon sequestration potential of land management projects.**

If you are interested in having your city's data mapped and incorporated into the UDI TPL Tool, please contact Taj Schottland at taj.schottland@tpl.org.

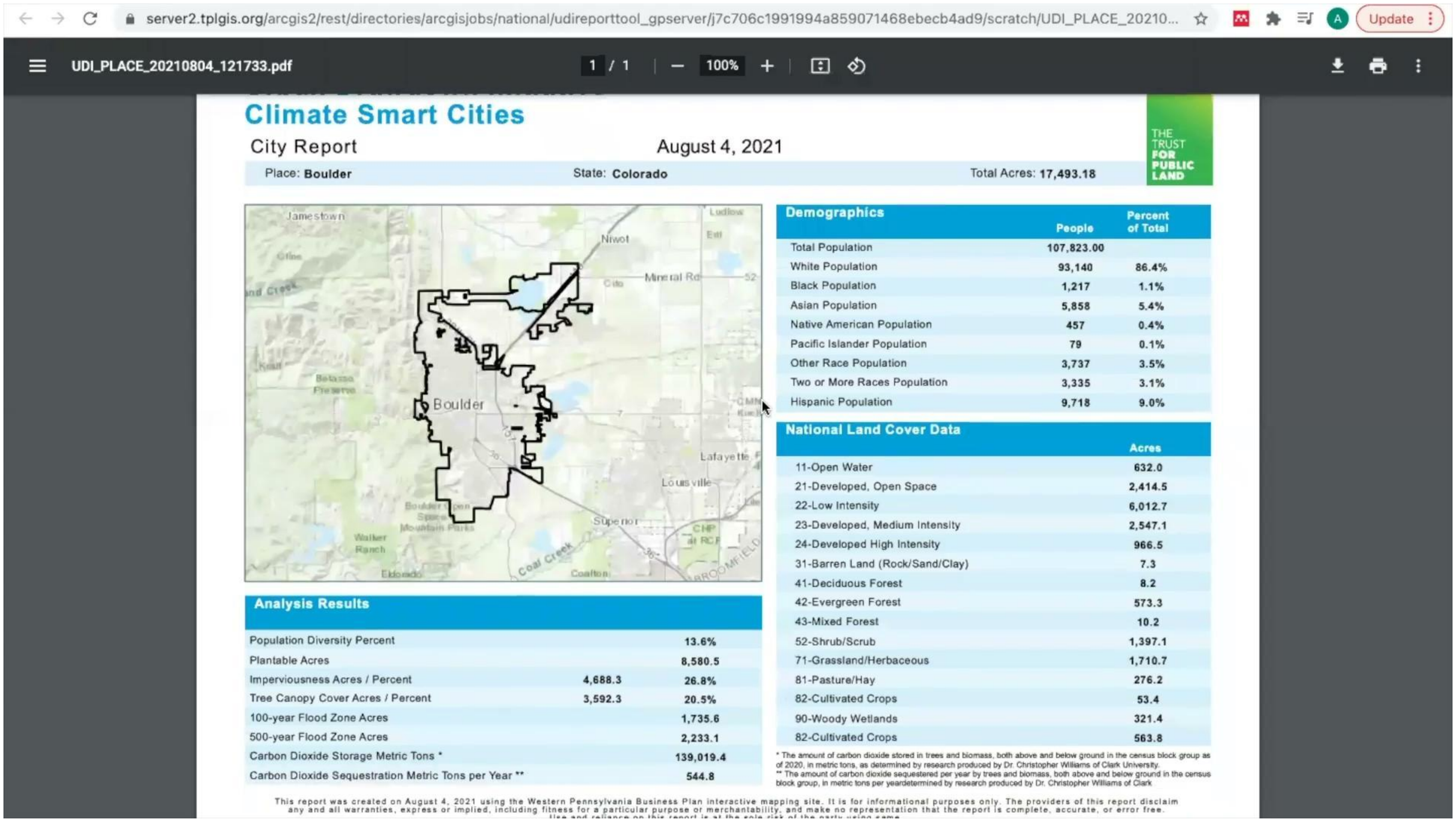


*Census data can have discrepancies. For example, income and race data may not be accurate based on respondent data.

Step 3b: Decision Support Tools

UDI TPL Tool

This video will briefly walk you through how to navigate the UDI TPL tool map layers and information, demographic information, and carbon calculator. A longer, more in depth instructional video will be available soon. Contact Taj Schottland at taj.schottland@tpl.org with any questions.



