



Green Infrastructure Webcast Series

Models and Calculators
Louisville Case Study

Guide to Our Webcasts

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Green Infrastructure Webcast Series

Tuesday, May 12, 2009

- Site Planning & Design Considerations
- Costs and WERF Cost Tool

Tuesday, June 23, 2009

- Funding & Incentives
- Brownfield Redevelopment

Tuesday, July 28, 2009

- Retrofits: Green Streets
- Operation & Maintenance

Green Infrastructure Website
www.epa.gov/greeninfrastructure

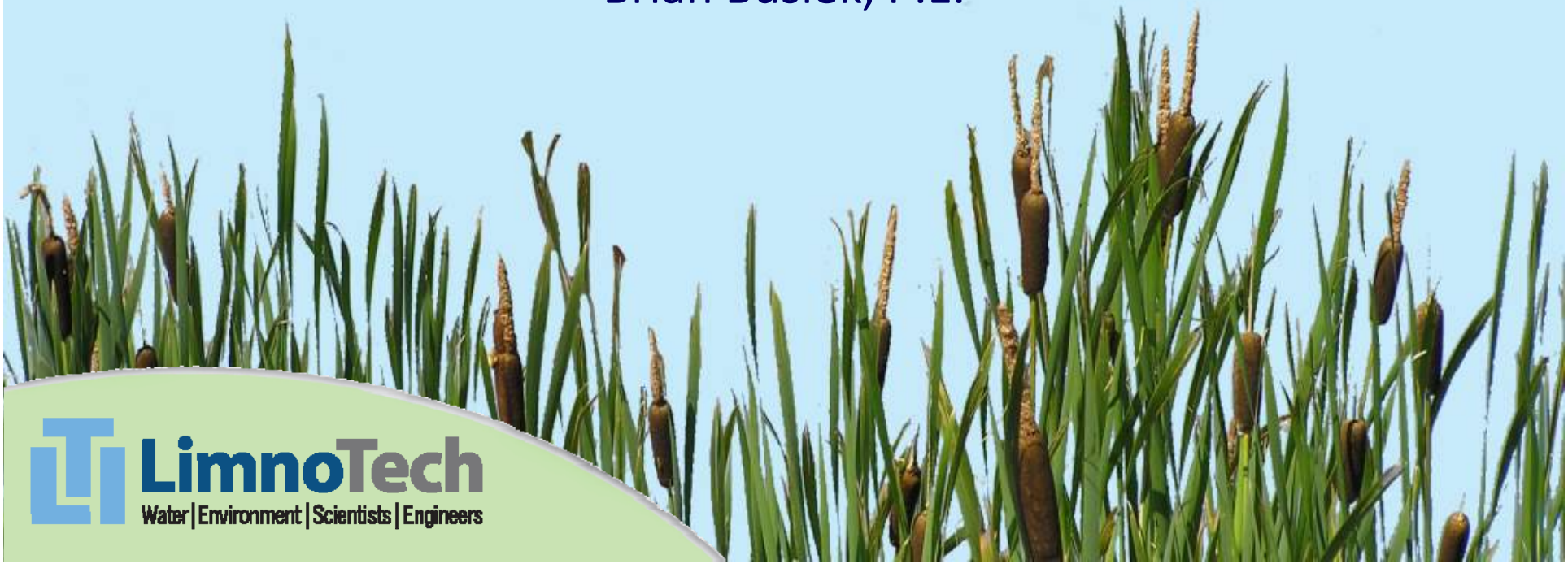
- General Information
- Key Resources
- Case Studies
- Performance Data
- Partnership Contacts
- Statement of Support

NEW! Click on Trainings and Conferences to download previous webcasts from the series and for info on upcoming workshops

Green Infrastructure: Models and Calculators

EPA Green Infrastructure Webcast
April 28, 2009

Brian Busiek, P.E.

