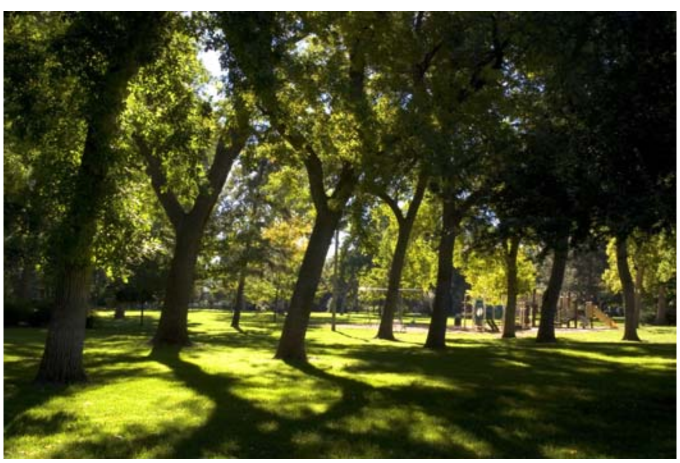
City of Longmont, Colorado

Urban Tree Canopy & CITYgreen Analysis Project Report



December 3, 2008

NCDC IMAGING

City of Longmont, CO Project Report: Urban Tree Canopy & CITYgreen Analysis

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Project Summary

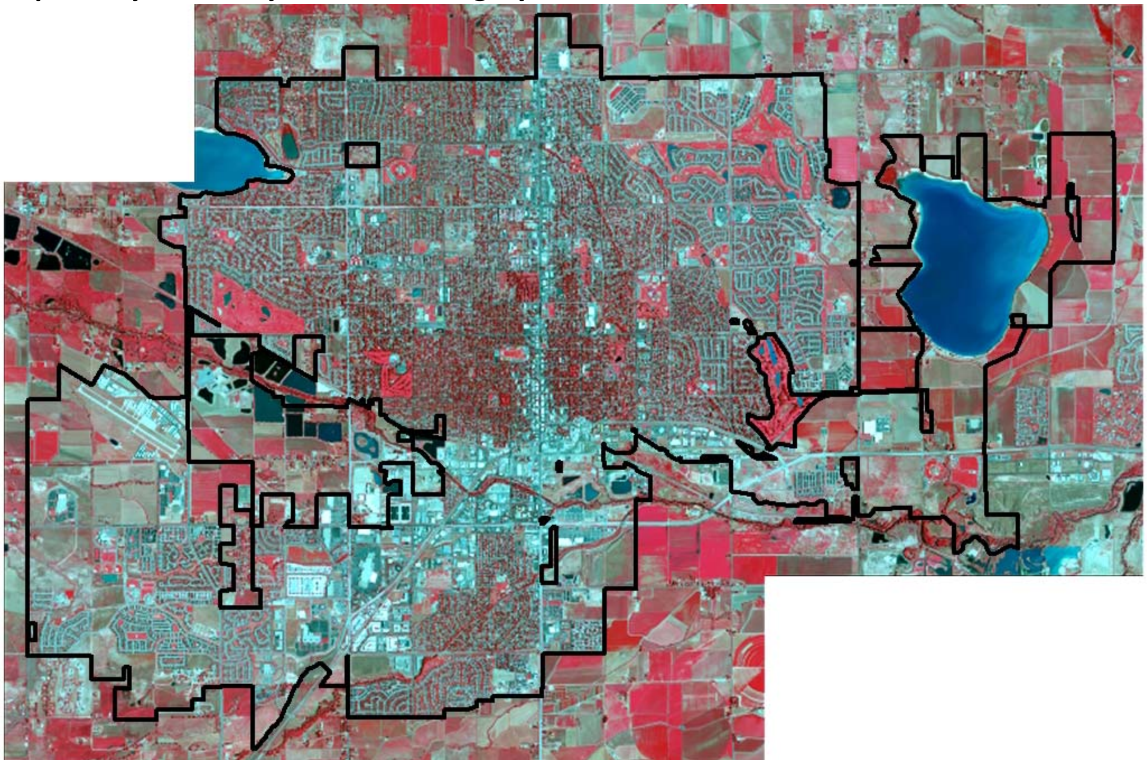
High-resolution color-infrared aerial imagery and supporting GIS datasets were used to create a GIS-ready, 6-class land cover layer, calculate land cover statistics at the parcel level, assess existing & possible urban tree canopy (UTC), and analyze ecosystem benefits of Longmont, Colorado's urban forest. Results identified Longmont's existing tree canopy cover at 8% (1478 acres) and possible tree canopy at 47% (8535 acres). Public right-of-way (PROW) contained 1% (207 acres) canopy cover. Residential land use (zoning) comprises the largest proportion of the city (46%) while impervious surfaces and grass are the dominant land cover types comprising 39% and 40% respectively. Longmont's current urban forest was found to store 62,873 tons of carbon, sequester 489.5 tons per year, and when including stormwater & water quality benefits, constitutes a combined value of over $8,400,000.00 in savings to the city.

While the city of Longmont's urban forest provides significant ecosystem services, this study highlights where and how much opportunity there is to improve canopy cover and associated dollar value benefits.

Description of Project

NCDC Imaging & Mapping ('NCDC') was contracted by the city of Longmont in order to map and assess their urban forest and produce additional data related to environmental sustainability goals. The latest geospatial tools & technologies were applied to increase the city's understanding of their current and possible urban forest as well as provide a comprehensive GIS-ready land cover classification useful to city and utility departments for a variety of planning and management purposes. The area of interest (AOI) was the City of Longmont, Colorado, an area of approximately 25 square miles.