Climate Smart Cities

City Report August 4, 2021

Place: Boulder State: Colorado Total Acres: 17,493.18

Demographics	People	Percent of Total
Total Population	107,823.00	
White Population	93,140	86.4%
Black Population	1,217	1.1%
Asian Population	5,858	5.4%
Native American Population	457	0.4%
Pacific Islander Population	79	0.1%
Other Race Population	3,737	3.5%
Two or More Races Population	3,335	3.1%
Hispanic Population	9,718	9.0%

National Land Cover Data	Acres
11-Open Water	632.0
21-Developed, Open Space	2,414.5
22-Low Intensity	6,012.7
23-Developed, Medium Intensity	2,547.1
24-Developed High Intensity	966.5
31-Barren Land (Rock/Sand/Clay)	7.3
41-Deciduous Forest	8.2
42-Evergreen Forest	573.3
43-Mixed Forest	10.2
52-Shrub/Scrub	1,397.1
71-Grassland/Herbaceous	1,710.7
81-Pasture/Hay	276.2
82-Cultivated Crops	53.4
90-Woody Wetlands	321.4
82-Cultivated Crops	563.8

Analysis Results		
Population Diversity Percent		13.6%
Plantable Acres		8,580.5
Imperviousness Acres / Percent	4,688.3	26.8%
Tree Canopy Cover Acres / Percent	3,592.3	20.5%
100-year Flood Zone Acres		1,735.6
500-year Flood Zone Acres		2,233.1
Carbon Dioxide Storage Metric Tons *		139,019.4
Carbon Dioxide Sequestration Metric Tons per Year **		544.8

* The amount of carbon dioxide stored in trees and biomass, both above and below ground in the census block group as of 2020, in metric tons, as determined by research produced by Dr. Christopher Williams of Clark University.
** The amount of carbon dioxide sequestered per year by trees and biomass, both above and below ground in the census block group, in metric tons per yeardetermined by research produced by Dr. Christopher Williams of Clark

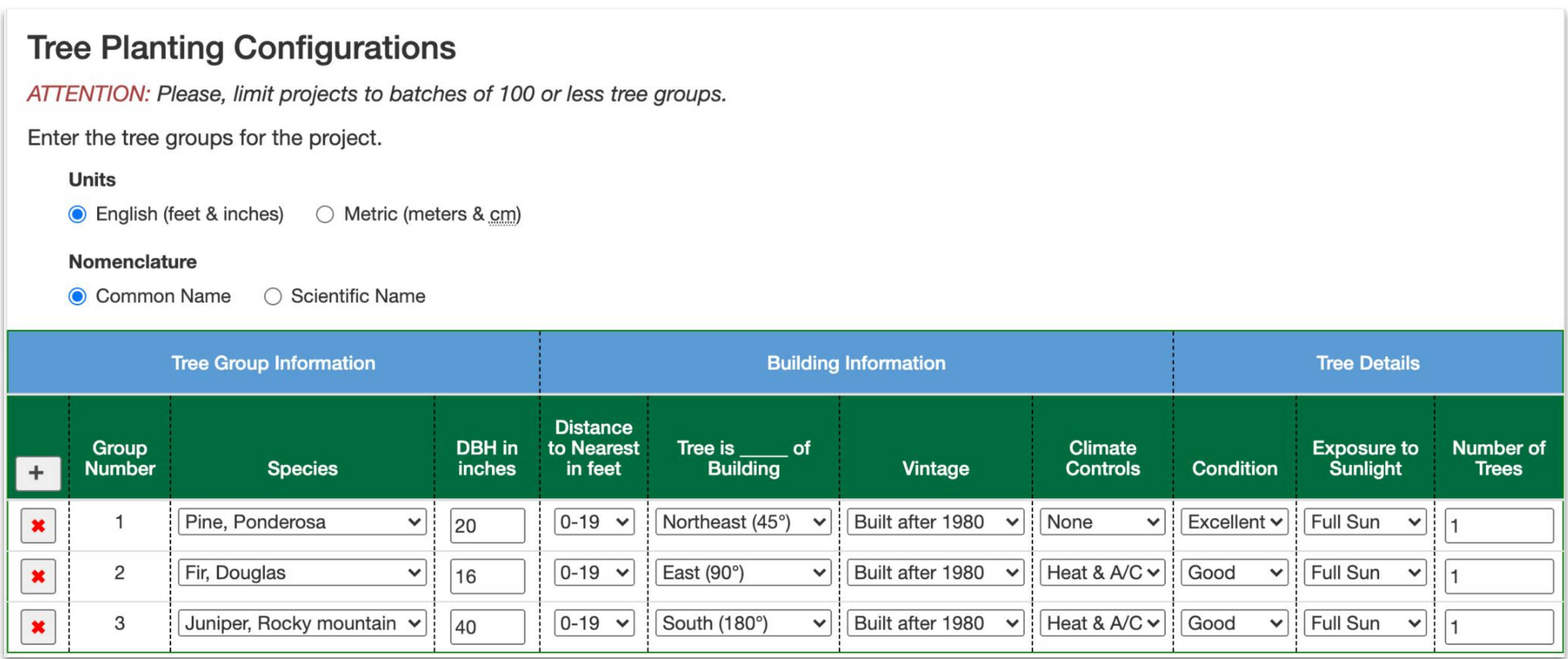
This report was created on August 4, 2021 using the Western Pennsylvania Business Plan interactive mapping site. It is for informational purposes only. The providers of this report disclaim any and all warranties, express or implied, including fitness for a particular purpose or merchantability, and make no representation that the report is complete, accurate, or error free.