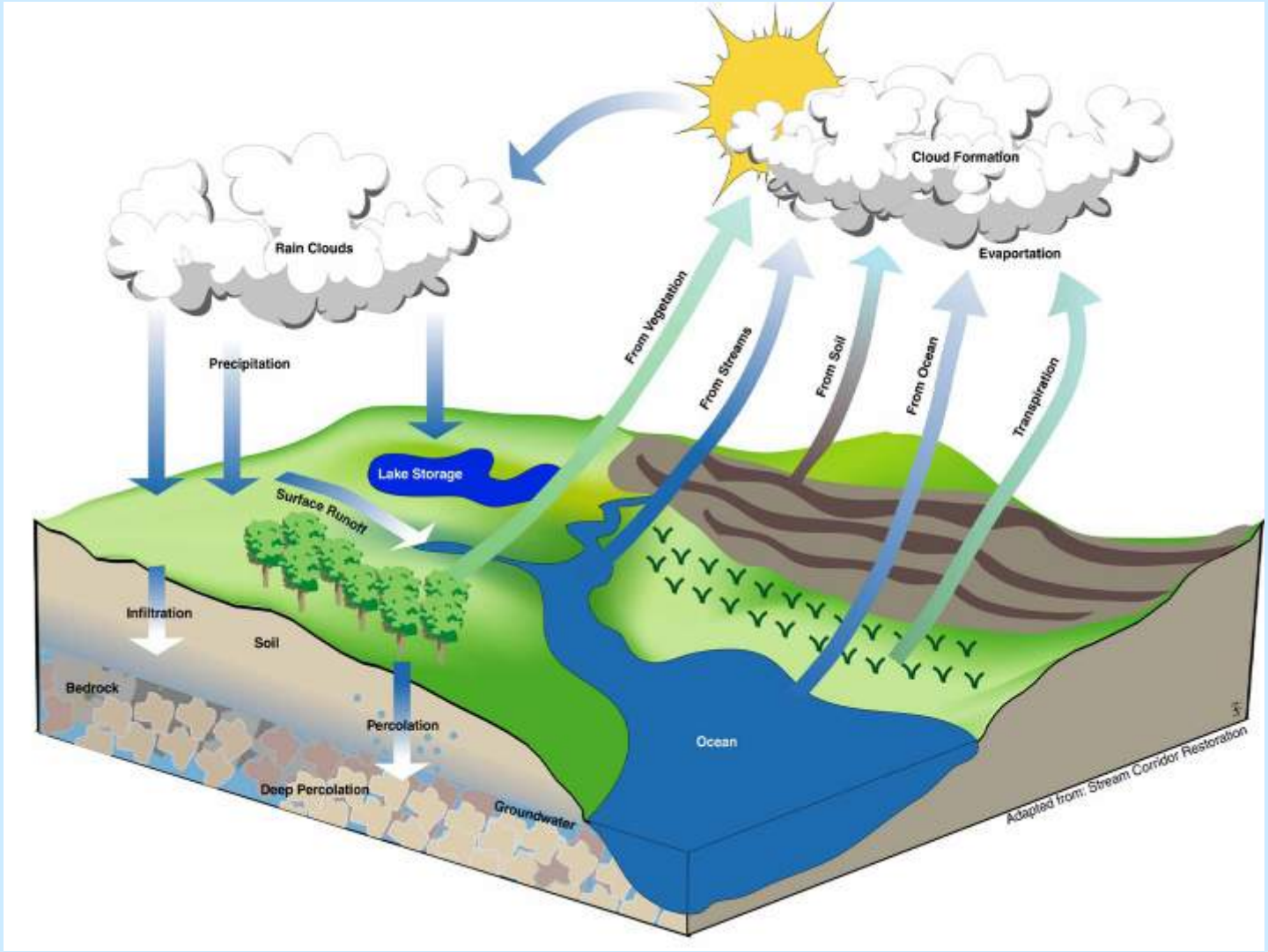


LimnoTech
Water | Environment | Scientists | Engineers

Introduction

- **Objective**
  - Provide overview of available green infrastructure calculators and models
  - Highlight specific green infrastructure modeling activities in other cities
- **Overview**
  - Background
  - Simple models and calculators
  - More complicated models

The Water Balance



Why Use a Model or Calculator

- **Applications**
  - Large scale planning level
  - Site or lot level
- **Purpose**
  - Determine stormwater runoff reductions (total and peak)
  - Determine pollutant load reductions and water quality benefits
  - Monetize costs and benefits
  - Facilitate design

Choosing a Model or Calculator

- Understand your objective
- Understand information and data requirements
- Use simplest method that can meet the objective
- Weigh whether increased accuracy is worth increased effort
- Do not forget assumptions underlying the model
- Understand significance of model results

Simple Models and Calculators

- **Uses**
  - Scoping level tools that you can use to help approximate stormwater benefits
  - Preliminary design and sizing estimations
- **Limitations**
  - Mathematical abstractions
  - Only as good as the data you have and assumptions you make
  - Often use local or regional assumptions
  - Typically single event calculations

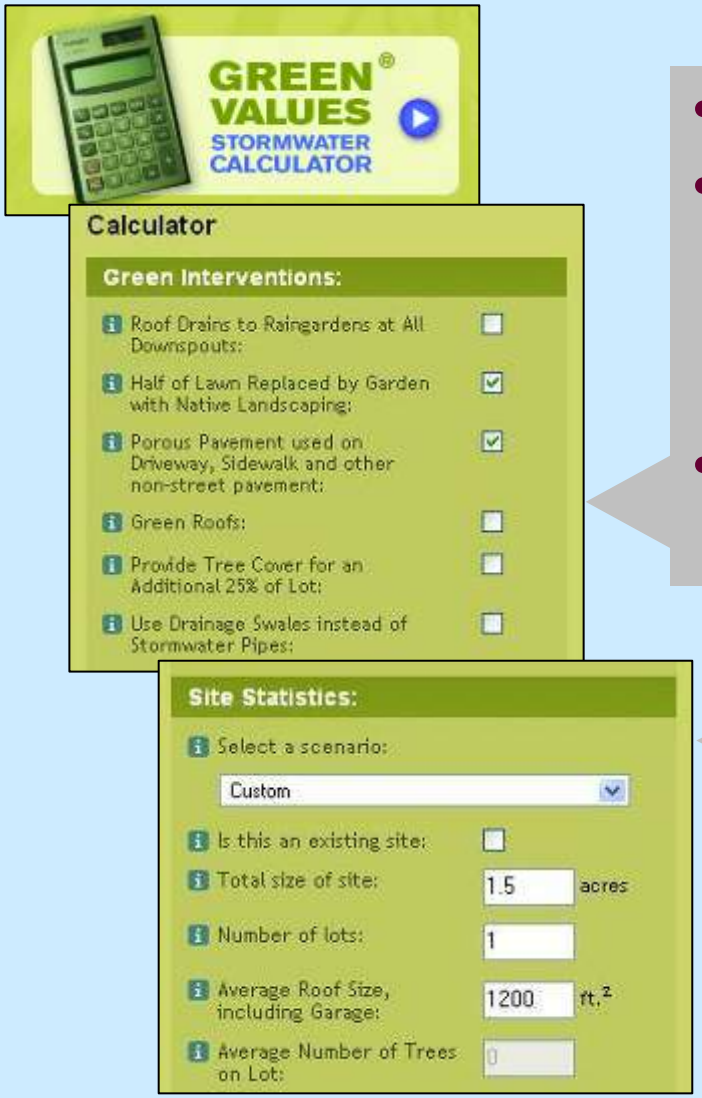
Simple Models and Calculators

- **Common Calculation Methods**
  - Runoff Volume
    - Runoff Curve Number Method (TR-55)
    - Small Storm Hydrology Method
    - Infiltration Models
  - Peak Runoff Rate
    - NRCS Unit Hydrograph Method
    - Rational Method
  - Pollutant Loading
    - Simple Method