Map of City Boundary & 1-ft CIR Imagery



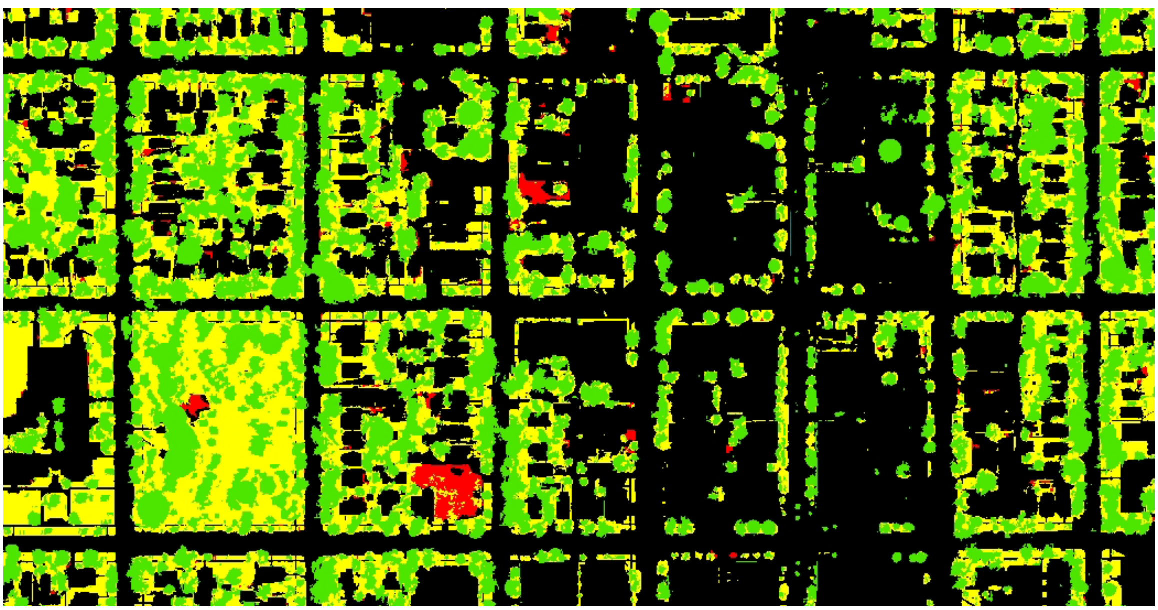
The primary tasks included developing a GIS-based land cover classification dataset, performing an urban tree canopy (UTC) assessment on existing and possible tree cover and creating detailed CITYgreen analysis reports calculating the dollar value of the urban forest.

Data Requirements & Land Cover Classification

Color-infrared, 1-ft resolution aerial photography from June 2007 was used as the base information layer for image classification & GIS analysis of Longmont's urban forest. Data layers provided to NCDC included parcels, existing aerial photography, digital elevation model (DEM), land use, buildings, streets, parking lots and city boundary.

NCDC's accelerated feature extraction (AFE) technology and existing GIS layers were utilized to extract 6 land cover classes; impervious surfaces, trees (includes shrubs), trees with impervious understory (a 'shared' category where these layers overlap), grass (all low-lying vegetation), bare soil (includes dry vegetative cover) and water.

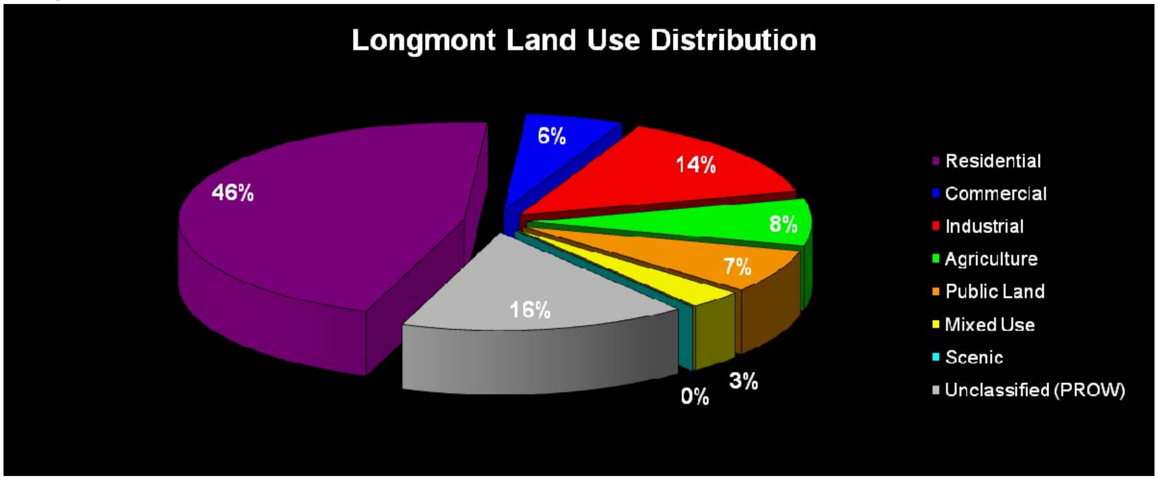
Example of Longmont's 6-Class Land Cover Data



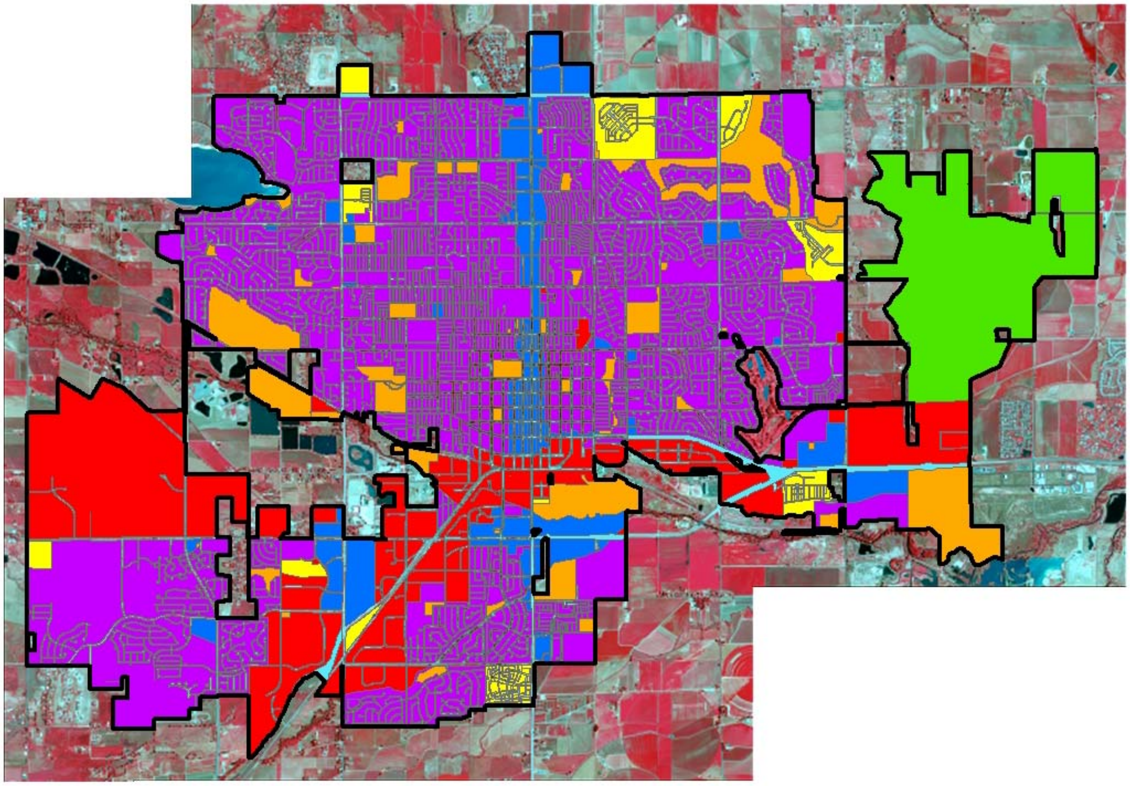
Impervious surfaces and grass land cover comprise the majority of land within Longmont (39% and 40% respectively). A pie chart included in the Appendix illustrates the land cover distribution throughout the city. Additionally, the 6-class land cover data was merged and summarized by parcel boundaries so that the area and percent of each land cover class is now embedded into the city parcels layer, extremely valuable for a variety of analyses and applications.