Step 3b: Decision Support Tools

i-Tree Planting

i-Tree Planting provides municipalities with the ability to **quantify carbon and environmental benefits of urban and rural tree planting projects**. In i-Tree Planting, you can select tree species and the number of trees planted based on available acres for approximate opportunity benefits over the **lifetime** of the project. Upon establishing plantable acres in the UDI TPL tool, a **baseline number of the carbon sequestration potential of the tree project** can be determined by i-Tree Planting. If the UDI TPL tool is not available for your city, you can consult with your GIS department.

Cities can utilize the data gathered from i-Tree to set priorities for effective decision-making, demonstrate value, and set priorities around planting trees, which can be further explored in Phase II. Consult with your local forestry department for guidance on which species to plant and where.



Tree Planting Configurations

ATTENTION: Please, limit projects to batches of 100 or less tree groups.

Enter the tree groups for the project.

Units

(●) English (feet & inches) ( ) Metric (meters & cm)

Nomenclature

(●) Common Name ( ) Scientific Name

Tree Group Information				Building Information				Tree Details		
+	Group Number	Species	DBH in inches	Distance to Nearest in feet	Tree is ____ of Building	Vintage	Climate Controls	Condition	Exposure to Sunlight	Number of Trees
✖	1	Pine, Ponderosa	20	0-19	Northeast (45°)	Built after 1980	None	Excellent	Full Sun	1
✖	2	Fir, Douglas	16	0-19	East (90°)	Built after 1980	Heat & A/C	Good	Full Sun	1
✖	3	Juniper, Rocky mountain	40	0-19	South (180°)	Built after 1980	Heat & A/C	Good	Full Sun	1

Step 3b: Identify Additional Benefits

There are **additional benefits that come from the land and resource management practices** identified in this guide that are difficult to measure as a first-order analysis. The difficulty stems from the current limitations of available tools, limited research, and the inherent challenges associated with quantifying environmental, social, and cultural values of ecosystem services.

While difficult to measure, **these benefits can be better assessed, whether quantitatively and/or qualitatively, during the second phase of this process**. In that phase, cities would dive deeper into each of the opportunity areas identified. Additional existing and emerging resources and guides will be made available to dive deeper into those additional and vital benefits.

For this first phase, we have provided **examples of additional benefits associated with the scenarios presented** for the City of Boulder, CO, and the City of Lincoln, NE, below. Finally, we have included an annotated bibliography of pertinent peer-reviewed research related to the benefits of each of the land/resource management areas identified in this guide. Included here are additional resources that contain information on the additional benefits of some of these urban landscape management systems:

- The Blue Carbon Initiative includes resources and information about the ecosystem services of aquatic ecosystems along with information on how to better protect them.
- Vibrant Cities Lab is a resource with many different case studies and reports concerning urban forestry and ecosystem services as well as an urban forestry toolkit.
- US Forest Service Grasslands has some additional information regarding the ecosystem services of grasslands in the US.

EXAMPLE 1: Step 3b

City of Boulder: CO2 Sequestered by Equitable Urban Forestry Management Scenario

Scenario 1

Determine how many plantable acres there are in lower-income census blocks that have minimal tree canopy cover and experience high heat anomalies to determine carbon sequestration benefits and additional ecosystem services of planting more trees.

If a city wants to look at the mitigation, adaptation & resilience, and equity benefits of planting more trees, they may consider assessing the combined impact of the urban heat island effect and low tree canopy cover on low-income census blocks across the city's boundaries.

Cities can utilize the UDI TPL tool to overlay these queries to analyze areas of high opportunity for action and tree planting. Included in the following slides is an example scenario you can run in the UDI TPL decision support tool to quantify mitigation, adaptation & resilience, and equity benefits from urban forestry management. If you plant trees in specific census blocks, you can increase the carbon drawdown potential while mitigating heat anomalies in an equitable way.

The logic and steps behind this example scenario is further detailed, step by step, here.