- **Typical Data Needs**
  - Land use
  - Soil types
  - Rainfall data

Green Values Stormwater Calculator

Center for Neighborhood Technology



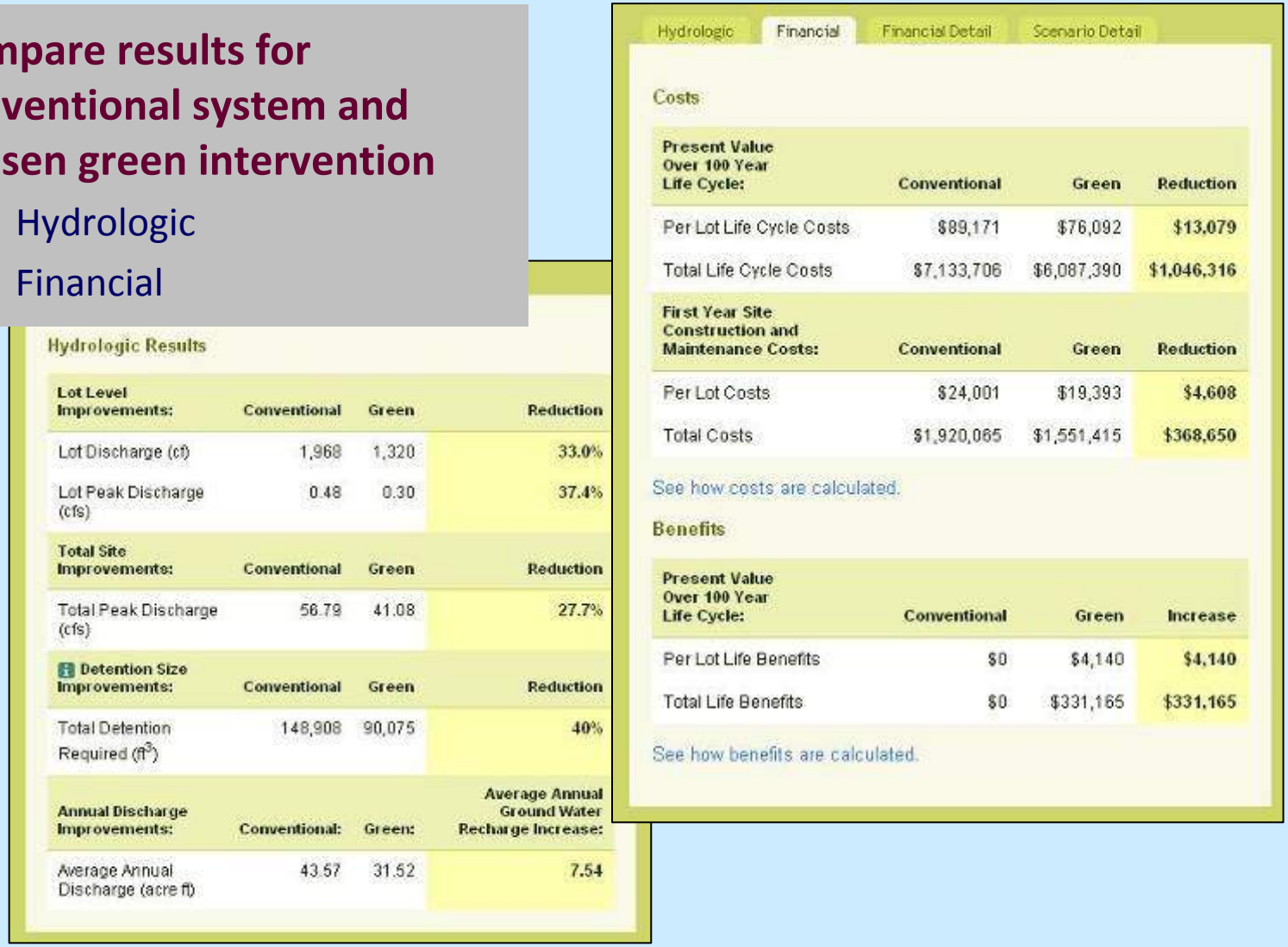
- **Web-enabled application**
- **Planning tool with lot and neighborhood level calculations**
  - Hydrologic
  - Financial
- **Evaluate range of green infrastructure practices**

- **Pre-defined or custom inputs**
  - Landscape details
  - Cost elements
- **Integrated pop-up help screens**

Green Values Stormwater Calculator

Results

- **Compare results for conventional system and chosen green intervention**
  - Hydrologic
  - Financial



Hydrologic Results

Lot Level Improvements:	Conventional	Green	Reduction
Lot Discharge (cf)	1,968	1,320	33.0%
Lot Peak Discharge (cfs)	0.48	0.30	37.4%
Total Site Improvements:	**Conventional**	**Green**	**Reduction**
Total Peak Discharge (cfs)	56.79	41.08	27.7%
Detention Size Improvements:	**Conventional**	**Green**	**Reduction**
Total Detention Required (ft^3)	148,908	90,075	40%
Annual Discharge Improvements:	**Conventional:**	**Green:**	**Average Annual Ground Water Recharge Increase:**
Average Annual Discharge (acre ft)	43.57	31.52	7.54

Hydrologic | Financial | Financial Detail | Scenario Detail

Costs

Present Value Over 100 Year Life Cycle:	Conventional	Green	Reduction
Per Lot Life Cycle Costs	$89,171	$76,092	$13,079
Total Life Cycle Costs	$7,133,706	$6,087,390	$1,046,316
First Year Site Construction and Maintenance Costs:	**Conventional**	**Green**	**Reduction**
Per Lot Costs	$24,001	$19,393	$4,608
Total Costs	$1,920,065	$1,551,415	$368,650

See how costs are calculated.

Benefits

Present Value Over 100 Year Life Cycle:	Conventional	Green	Increase
Per Lot Life Benefits	$0	$4,140	$4,140
Total Life Benefits	$0	$331,165	$331,165

See how benefits are calculated.