Longmont's land use data was provided to assess existing & possible UTC by single family residential, multi-family residential, commercial, industrial, agricultural, 'scenic', and public right-of-way (PROW) property types. The city is overwhelmingly comprised of residential land use (46%), followed next by industrial (14%) and the PROW (16%).

Longmont Land Use Distribution, Pie Chart Format



Longmont Land Use Distribution, Map-Based Format



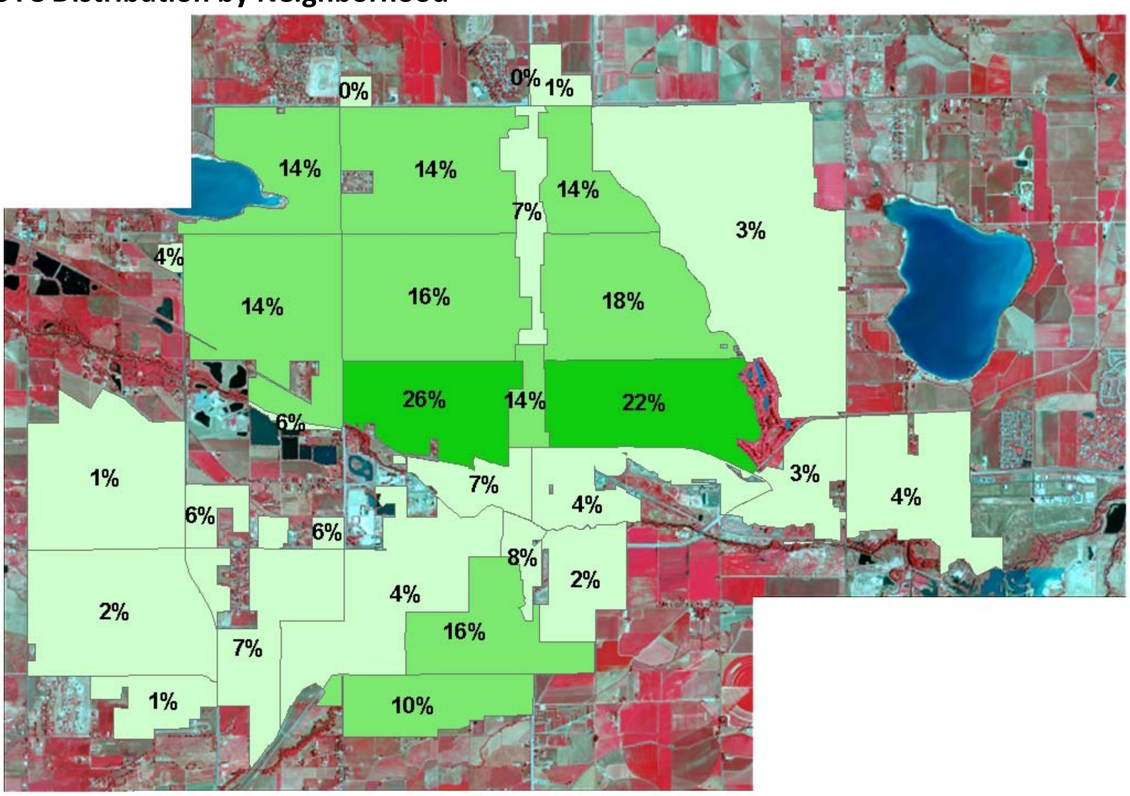
UTC Analysis

The UTC analysis model provided existing and possible tree canopy GIS data and statistics for the entire city, individual parcels, neighborhoods, and land use (zoning) boundaries. Portions of this model are based on tools developed by the U.S. Forest Service Northern Research Station and the University of Vermont Spatial Analysis Laboratory.

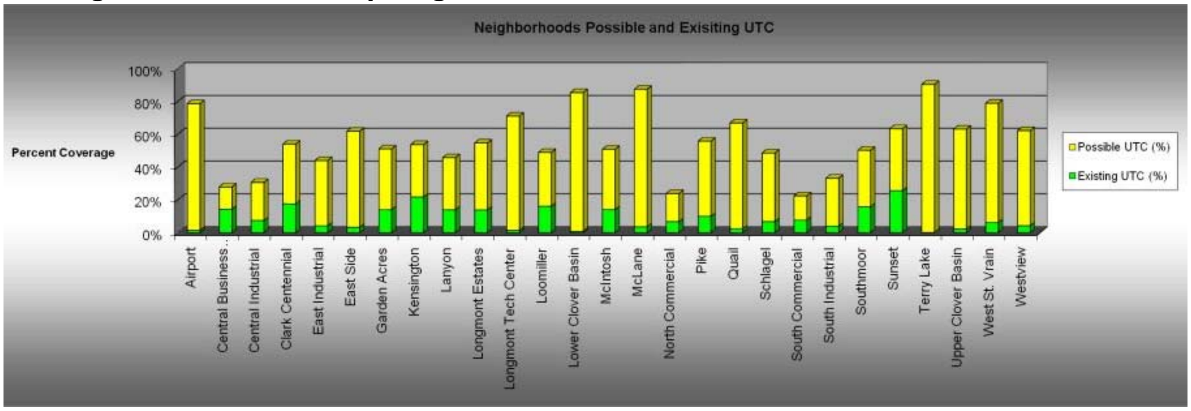
Existing UTC was a simple calculation of current tree canopy divided by the total area in the City. Possible UTC is defined as anywhere canopy could biophysically exist. Possible UTC excludes water, buildings, roads, and existing tree canopy. This 'initial cut' is liberal in that all remaining pervious area is considered available for planting while it is conservative in that future canopy growth over buildings and streets is not included. More details and additional options are provided below under "Recommendations".

Existing & possible UTC citywide was found to be 8% and 47% respectively. These metrics were also produced for parcels (area & percent metrics can be found in the city's updated parcels layer) and neighborhood boundaries. Longmont has 27 neighborhoods and their canopy cover ranged from 1% to 26%.