URBAN DRAWDOWN INITIATIVE

EXAMPLE 1: Step 3b

City of Boulder: CO2 Sequestered by Equitable Urban Forestry Management Scenario

Scenario 1

Determine how many plantable acres there are in lower-income census blocks that have minimal tree canopy cover and experience high heat anomalies to determine carbon sequestration benefits and additional ecosystem services of planting more trees.

This video will illustrate this scenario using the TPL Decision Support tool. The video covers how to add query conditions, filter down to focus areas within the city, and gather additional data such as plantable acres in each census block. These data will then be used to project the carbon benefits of potential tree projects.

URBAN DRAWDOWN INITIATIVE

EXAMPLE 1: Step 3b

City of Boulder: CO_2 Sequestered by Equitable Urban Forestry Management Scenario

Scenario 1

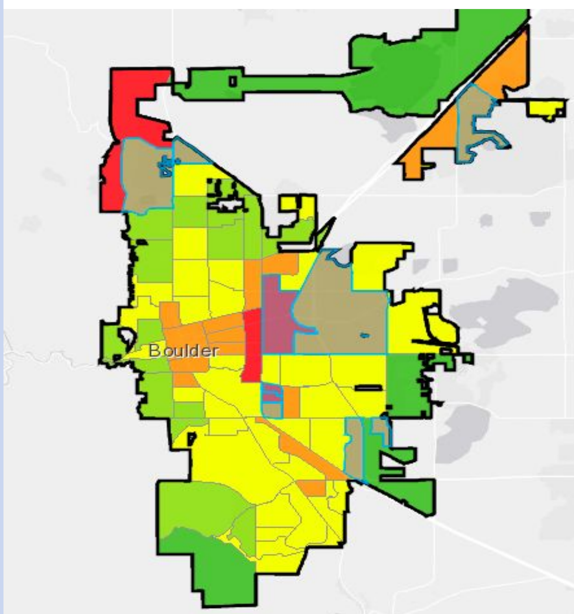
Determine how many plantable acres there are in lower-income census blocks that have minimal tree canopy cover and experience high heat anomalies to determine carbon sequestration benefits and additional ecosystem services of planting more trees.

The query results are the same for each map but are shown with different data overlays - Heat Anomaly overlay and Tree Canopy Cover overlay. Each census block that fits the query - highlighted in blue - is clickable to determine plantable acres. That data can then be used to run an i-Tree Planting analysis to determine the number of trees to plant in those census blocks as well as to quantify carbon sequestration and benefits from planting specific tree species.

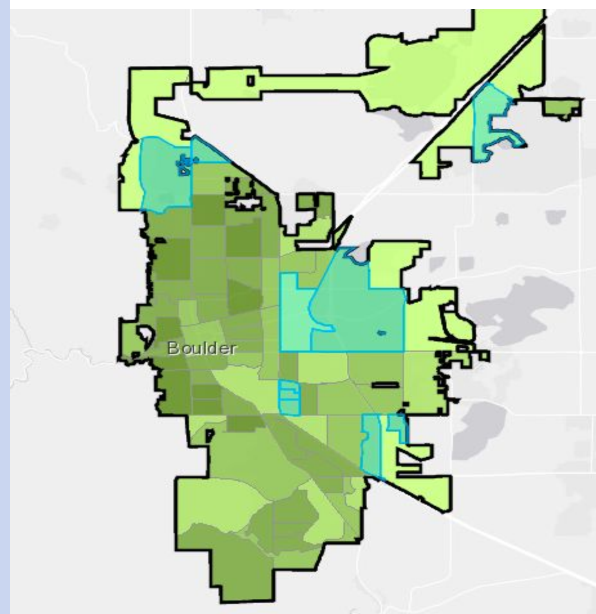
Heat Anomaly Legend

- 5 - Very High
- 4 - High
- 3 - Moderate
- 2 - Low
- 1 - Very Low

Query results with Heat Anomaly rank overlayed



Query results with Tree Canopy Cover rank overlayed



Tree Canopy Cover Legend

- 5 - Very High
- 4 - High
- 3 - Moderate
- 2 - Low
- 1 - Very Low

URBAN DRAWDOWN INITIATIVE

EXAMPLE 1: Step 3b

City of Boulder: CO2 Sequestered by Equitable Urban Forestry Management Scenario

Scenario 2

Determine ideal tree species along with number of trees to plant in order to quantify carbon sequestration and ecosystem service benefits. See full scenario here.

After narrowing down the priority census blocks, a city can estimate how many trees that can be planted and the associated carbon drawdown in tons from this project. These trees will help to address the heat island effect in more equitable areas, especially where median income is low but it is difficult to measure this cooling effect.

In this scenario, the plantable acres overlay was used to determine the plantable acres for each census block and added up. We are operating with an assumption of 25 trees per acre, however this is a somewhat conservative estimate and will be city-specific. We are also splitting up the trees into ten different species for diversity and resilience purposes. We utilized the City of Boulder's *Best Trees for Boulder* list to determine applicable species for this scenario.