Green Values Stormwater Calculator

Methods and Calculations

HYDROLOGIC

- **Lot discharge**
  - TR-55 Runoff Curve Number Method
  - 2-year, 24 hour storm
- **Lot peak discharge**
  - Rational Method

FINANCIAL

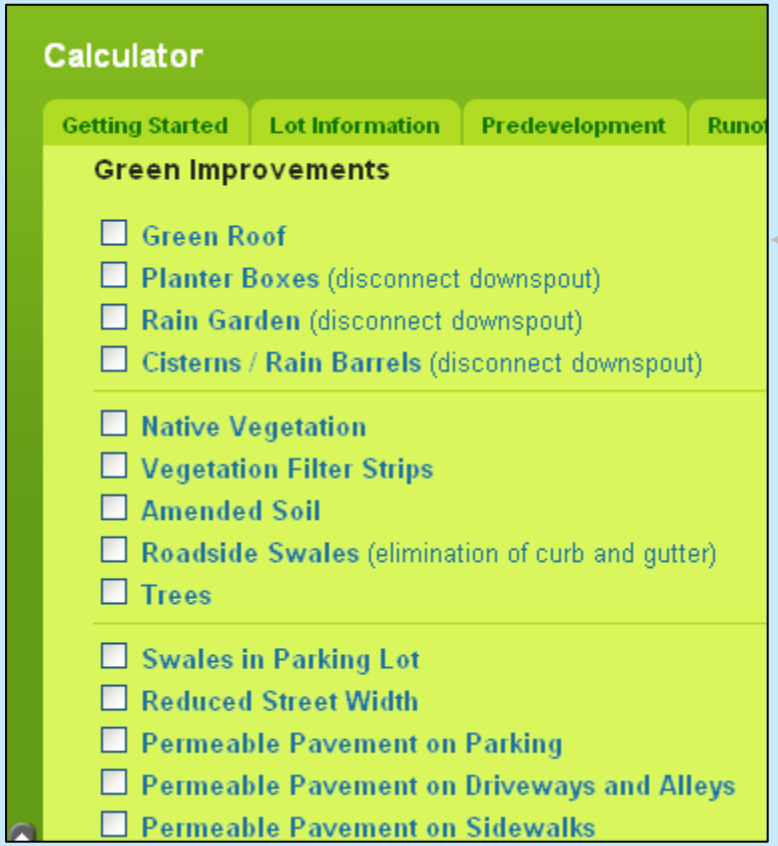
- **Life Cycle Costs**
- **Unit costs and lifespan data from literature review**
- **Monetized benefits from literature review**

All calculations and assumptions fully documented

Supporting calculations are provided in separate detail tabs

National Green Values Calculator

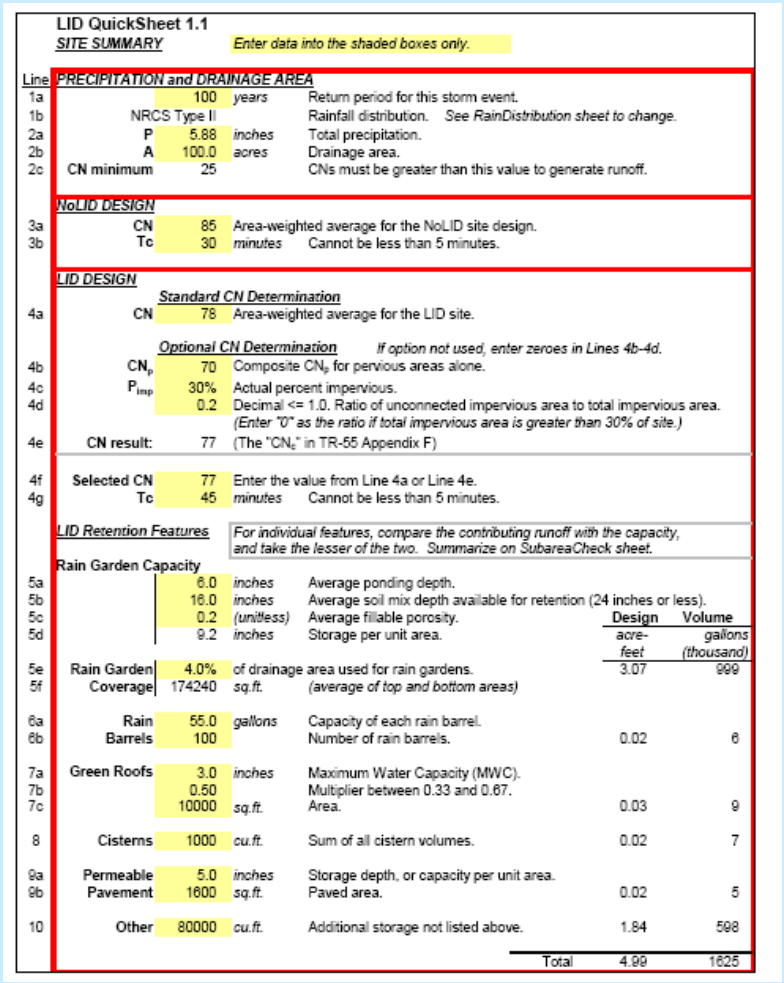
Center for Neighborhood Technology



- Expanded calculator
- Limited to site level
- Contains broader range of green practices
- Calculates runoff volume reduction (no peak flow)
- Uses historic precipitation data, not design storms
- Compare against specific management goal
- Expected to be released later this spring

LID Quicksheet

Milwaukee Metropolitan Sewerage District



LID QuickSheet 1.1

SITE SUMMARY — *Enter data into the shaded boxes only.*

Line				
	PRECIPITATION and DRAINAGE AREA			
1a		100	*years*	Return period for this storm event.
1b		NRCS Type II		Rainfall distribution. *See RainDistribution sheet to change.*
2a	P	5.88	*inches*	Total precipitation.
2b	A	100.0	*acres*	Drainage area.
2c	CN minimum	25		CNs must be greater than this value to generate runoff.
	NoLID DESIGN			
3a	CN	85		Area-weighted average for the NoLID site design.
3b	Tc	30	*minutes*	Cannot be less than 5 minutes.
	LID DESIGN			
		Standard CN Determination		
4a	CN	78		Area-weighted average for the LID site.
		Optional CN Determination		*If option not used, enter zeroes in Lines 4b-4d.*
4b	CN_p	70		Composite CN_p for pervious areas alone.
4c	P_{imp}	30%		Actual percent impervious.
4d		0.2		Decimal <= 1.0. Ratio of unconnected impervious area to total impervious area. *(Enter "0" as the ratio if total impervious area is greater than 30% of site.)*
4e	CN result:	77		(The "CN_c" in TR-55 Appendix F)
4f	Selected CN	77		Enter the value from Line 4a or Line 4e.
4g	Tc	45	*minutes*	Cannot be less than 5 minutes.