UTC Distribution by Neighborhood



Existing and Possible UTC by Neighborhood

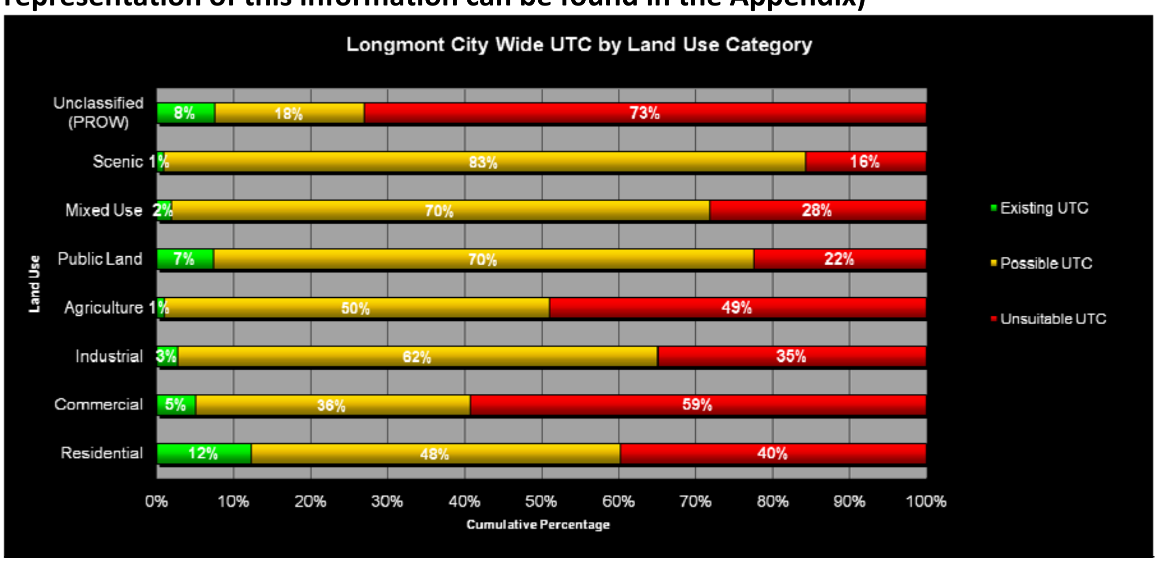


Example of Existing & Possible UTC by Parcel Boundary in High Density Canopy Area

Example of Existing & Possible UTC by PROW in High Density Canopy Area

The vast majority of Longmont's UTC can be found in residential land use (69% of total citywide UTC) with 15% coming from public right-of-way (PROW), 7% from public land, 5% from industrial and 3% from commercial. Possible UTC was found to be very high in all categories except PROW. Additional analysis is available for more detailed assessments that can further refine possible UTC and even potential planting sites, but this provides base information for improved management and / or subsequent work.

Percentage of UTC broken out by Land Use Category (Note: a map-based representation of this information can be found in the Appendix)



Ecosystem Benefits: CITYgreen Analysis

NCDC conducted a monetary and environmental analysis of the City's urban forest using CITYgreen software created by American Forests. Six reports were created and identify the air pollution removal capacity, carbon storage & sequestration, stormwater runoff mitigation and water quality (i.e. contaminant loading) benefit of Longmont's urban forest.

CITYgreen software utilizes decades of widespread research conducted and refined by well-known institutions and experts to analyze not only current tree canopy benefits but also modeled tree canopy benefits useful for driving urban forest public policy.

The City of Longmont has a current tree canopy of 1461 acres or about 8.7% of the city-wide area of 16,704 acres. The impervious surfaces total close to 40% of the city (7766 acres), which includes impervious surfaces that are drained to a sewer and compacted dirt or gravel surfaces.

The current tree canopy cover CITYgreen report for Longmont reflects a value of $246,825 in air quality pollutant removal savings and a total carbon storage capacity of around 62,873 tons. With an increase in total tree canopy to 25% coverage or an additional 2715 acres, the storage capacity increases to 179,696 tons with an additional 1399 tons sequestered annually based on tree growth. Moreover, the city realizes a significant cost savings due to the improved canopy ($705,441), an increase of $458,616. The payback includes tens of thousands of pounds of widespread air pollutant removal, greater than before health benefits, lesser costs associated with poor health, and an aesthetically more pleasing cityscape, just to name a few.

Trees impact stormwater runoff in a number of ways. With an increased tree canopy from 9% to 25%, the city could potentially realize over $20M (twenty million dollars) in runoff savings and would require almost 10 million cubic feet less in water retention facilities capability.

The water quality model also works hand-in-hand with the CITYgreen watershed management model (TR-55) and can predict contaminant loadings using the L-THIA spreadsheet developed by Purdue University and the EPA, by matching curve numbers with pollutant loadings that may affect water quality during a typical 24 hour rainfall event.

The more runoff, the higher the percentage of contaminant loadings are possibly suspended within the water. Default values for loadings are based on expert findings and used to systematically model and assess pollutant loadings. A table of typical pollutants and other technical details for water quality as well as a more detailed explanation of CITYgreen analysis and methodology can be found in the Appendix of this report under the section labeled: *Urban Land Cover Analysis with CITYgreen Report, Longmont, CO.*

Recommendations

Longmont's urban forest is a growing asset to the city in a number of ways and this project & report aimed to illustrate existing conditions, opportunities and justifications for increased funding and management. A variety of other tools & technologies are available to expand upon this project and are briefly provided here.

Looking at canopy cover distribution in Longmont, one can see that there are areas where tree canopy is likely to increase in the future vs. areas where efforts need to be made in order to achieve higher canopy cover. In order to most realistically model potential future ecosystem services in CITYgreen, a percent canopy cover target needs to be determined. Using the trees land cover layer, a count of trees could be taken in particular neighborhoods or land use types to estimate future canopy cover with or without additional planting efforts, which could then be used in CITYgreen modeling. This is just one recommendation on utilizing this project's data for further assessment.

CITYgreen is a modeling tool to influence public policy and decision-making and like any modeling tool it has its limitations. The TR-55 stormwater model that is included may not be appropriate in all urban settings, and the USFS is currently working on a beta release for a model called UFORE-Hydro that will provide similar metrics on the effect of tree canopy & impervious surfaces in regards to peak flows and runoff. With the accurate base land cover data from this project, only topography, stream gauge data and weather data would be needed to run UFORE-Hydro sometime in 2009. Additionally, CITYgreen does not include a model to assess energy conservation benefits provided by shade trees, however identifying tree planting sites in strategic locations (e.g. east & west sides of 2-story buildings) is feasible as is tying in existing USFS and other research containing potential average kilowatt hour and dollar savings. Tied to this assessment could be a process of prioritizing all tree planting sites for maximum ecosystem benefit & sustainability goals.