1,016 Plantable Acres Over Ten Census Blocks × **25 Trees Per Plantable Acre*** = **25,400 TOTAL Trees Per Plantable Acre**

25,400 Total Trees for Project / **10 Tree Species** = **2,540 TOTAL Trees Per Species Per Plantable Acre**

*Assumption

EXAMPLE 1: Step 3b

City of Boulder: CO2 Sequestered by Equitable Urban Forestry Management Scenario

Scenario 2

Determine ideal tree species along with number of trees to plant in order to quantify carbon sequestration and ecosystem service benefits. See full scenario here.

Estimates of CO2 sequestered and CO2 avoided are shown in this sample report from i-Tree. Note the difference in numbers between species. These benefits become more apparent at scale. See the full scenario and table here.

Location		CO_2 Benefits			
Group Identifier	Tree Group Characteristics	CO_2 Avoided (pounds)	CO_2 Avoided ($)	CO_2 Sequestered (pounds)	CO_2 Sequestered ($)
1	• (2540.0) Maple, Sugar (Acer saccharum) at 1.0 inch DBH. • Planted 0-19 feet and north (0°) of buildings that were built post-1980 with heat and A/C. • Trees are in excellent condition and planted in full sun.	15,719,168.4	$365,579.41	3,137,581.6	$72,970.48
2	• (2540.0) Horsechestnut (Aesculus hippocastanum) at 1.0 inch DBH. • Planted 0-19 feet and north (0°) of buildings that were built post-1980 with heat and A/C. • Trees are in excellent condition and planted in full sun.	12,955,197.2	$301,297.96	5,972,301.4	$138,897.32
3	• (2540.0) Catalpa (Catalpa species) at 1.0 inch DBH. • Planted 0-19 feet and north (0°) of buildings that were built post-1980 with heat and A/C. • Trees are in excellent condition and planted in full sun.	9,242,391.6	$214,949.54	6,563,803.2	$152,653.83
4	• (2540.0) Honeylocust (Gleditsia triacanthos) at 1.0 inch DBH. • Planted 0-19 feet and north (0°) of buildings that were built post-1980 with heat and A/C. • Trees are in excellent condition and planted in full sun.	9,015,862.3	$209,681.17	6,795,752.7	$158,048.26
5	• (2540.0) Coffeetree, Kentucky (Gymnocladus dioicus) at 1.0 inch DBH. • Planted 0-19 feet and north (0°) of buildings that were built post-1980 with heat and A/C. • Trees are in excellent condition and planted in full sun.	8,548,105.0	$198,802.58	1,472,013.1	$34,234.49

URBAN DRAWDOWN INITIATIVE

EXAMPLE 1: Step 3b

City of Boulder: CO2 Sequestered by Equitable Urban Forestry Management Scenario

Below is a summarized table of the previous i-Tree Planting report. Note that the previous report included CO2 in pounds and this chart reflects CO2 sequestered in metric tons. These values are estimated by i-Tree to include total sequestration of each species over the tree lifetime of 40 years. The total CO2 sequestered (30,275.62 metric tons over 40 years) is the equivalent of taking almost 6,582 cars off the road for one year (1).

TREE SPECIES (2,450 TREES OF EACH SPECIES)	CO2 SEQUESTERED (METRIC TONS)
Sugar Maple	1,423.18
Horsechestnut	2,708.99
Catalpa	2,977.29
Honeylocust	3,082.50
Kentucky Coffeetree	667.69
English Oak	3,641.62
Sweetgum	2,590.26
Tulip Tree	3,140.01
Northern Hackberry	587.16
Ohio Buckeye	9,456.92
TOTAL CO2 SEQUESTRATION OVER 40 YEARS	**30,275.62 METRIC TONS**

Source: (1) EPA: Greenhouse Gas Emissions from a Typical Passenger Vehicle

EXAMPLE 1: Step 3b

City of Boulder: Perspective Additional Benefits from Scenario

ADDITIONAL BENEFITS			
QUANTITATIVE BENEFITS		QUALITATIVE BENEFITS	
Economic value	The **economic value** of sequestering carbon through this project is **$1,552,314.67.** Source: i-Tree Planting	**Erosion Prevented**	Planting trees **holds soil in place** where otherwise the soil would be susceptible to erosion.
Electricity Saved	By planting trees near buildings, Boulder can **save up to 57,024,868.90 kWh** over 40 years. Source: i-Tree Planting	**Temperature Moderation**	Tree canopy can help **mitigate the heat island effect** by lowering temperatures by 2-9 degrees fahrenheit in the summer months. Source: EPA
Rainfall Intercepted	This new tree canopy can **intercept 455,508,423.60 gallons** of rainfall over the course of 40 years. Source: i-Tree Planting	**Cultural & Aesthetic Values**	Trees provide communities with **increased** aesthetic value.
Pollution Removed	This tree project will remove **256,984.60 pounds of Ozone, 46,607.90 pounds of NO2, and 4,525.10 pounds of PM2.5** from the air. Source: i-Tree Planting	**Pollination & Biological Pest Management**	Trees provides **plant-pollinator interactions, pollinator nutrition, and overall performance.**