LID Retention Features — *For individual features, compare the contributing runoff with the capacity, and take the lesser of the two. Summarize on SubareaCheck sheet.*

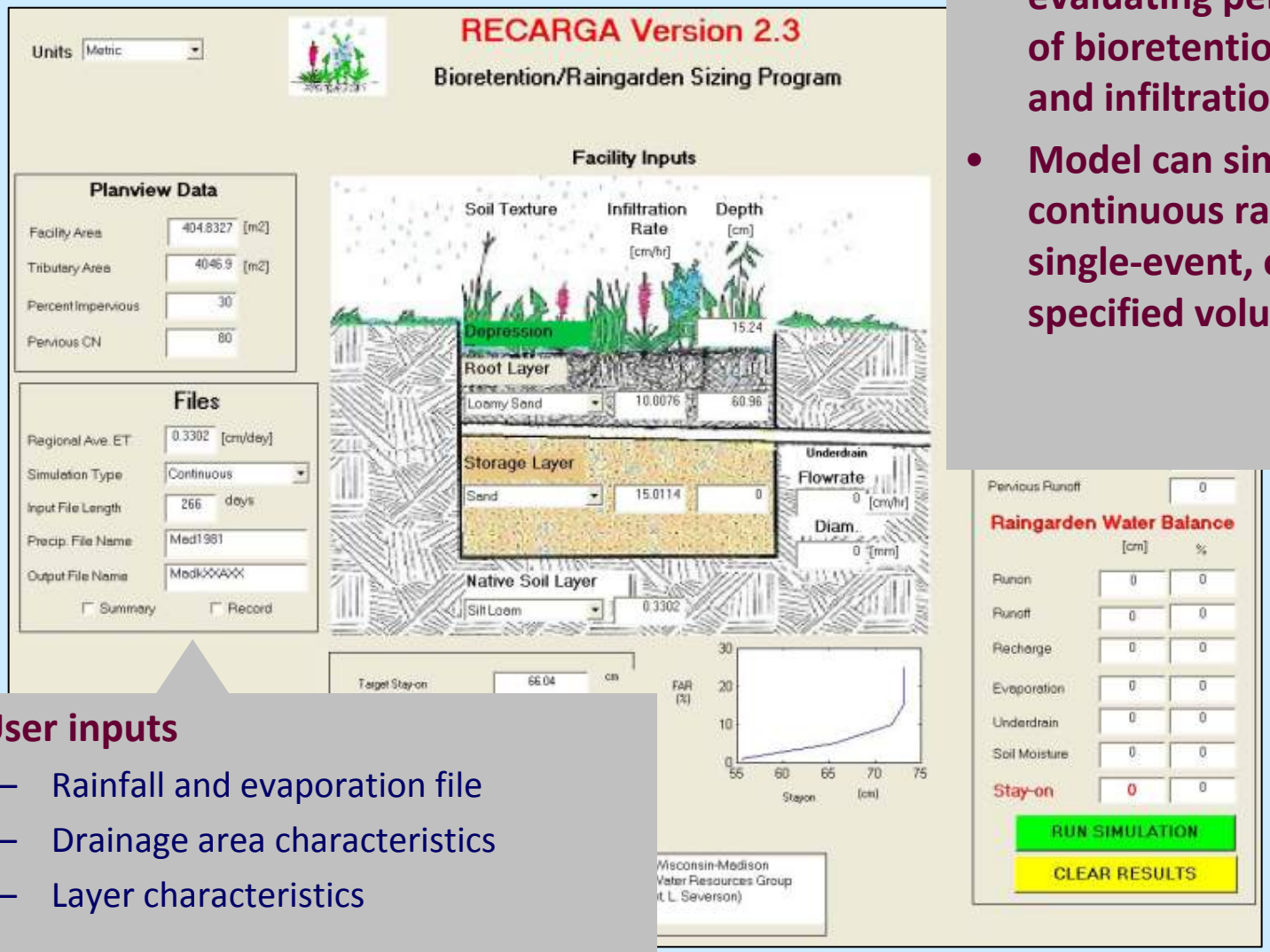
Line					Design acre-feet	Volume gallons (thousand)
	Rain Garden Capacity					
5a		6.0	*inches*	Average ponding depth.		
5b		16.0	*inches*	Average soil mix depth available for retention (24 inches or less).		
5c		0.2	*(unitless)*	Average fillable porosity.		
5d		9.2	*inches*	Storage per unit area.		
5e	Rain Garden	4.0%		of drainage area used for rain gardens.	3.07	999
5f	Coverage	174240	*sq.ft.*	*(average of top and bottom areas)*		
6a	Rain	55.0	*gallons*	Capacity of each rain barrel.		
6b	Barrels	100		Number of rain barrels.	0.02	6
7a	Green Roofs	3.0	*inches*	Maximum Water Capacity (MWC).		
7b		0.50		Multiplier between 0.33 and 0.67.		
7c		10000	*sq.ft.*	Area.	0.03	9
8	Cisterns	1000	*cu.ft.*	Sum of all cistern volumes.	0.02	7
9a	Permeable	5.0	*inches*	Storage depth, or capacity per unit area.		
9b	Pavement	1600	*sq.ft.*	Paved area.	0.02	5
10	Other	80000	*cu.ft.*	Additional storage not listed above.	1.84	598
				Total	4.99	1625

- **Excel spreadsheet**
- **Evaluates various green infrastructure features on a development site to reduce detention requirements**
- **Can evaluate 2-year and 100-year, 24 hour storm events**
- **Practices include:**
  - **Rain gardens**
  - **Rain barrels**
  - **Green roofs**
  - **Cisterns**
  - **Permeable pavement**

RECARGA

University of Wisconsin-Madison

- **MATLAB application**
- **Design tool for evaluating performance of bioretention facilities and infiltration basins**
- **Model can simulate continuous rainfall, a single-event, or user specified volume**