The base data created in this project such as land cover statistics per parcel can also be tied to utility bills and made accessible through a web-mapping server (WMS) to evaluate & educate on carbon footprint inventory data, landscape composition regulations & return on investment (ROI) from strategic tree planting programs. Finally, funding opportunities for such programs can be made more readily accessible to the general public through TreeLink.org's TreeBank program, and should be considered in the future.

Final Project Deliverables

The following geospatial data layers were provided in Erdas IMAGINE .img and ESRI-based shapefile format in NAD83, Colorado State Plane Coordinate System North (feet), accompanied by FGDC compliant metadata:

- 2007 1-ft resolution, color-infrared orthorectified aerial imagery
- 6-class land cover classification – polygon shapefile including impervious, trees/shrub, tree w/impervious understory, grass, bare soil / dry vegetation and water
- Existing & Possible UTC shapefiles – canopy by target geographies
- UTC Analysis – tables, graphs and charts of UTC statistics (metrics) by parcel, land use / zoning type and neighborhood boundary
- Six (6) CITYgreen reports
- Land Use / Land Cover (LU/LC) parcels database
- Updated buildings footprints shapefile
- Excel spreadsheets containing tabular UTC statistics data (& some graphs)
- Report summarizing methods and results

APPENDIX

Company History

NCDC Imaging & Mapping (www.ncdcimaging.com) is a private Native American-owned business based in Colorado Springs, Colorado. Founded in 2000, NCDC's mission is to provide its customers with innovative Remote Sensing and GIS solutions through the use of high-resolution satellite imagery and automated feature extraction (AFE). NCDC Imaging specializes in image processing, mapping services and training for tribal, federal, state and local agencies in addition to rural community organizations, fire protection districts, private companies and individual organizations.

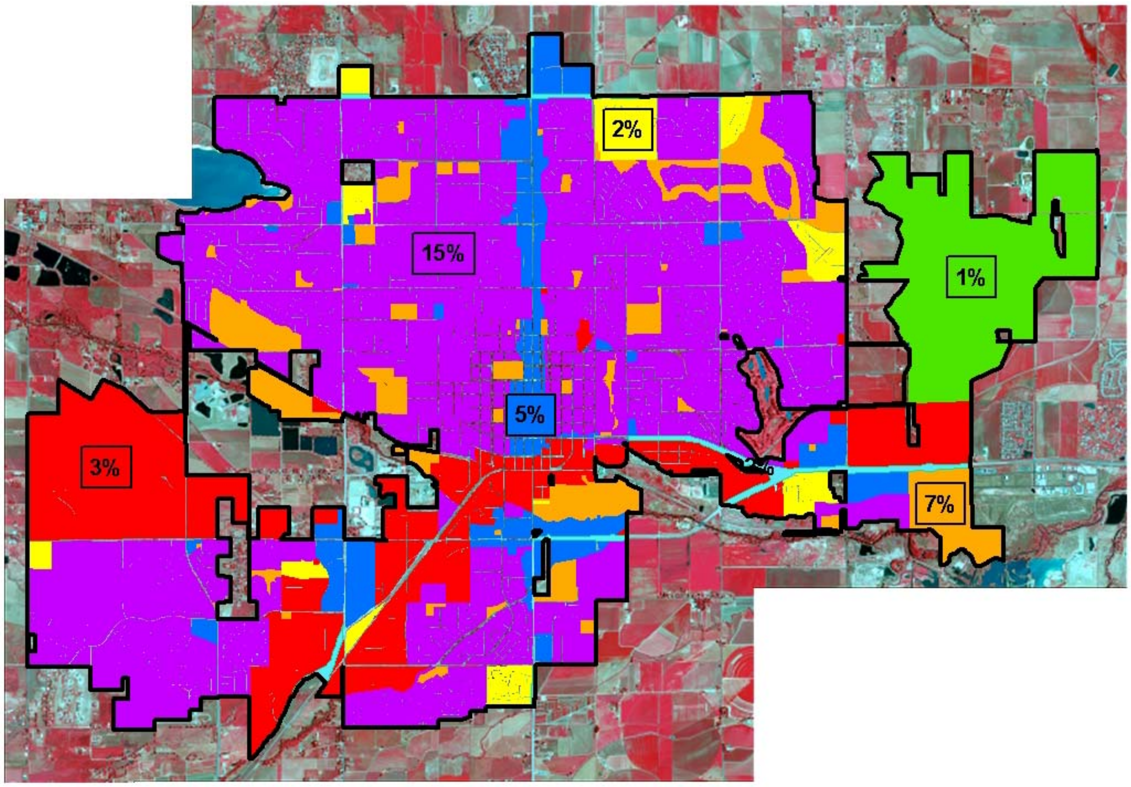
NCDC works with a variety of strategic partnerships on both software and hardware in order to deliver customized solutions from start to finish.
NCDC utilizes state-of-the-art remote sensing, mapping and assessment technologies designed specifically for use with high-resolution imagery to support the market sectors and applications listed in the following table.

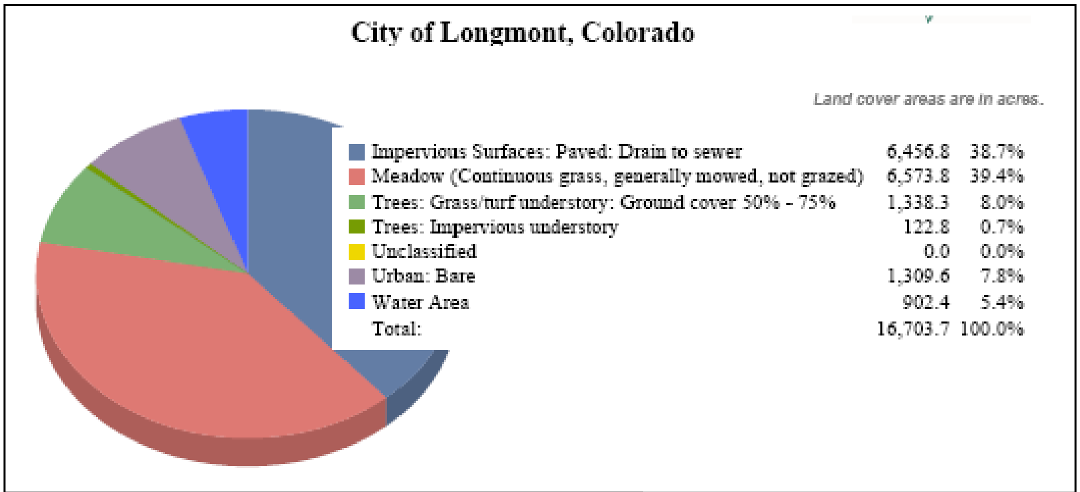
NCDC has specialized in remote sensing and GIS applications using high-resolution imagery for the past nine (9) years. We have performed numerous natural resource, forestry and environmental analysis projects for local, state and federal clients throughout the U.S. using advanced image analysis and automated feature extraction technology (AFE). We are very proud to be the recipient of the 2005 and 2006 Visual Learning Systems “AFE Analyst of the Year” award. Our technicians, analysts and project managers have all received a minimum of one accredited undergraduate degree in environmental studies, forestry or a related field. The staff at NCDC is encouraged and aided in the pursuit of continuing education for both personal and professional development, so that we might as a company, always be on the cutting edge of new developments in the remote sensing industry.