URBAN DRAWDOWN INITIATIVE

EXAMPLE 2: Step 3b

City of Lincoln: CO2 Emissions Avoided by Diverting Organic Waste From Landfill to Compost Scenario

If a city wants to look at possible benefits of diverting organic waste from a landfill to compost, the Carbon Calculator within the UDI TPL decision support tool can help to estimate potential carbon sequestration based on different land management practices and treatments available. See full scenario here.

Scenario 1

Use the UDI TPL decision support tool Carbon Calculator to determine carbon emissions avoided by diverting 80% of organic waste from landfill to commercial composting.

2018 Organic Waste Characterization Lincoln, NE	
Food Waste	33,070 Tons
Yard/Wood Waste and Compostable Paper Products	26,596 Tons
Organic Waste Total	**59,667 Tons**
- Amount of Compost if 100% Organic Waste is Diverted*	**29,833.50 Tons**
80% of Total Organic Waste	**47,733.60 Tons**
- Amount of Compost if 80% Organic Waste is Diverted*	**23,866.80 Tons**
*Assuming organic waste loses half of its mass when composted	

URBAN DRAWDOWN INITIATIVE

EXAMPLE 2: Step 3b

City of Lincoln: CO2 Emissions Avoided by Diverting Organic Waste From Landfill to Compost Scenario

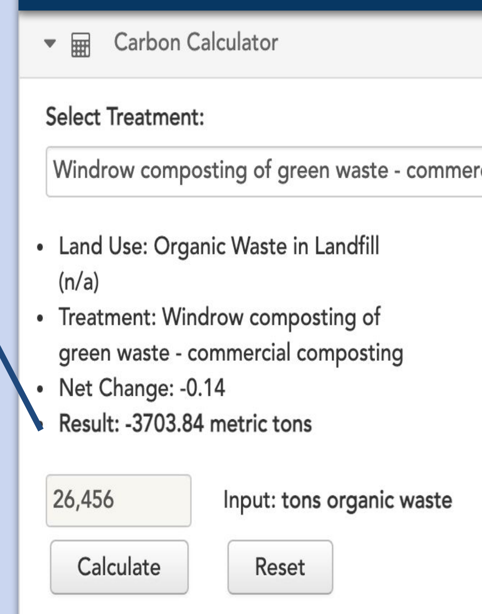
Scenario 1

Use the UDI TPL decision support tool Carbon Calculator to determine carbon emissions avoided by diverting 80% of organic waste from landfill to commercial composting. See full scenario here.

- *In the UDI TPL decision support tool, select Lincoln, NE as a location and open the Carbon Calculator*
- *Under Select Land Use, choose Organic Waste in Landfill (n/a)*
- *Under Select Treatment, choose either Aerated Static Pile Composting of Green Waste- Commercial Composting or Windrow Composting of Green Waste - Commercial Composting*
- *Enter the tons of organic waste as Input and click Calculate*

WASTE TYPE	QUANTITY (METRIC TONS)	COMPOSTING METHOD COMPARISON - WINDROW VS AERATED STATIC PILES	CO_2e EMISSIONS AVOIDED
Food Waste	33,070 tons*.8 = 26,456 metric tons	Windrow- Commercial Composting	3,703.84 metric tons
		Aerated Static Piles- Commercial Composting	4,762.08 metric tons
Yard/Wood Waste	26,596 tons*.8 = 21,276.8 metric tons	Windrow- Commercial Composting	2,978.75 metric tons
		Aerated Static Piles- Commercial Composting	3,829.82 metric tons
Total	**59,667 tons* .8 = 47,733.60 metric tons**	**Windrow - Commercial Composting**	**6,682.59 metric tons**
		Aerated Static Piles - Commercial Composting	**8,591.90 metric tons**

The carbon calculator estimates CO2e emissions avoided.



EXAMPLE 2: Step 3b

City of Lincoln: CO2 Emissions Avoided by Diverting Organic Waste From Landfill to Compost Scenario

Scenario 2

Use the UDI TPL decision support tool Carbon Calculator to determine the CO_2 emissions avoided by replacing synthetic fertilizer on the city's turfgrass with locally produced compost where possible. See full scenario here..