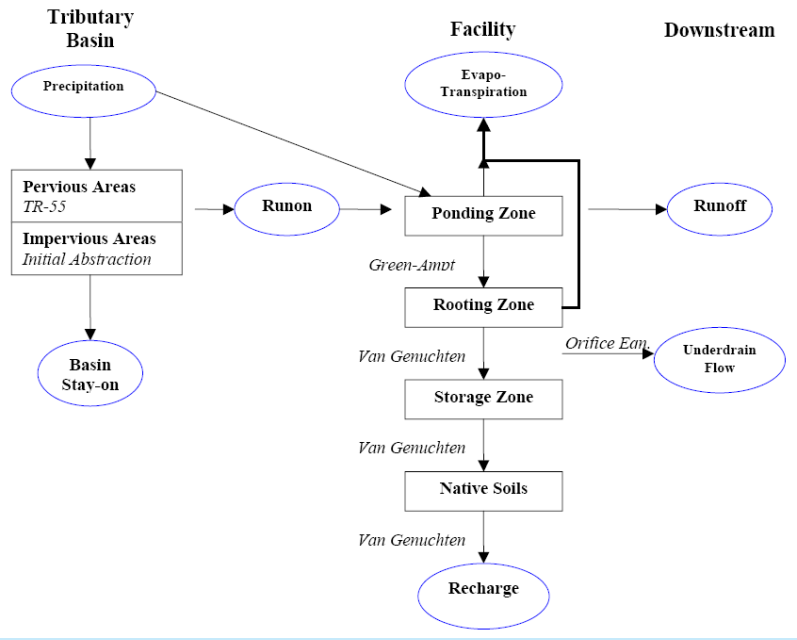


- **User inputs**
  - Rainfall and evaporation file
  - Drainage area characteristics
  - Layer characteristics

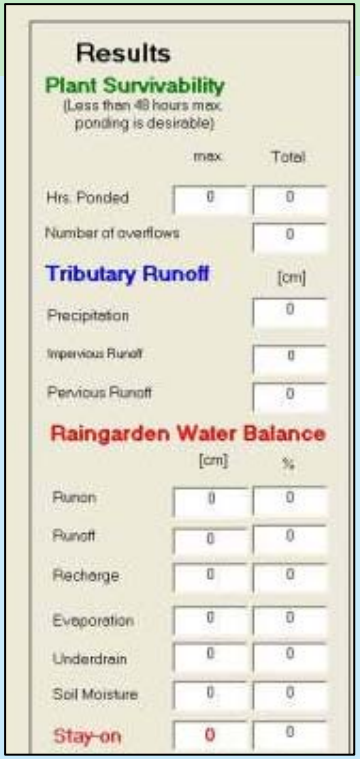
RECARGA

Calculations and Results

- **Model calculates movement of water through facility and water balance at each time step**



- **Results shown in application**
  - Plant Survivability
  - Tributary Runoff
  - Rain Garden Water Balance
- **Summary output text file**
- **Record file output with water balance quantities for each time step**



Long-Term Hydrologic Impact Assessment Model

Local Government Environmental Assistance Network

LAND USE	SCENARIO 1 Area	HYD. SOIL GROUP (View Maps)	SELECT Land use Similar to the Custom Land use	Modify EMC Values if Desired (all concer				
				Nitrogen	Phosphorou:	Susp Solids	Lead	Copper
Residential 1/4 acre	500	C	SELECT LANDUSE	1.82	0.57	41	0.009	0.009
Residential 1/8 acre	400	A	SELECT LANDUSE	1.82	0.57	41	0.009	0.009
Parking/Paved Spaces	150	D	SELECT LANDUSE	1.82	0.57	41	0.009	0.009
Residential 1/2 acre	275	A	SELECT LANDUSE	1.82	0.57	41	0.009	0.009
Grass/Pasture	1000	A	SELECT LANDUSE	0.7	0.01	1	0.005	0.010
SELECT LANDUSE		A	SELECT LANDUSE					
SELECT LANDUSE		A	SELECT LANDUSE					
SELECT LANDUSE		A	SELECT LANDUSE					
SELECT LANDUSE		A	SELECT LANDUSE					
SELECT LANDUSE		A	SELECT LANDUSE					

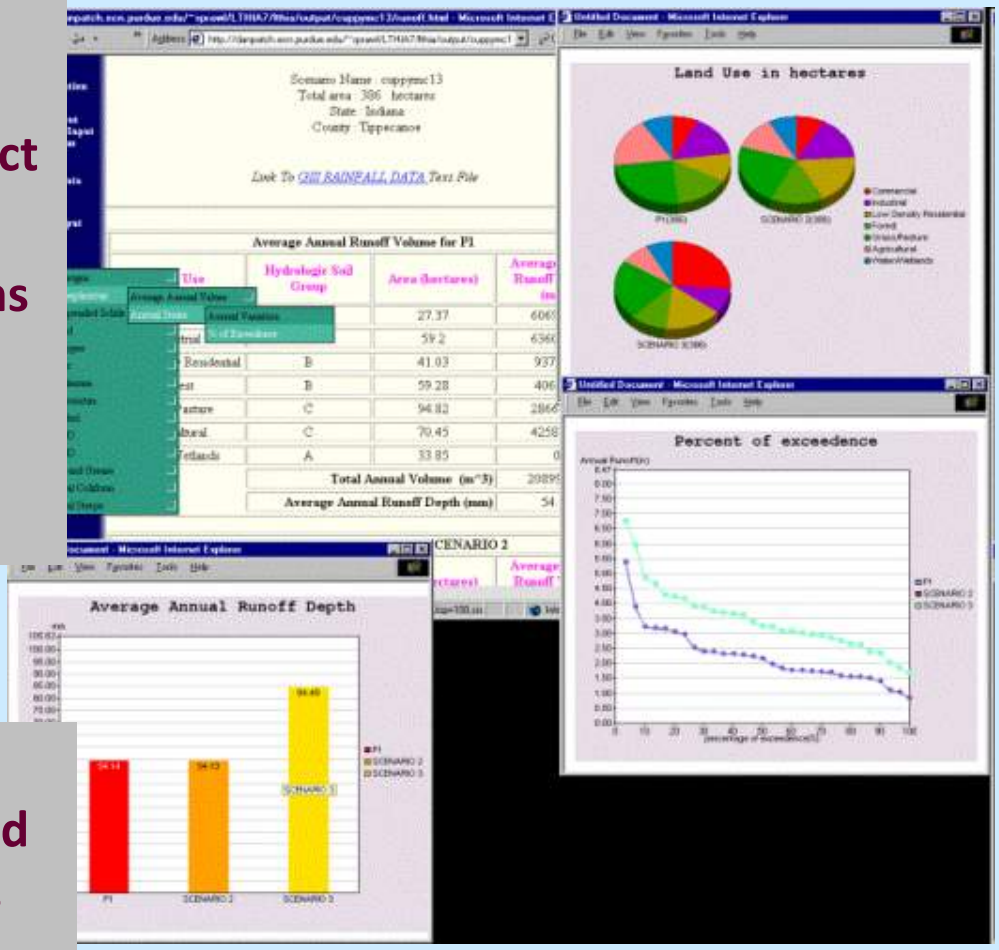
Land Use	Soil Type	Area		
(Use as many as necessary)	Check Map	Current	Scenario 1	Scenario 2
Commercial	B	10	15	0
Industrial	C	20	35	0
Agricultural	A	40	20	0
High Density Residential	B	10	20	0
Forest	A	20	10	100
SELECT LAND USE	A			
SELECT LAND USE	A			
SELECT LAND USE	A			
SELECT LAND USE	A			
	Total Area:	100	100	100