NCDC brings to the remote sensing industry a lead in analytical solutions aimed at helping managers deal with large areas, complexity, unknowns, short project timelines and tight budgets.

Other supporting examples of Longmont's Urban Forest:

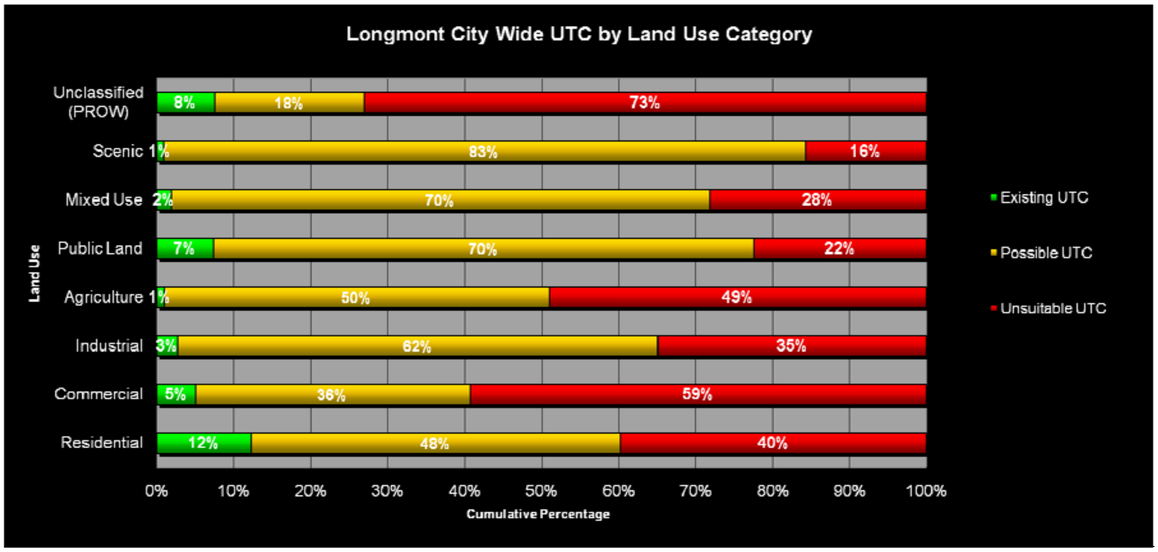
Existing Urban Tree Canopy by Land Use





Land_Use	Acres	Existing UTC / Acres	Existing UTC / %	Acres Possible / UTC	Possible UTC / %
Agriculture	1418.67	12.9	0.908974	710.36	50.071369
Commercial	1006.35	50.66	5.03358	360.81	35.852531
Industrial	2566.93	71.6	2.78915	1616.01	62.954144
Mixed_Use	506.00	10.43	2.061591	395.35	78.131978
Public	1312.05	96.46	7.351455	920.76	70.176309
Residential	6985.70	1016.31	14.548249	3979.03	56.959019
Scenic	185.87	3.47	1.869082	82.64	44.461473

Tabular Distribution of Existing and Possible UTC by Land Use, Longmont, CO



Existing, Possible and Not Suitable Tree Canopy by Land Use (Zoning) Category Longmont, CO

Urban Land Cover Analysis with CITYgreen Report, Longmont, CO

American Forests CITYgreen software is used by NCDC Imaging to conduct analyses that serve to quantify the role urban forests serve in society. The function of trees in maintaining air and water quality are evaluated and stormwater runoff is measured in order to place a dollar amount on what it would cost a city to lose its tree canopy coverage. And inversely, the software is used to model scenarios in which the tree canopy is much improved and again examine the possibility of savings through conscientious management of trees as a natural resource.

The City of Longmont contracted with NCDC Imaging to produce just such a series of modeled scenarios using CITYgreen software. Tree canopy that exists now will be evaluated as well as what it would be worth to improve the City's tree canopy by a set percentage. In Longmont, four areas were identified for analysis; one City-wide and three neighborhoods including HINA, Schlagel, and North Commercial. Two reports were created for each; one report to reflect current conditions, one to model an ideal tree canopy of 25% or more depending on existing tree canopy.

NCDC Imaging used the 7-class land cover layer created for Longmont, which included Impervious Surfaces, Water, Grass, Open Space, Bare Soil, Trees over Impervious Surfaces, and Trees. The analysis in CITYgreen focuses on the inverse relation between primarily two feature classes: Impervious Surfaces-Paved and Tree Canopy in which one is decreased and the other increased.

CITYgreen uses a variety of documentation and methodologies to compute air pollution removal, carbon storage and sequestration, storm water runoff reduction, and water quality. Some of the models referenced include The Urban Hydrology for Small Watersheds, or more commonly, the TR-55 hydrologic analysis model for analyzing stormwater runoff and water quality along with the L-THIA spread sheet model created by Purdue University and the U.S. Environmental Protection Agency (EPA), which in turn references the UFORE (Urban Forest Effects) model, developed by USDA Forest Service model in particular. All are widely used to manage and direct conservation practices by evaluating the effects of land cover and/or land use changes.

CITYgreen software is able to calculate and summarize land cover data and other site specific characteristics such as soil type and typical rainfall contained in vast databases upon which the models draw values and formulas that have long been used and accepted by American Forests, the software creators, and other industry experts. However, in order for the CITYgreen software to perform the proper calculations and relate the feature layers to these existing databases and models upon which the software is built, the input land cover data is first converted to native CITYgreen feature categories such as in the following table.