First, determine the acres of potential turfgrass. In this scenario, we used an intersection of Lincoln's ParkServe Data and National Land Cover Data in the UDI TPL decision support tool.

Next, determine the acres of potential fertilized turfgrass. In this scenario, we assumed 10% of potential turfgrass in Lincoln, NE is fertilized.

Potential Turfgrass in Lincoln, NE*	3,392 Acres
Potential Fertilized Turfgrass in Lincoln, NE**	339.2 Acres
* Determined by Intersection of Lincoln's ParkServe Data and National Land Cover Data in UDI TPL Tool ** Assuming 10% of Potential Turfgrass is Fertilized	

URBAN DRAWDOWN INITIATIVE

EXAMPLE 2: Step 3b

City of Lincoln: CO2 Emissions Avoided by Diverting Organic Waste From Landfill to Compost Scenario

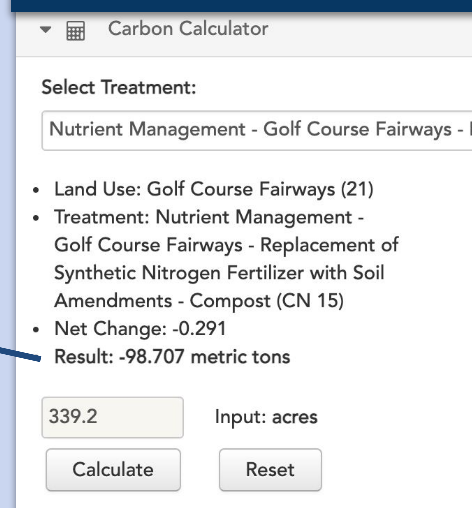
Scenario 2

Use the UDI TPL decision support tool Carbon Calculator to determine the CO2 emissions avoided by replacing synthetic fertilizer on the city's turfgrass with locally produced compost where possible. See full scenario here..

- *In the UDI TPL decision support tool, select Lincoln, NE as a location and open the Carbon Calculator*
- *Under Select Land Use, choose Developed, Open Space (21) in the form of Athletic Fields, Golf Course Fairways, or Golf Course Roughs*
- *Under Select Treatment, choose Nutrient Management - [Athletic Fields, Golf Course Fairways, or Golf Course Rough] - Replacement of Synthetic Nitrogen Fertilizer with Soil Amendments - Compost (CN 15)**
- *Enter the tons of organic waste as the Input and Calculate*
  **A C:N ratio of 10 indicated possible carbon emissions.*

LAND USE	ALTERNATIVE NUTRIENT MANAGEMENT TREATMENTS	AREA	CO2e EMISSIONS AVOIDED
Athletic Fields	Replacement of Synthetic Nitrogen Fertilizer with Soil Amendments – Compost (CN 15)	339.2 acres	201.82 metric tons
Golf Course Fairways	Replacement of Synthetic Nitrogen Fertilizer with Soil Amendments – Compost (CN 15)	339.2 acres	98.71 metric tons
Golf Course Rough	Replacement of Synthetic Nitrogen Fertilizer with Soil Amendments – Compost (CN 15)	339.2 acres	127.54 metric tons

The carbon calculator estimates CO2e emissions avoided.



URBAN DRAWDOWN INITIATIVE

EXAMPLE 2: Step 3b

City of Lincoln: Perspective Additional Benefits from Scenario

ADDITIONAL BENEFITS			
QUANTITATIVE BENEFITS		QUALITATIVE BENEFITS	
Climate Regulation and Resilience	**8,465.92 metric tons of avoided CO2e** by diverting organic waste from landfills where it emits GHGs. **98 to 201 metric tons of avoided CO2e** from replacing synthetic fertilizers with compost, therefore lowering nitrous oxide emissions.	**Biodiversity and Natural Habitat**	Healthy soils nurtured with compost can enable **growth of diverse plant species** that in turn can serve as habitat for other species.
Food Supply	The estimated **23,866.8 tons of compost created** would contribute to urban farming initiatives in Lincoln, which in turn provide nutritious local food for residents.	**Pollinator and Natural Pest Control**	Compost creates healthy soils that **greatly affect plant-pollinator interactions, pollinator nutrition, and overall performance**.
		Erosion Prevention	Soils fertilized with compost can have enhanced complex root systems of plants that **hold soil in place** where otherwise the soil would be susceptible to erosion.
		Education & Cognitive Development	Educating students and residents can help to **divert organic waste from landfills** to be composted by individuals and to build support for city-wide composting.