- **Web enabled tool**
- **Used to quantify the impact of land use change on water quantity and quality**
- **Five versions:**
  - **Basic L-THIA**
  - **Impervious L-THIA**
  - **GIS L-THIA**
  - **Detailed Input L-THIA**
  - **Advanced Input L-THIA**

Long-Term Hydrologic Impact Assessment Model

Calculations and Results

- **Uses Runoff Curve Number approach**
- **Uses 30 years of precipitation data to predict yearly runoff**
- **Event Mean Concentrations are used to estimate pollutant loading**



- **Provides graphical and tabular runoff volumes and associated pollutant loads**

Pollutant Load and Reduction Model

Comprehensive Environmental Inc (CEI)

- **Excel-based tool**
- **Site level calculations of pollutant load reductions based on BMPs**
- **Assign area, landuse category, and BMPs to each watershed**

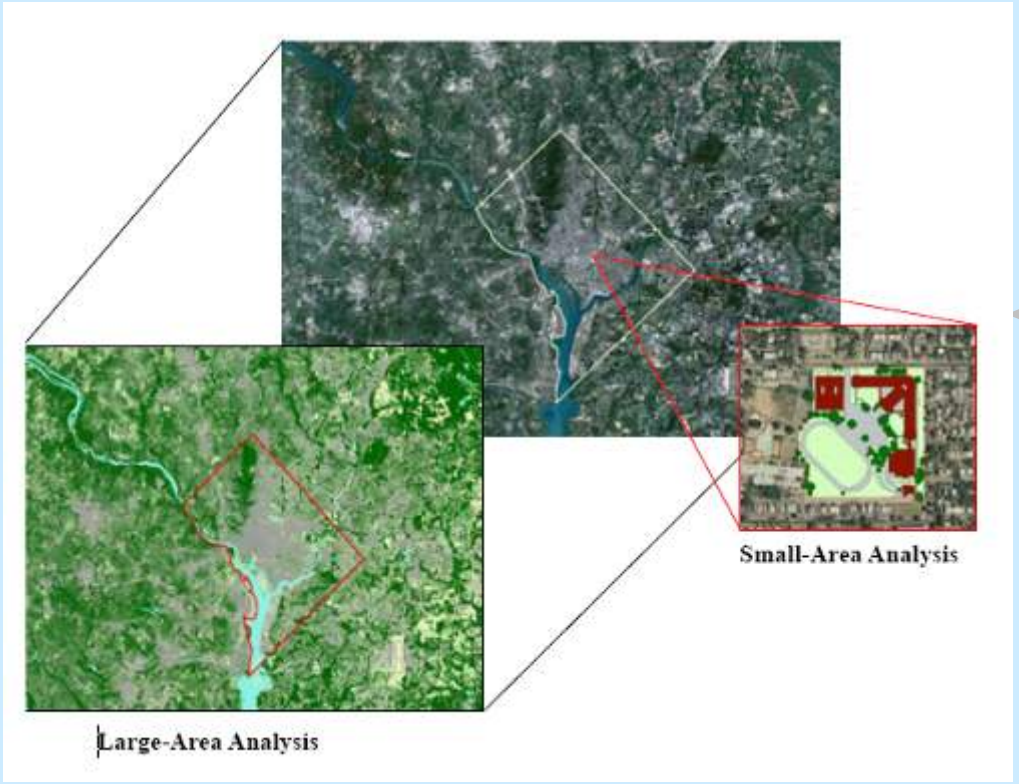
- **Literature values for**
  - **% impervious**
  - **Pollutant loading**
  - **Pollutant removal efficiency**
- **Uses Simple Method to calculate pollutant removal results**
  - **Annual TSS removed**
  - **Annual TP removed**
  - **Annual TN removed**

No.	Watershed Name	Landuse	Area (acres)
1	AF-1	Industrial	450.00
2	AF-2	Commerical	122.00
3	AF-3	Residential-Low Density	380.00
4	AF-4	Residential-High Density	226.00
5	LG-6	Comm	
6			

No.	Watershed Name	BMP Type	BMP Drainage Area (acres)	TSS Removal (%)	TP Removal (%)	TN Removal (%)	Annual TSS Removed (lbs)	Annual TP Removed (lbs)	Annual TN Removed (lbs)
1	AF-1	Constructed Wetland		80%	55%	30%	0	0.00	0.0
2	#REF!	Infiltration - 1"		90%	65%	58%	0	0.00	0.0
3	AF-2	Raingarden - 1"		90%	65%	58%	0	0.00	0.0
4	AF-3	Baffle Tank		70%	30%	0%	0	0.00	0.0
5	LG-6	Constructed Wetland		80%	55%	30%	0	0.00	0.0
6							0	0.00	0.0