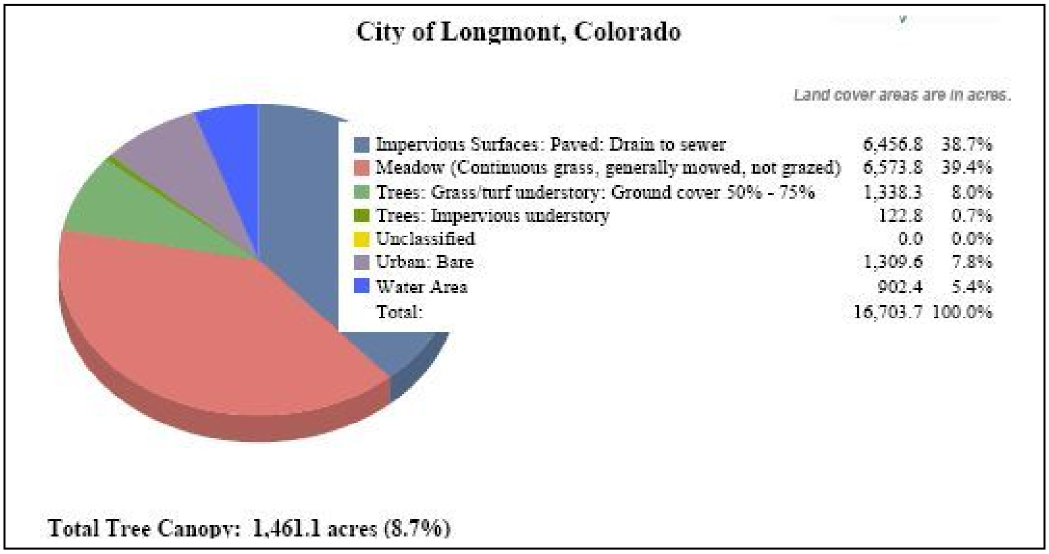
Example of how a 7-class land cover would translate to CITYgreen features:

Input Layers	**CITYgreen Output Layers**
Impervious Surfaces	Impervious Surfaces: Paved: Drain to sewer
Trees over Impervious Surfaces	Trees: Impervious Understory
Bare Soil	Urban: Bare
Water	Water: Area
Grass	Meadow (Continuous grass, generally mowed, not grazed)
Open Space	Open Space – Grass/Scattered Trees: Grass cover 50% - 75%
Trees	Trees: Grass/Turf Understory: Ground cover 50% - 75%

The results for the City of Longmont unequivocally reveal a significant increase in benefits to the City.

Air Pollution Removal and Carbon Storage Sequestration

The City of Longmont has a current tree canopy of 1461 acres or about 8.7% of the city-wide area of 16,704 acres. The impervious surfaces total a little under 50%, which includes impervious surfaces that are drained to a sewer and compacted dirt or gravel surfaces. Together impervious surfaces cover about 7766 acres.



Carbon storage sequestration is calculated by examining the total study area and the percentage of actual canopy cover, enabling the software to derive a unit value of carbon storage by the area of canopy. With this unit established CITYgreen can generate carbon dioxide removal rates based on multiplying a per unit value of carbon storage by existing tree canopy or biomass area. Further, it extrapolates current storage capability based on total biomass as well as an annual additional carbon storage and sequestration amounts based on that total tree biomass as those trees grow.

Common pollutants analyzed include, Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2), Ozone (O_3), Carbon Monoxide (CO), and particulate matter less than 10 microns (PM10). Removal rates were collected for 55 cities, at the time data was being calculated, organized, and analyzed for the release of the TR-55 manual. CITYgreen determines the air quality based on the nearest large study site, therefore Denver shall serve as the profile area for Longmont.

The savings dollar value is based on indirect costs, or external costs, associated with poor air quality. Indirect costs could be any number of things from loss of tourism revenue to higher health care costs. Better air quality through management of urban forests and correctly planting larger and longer living trees, could result in lowering indirect costs to society. These values are derived from the application of the UFORE (Urban Forest Effects) model, developed by USDA Forest Service.

The current conditions report for Longmont displays a minimal dollar savings of $246,825.00 in the air quality model and further returns the total carbon storage capacity of the tree biomass currently, which is 62,873.30 tons. The annual number reflects the additional per year carbon sequestration capacity as the current canopy grows. With an increase in total tree canopy to 25% coverage or an additional 2714.8 acres, the storage capacity jumps to 179,696 tons with an additional 1399 tons annually based on tree growth. Moreover, the city realizes a significant cost savings due to the improved canopy, $705,441.00, an increase of $458,616.00. The payback includes tens of thousands of pounds of widespread air pollutant removal, greater than before health benefits, lesser costs associated with poor health, and an aesthetically more pleasing cityscape, just to name a few.

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10) in their leaves, urban trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for the pollutants listed below. To calculate the dollar value of these pollutants, economists use "externality" costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue. The actual externality costs used in CITYgreen of each air pollutant is set by the each state, Public Services Commission.

Nearest Air Quality Reference City: **Denver**

	Lbs. Removed/yr	Dollar Value
Carbon Monoxide:	2,605	$1,112
Ozone:	27,351	$84,029
Nitrogen Dioxide:	23,444	$72,025
Particulate Matter:	40,376	$82,817
Sulfur Dioxide:	9,117	$6,842
Totals:	102,893	$246,825

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree's dry weight, in fact, is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and carbon sequestration rates of trees within a defined study area.

Total Tons Stored:	**62,873.30**
Total Tons Sequestered (Annually):	**489.49**

Water Quality and Storm Water Runoff

There is a considerable amount of savings to the city in mitigated stormwater runoff. The TR-55 model utilized by CITYgreen software analyzes runoff patterns in a single 24-hour storm event. The values are based on USDA Natural Resources Conservation Service (NRCS) research and typical stormwater facilities design costs based on rainfall patterns and distribution. To find a negative value in this category is ***positive*** to the city, it means there are in fact less expenses involved in trying to maintain water drainage and containment systems.

Determining the potential for runoff by analyzing a combination of surrounding land cover, underlying soils and hydrologic data, CITYgreen estimates the impact of trees on storm water runoff through the use of the RCN or runoff curve number. It is important to note that the land cover map data is derived from aerial or satellite photography taken while trees are in full leaf.

Storm water runoff volumes, peak flow, and concentration values during a typical storm and any associated runoff are estimated based on tree canopy coverage, local rainfall patterns, soil type, and other site specific information taken from the study conducted by USDA Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), and resulting in the TR-55 manual. A dollar value is then placed on the cost to capture, retain, and/or recycle such runoff.

As with other models, land cover, average precipitation data, rainfall distribution tables, slope, and soil types are used to determine how trees and impervious areas affect runoff, peak flow, and concentration during a storm event and to compute the amount of storm water runoff. The output is in cubic feet because most planners and engineers know and use the local cost per cubic foot to build retention ponds or other storm water management facilities.

CITYgreen software uses a generalized slope taken from the databases created after the 55 city sample study and formulas derived by engineers to estimate curve numbers, quantity of storm water runoff, times of concentration and peak flows, and establish current conditions contaminant loadings. The models are great for estimating effects of runoff due directly to changes in land cover and the results can be used to support stormwater management practices.

The key to understanding the reports and in turn possible savings to a City is to first understand the curve number which is an established and generally accepted number assigned to land cover land use features, based on rainfall and land use data studied in 97 gauging sites. These studies have been extensive and performed by various entities, including the NRCS and American Forests, and based on the work of Don Woodward, a National Hydraulic Engineer to establish and support representative curve numbers based again on land use land cover and soils data collected. A higher curve number is associated with a more impervious surface and therefore means a larger quantity of runoff and higher costs to a city to capture and retain that water.