EXAMPLE 3: Step 3b

Long-Term Carbon Reduction Potential from Multiple Management Opportunities

A city may want to evaluate potential long-term benefits from multiple urban landscape and organic resource management opportunities related to carbon sequestration. The Trust for Public Land ran a scenario for the City of Lincoln, Nebraska (using the UDI TPL and i-Tree Planting decision support tools) that analyzed specific tree species, cultivated crop coverage, and grassland acres over the course of a **30 year period.** The purpose of this scenario was to see how much potential **CO2 could be sequestered** over the course of the project, which resulted in an estimated **1,364,106 metric tons of CO2** sequestered over 30 years. That is the equivalent of taking almost 296,545 cars off the road for one year (1).

Once you calculate how much carbon can be sequestered, it can help guide you in creating and implementing programs and policies that can **increase ecosystem services and sequester carbon**. This data informs the decisions of stakeholders and offers potential goals for the city.

Forest Carbon Benefits
884,176 metric tons of CO2 sequestered over 30 years

+

Cultivated Crops
341,990 metric tons of CO2 sequestered over 30 years

+

Grasslands
137,940 metric tons of CO2 sequestered over 30 years

=

1,364,106 metric tons of CO2 sequestered over 30 years

Source: (1) EPA: Greenhouse Gas Emissions from a Typical Passenger Vehicle

Next Steps: Phase II Guide

In Phase II of this process, you will be able to take what you have learned from the initial opportunity assessment into deeper layers of analysis. A future Phase II Guide will aim to provide users with guidance and tools needed to:

- Conduct internal *and* external **stakeholder engagement and feedback** processes
- Engage in **project identification and implementation**
- Plan for the **integration and alignment of equity-based policy** at the local level

URBAN DRAWDOWN INITIATIVE

Next Steps: Tools for Phase II Guide

As part of Phase II, the guide (in development) will introduce various tools for project planning. These include:

Urban Forests

i-Tree Planting has various tools that can be used to calculate benefits and aid in urban forestry project planning.

Google Tree Canopy Using aerial imagery collected via planes, this tool allows cities to quantify their tree canopy coverage.

Vibrant Cities Lab has a comprehensive toolkit for urban forestry project planning.

Organics Management

UDI TPL Decision Support Tool

Organics Management Guide: A process guide and spreadsheet based tool to optimize the capture and utilization of urban organic waste.

The UDI TPL tool has the capacity to calculate the projected carbon benefits of various organics management practices using the tool's carbon calculator.

Agricultural Systems

COMET Farm is a farm and ranch greenhouse gas and carbon accounting system. This tool allows farmers and ranchers to calculate their 'carbon footprint' and determine ways to sequester more carbon.

Parks & Grassland (turf)

UDI TPL Decision Support Tool

The UDI TPL tool has the capacity to calculate the projected carbon benefits of different management and treatment options in parks and grasslands using the tool's carbon calculator.

Additional Resources

- **American Forests Tree Equity Score:** The Tree Equity Score calculates a score that "indicates whether there are enough trees for everyone to experience the health, economic and climate benefits that trees provide." These scores are calculated by current tree canopy, income & demographics, temperature, and community health. Complete with an interactive map, the Tree Equity Score contains data for most municipalities in the US.
- **Annotated Bibliography of Associated Ecosystem Services:** Outlines compiled research on ecosystem services provided by natural resources and systems.
- **COMET Farm:** COMET Farm is a farm and ranch greenhouse gas and carbon accounting system. This tool allows farmers and ranchers to calculate their 'carbon footprint' and determine ways to sequester more carbon.
- **Google Tree Canopy:** Using aerial imagery collected via planes, this tool allows cities to quantify their tree canopy coverage along a set of possible criteria such as median income, maximum land surface temperature, and population density.
- **Green Values Strategy Guide: Linking Green Infrastructure Benefits to Community Priorities:** This guide, from the Center for Neighborhood Technologies, provides a series of quantification methods and evidence for the benefits of green infrastructure in the management of stormwater in urban areas. This is an update to their useful report "Value of Green Infrastructure Guide".
- **iTree Tools:** the various iTree tools are part of a "peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefits assessment tools." A list of all available tools can be found here.
- **Urban Drawdown Initiative Resource Page:** The Urban Drawdown Initiative website frequently updates the latest resources related to drawdown actions, policies, and educational materials on this emerging field of study. The site is also where the latest version of this and future guides will be made available to the public.
- **USDN Organics-to-Sequestration Process Guide:** Redesigning Municipal Organic Materials Systems for Climate & Community Resilience & Equitable Economic Diversification - This is a process guide and spreadsheet-based tool to optimize the capture and utilization of urban organic waste.
- **Vibrant Cities Lab:** "A joint project of the U.S. Forest Service, American Forests and the National Association of Regional Councils, merging the latest research with best practices for implementing green infrastructure projects in your community" which includes an Urban Forestry Toolkit.

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