Land Use Type	Curve Number
Agricultural	85
Commercial	94
Forest	70
Rural Grass/Pasture	79
Industrial	91
Open Spaces/Parkland	84
Parking and Paved Spaces	98
Low Density Residential	77
Medium Density Residential	81
High Density Residential	90
Water/ Wetlands	0/100

Table of *typical* TR-55 (not exact) curve numbers

Based on the current landcover map of Longmont, the curve number is 79: typical of usually a more rural area or an urban area setting that may have several parks, residential lots, and other open spaces inter mixed with buildings and structures. Also, the curve number is directly and significantly influenced by the underlying soils in the area. One of the underlying assumptions made in City of Longmont was in the assignation of a type B soil, which is characteristically "somewhat pervious". The role of soils information in modeled scenarios is that for every acre of trees that are planted, an acre of impervious shell is removed. It is at that point that the soil types and conditions affect the curve number assigned to a land use area. And as stated, the curve number ties directly to the amount of runoff, contaminant loadings, and savings versus cost to the city.

In the reports labeled "*nn*_noTrees.pdf", notice that an assumption is made in the water quantity runoff section, that there will in fact be a total loss of trees and so the curve number jumps to 81. In turn, the stormwater savings number is over $8 million. This $8 million actually is a reflection of what ***additional*** costs would be incurred by the city should the tree canopy be removed whether by natural disaster or building and construction. However, with each successive modeled improvement report after, notice that this stormwater savings number is a negative number in the millions, and is in fact the true additional savings to the City that can be achieved.

Water Quantity (Runoff)

2-yr, 24-hr Rainfall: 1.75 in.

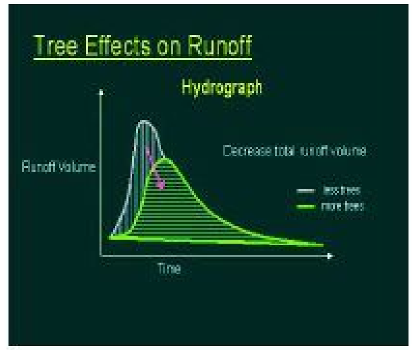
Curve Number reflecting existing conditions: 79
Curve Number using default replacement landcover: 81

Additional stormwater storage volume needed: 4,212,812 cu. ft.

Construction cost per cu. ft.: $2.00

Total Stormwater Savings: **$8,425,624**

Annual costs based on payments over 20 years at 6% Interest: **$734,584 per year**



Trees hinder runoff. With an increased tree canopy, or an enhancement from 9% to 25%, the city realizes over twenty million dollars in stormwater runoff savings and would require almost 10 million cubic feet less in water retention facilities capability. The reports labeled “*nn*_25%.pdf” will reflect your modeled scenarios with increased tree canopy.

The water quality model additionally works hand-in-hand with the TR-55 model and can predict contaminant loadings using the L-THIA spreadsheet developed by Purdue University and the EPA, by matching curve numbers with pollutant loadings that may affect water quality during a typical 24 hour rainfall event.

The more runoff, the higher the percentage of contaminant loadings are possibly suspended within the water. Following is a table of default values for loadings based on the work of Don Woodward with the NRCS and the L-THIA model using curve numbers to develop a systematic model to assess these pollutant loadings.

Contaminants Loading Default Values

Land Use	Curve Number	Nitrogen (mg/l)	Phosphorus (mg/l)	Suspended Solids (mg/l)	Zinc (ppm)	Lead (ppm)	Copper (ppm)	Cadmium (ppm)	Chromium (ppm)	Biological Oxygen Demand - BOD (ppm)	Chemical Oxygen Demand - COD (ppm)
Paving Lot	98	1.8070	0.4430	212.3300	0.0800	0.0090	0.0090	0.0075	0.0021	49.5000	25.5000
Commercial	85	2.0960	0.4430	69.0000	0.1800	0.0130	0.0090	0.0075	0.0100	116.0000	23.0000
Urban	83	2.0960	0.2090	69.0000	0.0800	0.0090	0.0090	0.0075	0.0021	49.5000	25.5000
Forest	73	0.7800	0.1500	39.0000	0.0060	0.0050	0.0100	0.0010	0.0075	0.0000	0.5000

Contaminant loadings are calculated in the “*nn*_noTrees” reports only, and again this report reflects an assumed scenario in which the tree canopy is adversely affected or removed, in order to present a worse case model for comparison’s sake. As the canopy increases, the contaminant loadings are not calculated for various reasons including that the American Forests determined that it does not follow to include “negative” values in this portion of the report, because the numbers cannot be accurately quantified.

Water Quality (Contaminant Loading)

Cities must comply with Federal clean water regulations and develop plans to improve the quality of their streams and rivers. Trees filter surface water and prevent erosion, both of which maintain or improve water quality. Using values from the US Environmental Protection Agency (EPA) and Purdue University's L-thia spreadsheet water quality model, American Forests developed the CITYgreen water quality model. This model estimates the change in the concentration of the pollutants in runoff during a typical storm event given the change in the land cover. This model estimates the Event Mean Concentrations of Nitrogen, Phosphorus, Suspended Solids, Zinc, Lead, Copper, Cadmium, Chromium, Chemical Oxygen Demand(COD), and Biological Oxygen Demand (BOD). Pollutant values are shown as a percentage of change.

Percent Change in Contaminant Loadings

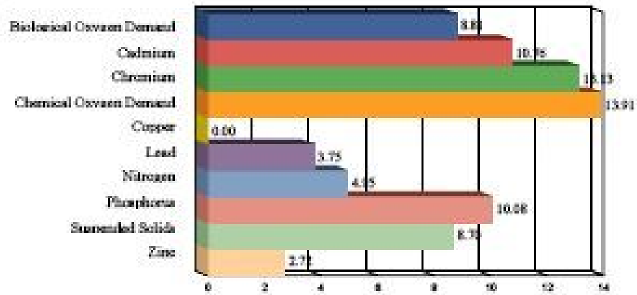


Table from Longmont report reflects the percent of change in water contaminant loadings should tree canopy be removed.

Included here is a link to a document that will help you to further explore and understand how the methodology is applied, the basic assumptions made in general for all types of scenarios and settings, and to help you understand the curve numbers and how they affect the outcome. The higher the curve number the more runoff and therefore you will have MORE expense incurred based on being able to trap and retain the storm water runoff versus a low curve number, wherein the runoff is less due to the ground cover's pervious nature, etc.

Please take look at it: http://www.ecn.purdue.edu/runoff/documentation/tr55.pdf