CityGreen

American Forests

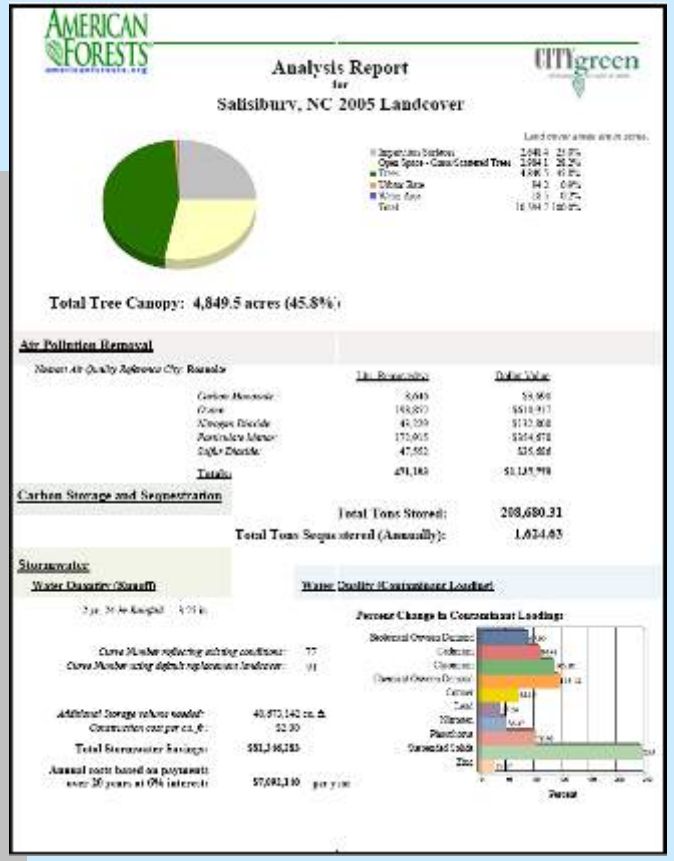


- ArcGIS extension (not free)
- Analyzes ecological and economic benefits of tree canopy and other green space for any size area
- Analyzes user provided land cover raster data

CityGreen

Calculations and Results

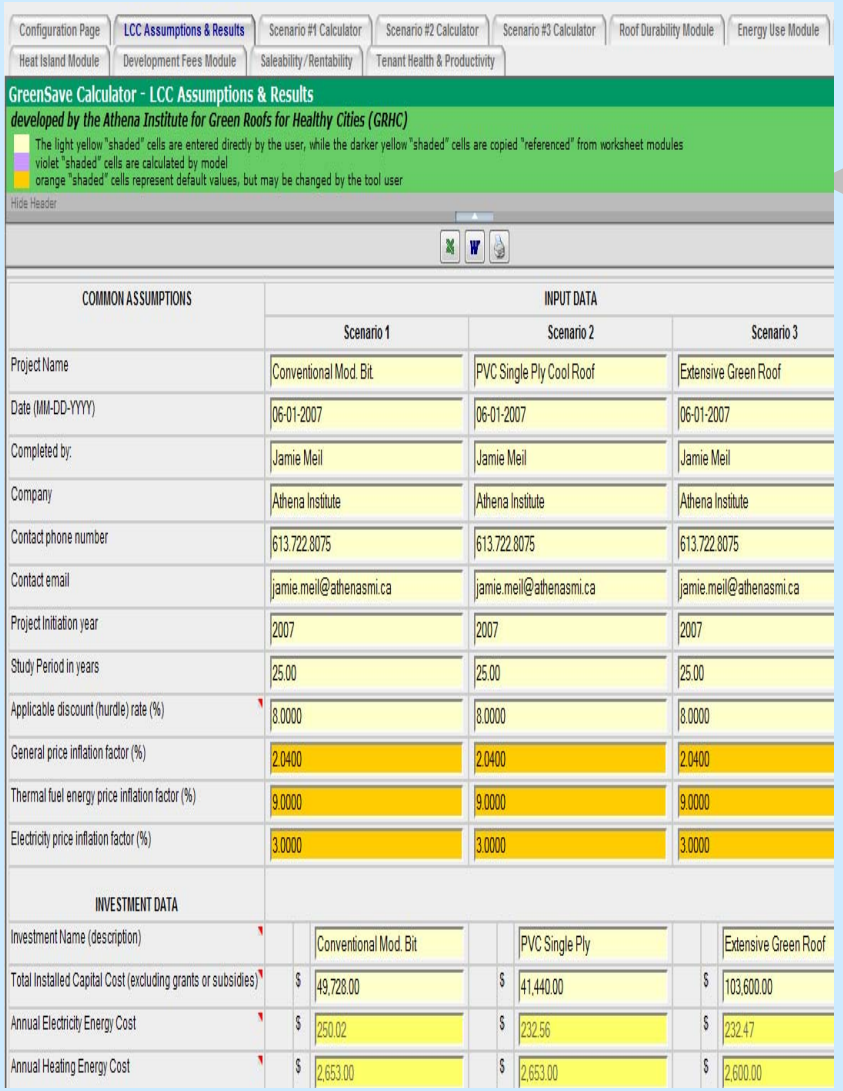
- **Stormwater Runoff**
  - Calculates runoff volume based on 2-year, 24-hour storm
  - Based on Runoff Curve Number (TR-55)
- **Air Pollution Removal**
  - Calculates pollutant removal capacity of tree canopy and financial benefit
  - Based on US Forest Service air pollution model
- **Carbon Storage and Sequestration**
  - Calculates amount of carbon stored in trees and annual carbon removal
  - Based on US Forest Service model



- **Additional free web-based air pollution calculator**

GreenSave Calculator

Green Roofs for Healthy Cities



Configuration Page | LCC Assumptions & Results | Scenario #1 Calculator | Scenario #2 Calculator | Scenario #3 Calculator | Roof Durability Module | Energy Use Module | Heat Island Module | Development Fees Module | Saleability/Rentability | Tenant Health & Productivity

GreenSave Calculator - LCC Assumptions & Results

developed by the Athena Institute for Green Roofs for Healthy Cities (GRHC)

The light yellow "shaded" cells are entered directly by the user, while the darker yellow "shaded" cells are copied "referenced" from worksheet modules
violet "shaded" cells are calculated by model
orange "shaded" cells represent default values, but may be changed by the tool user

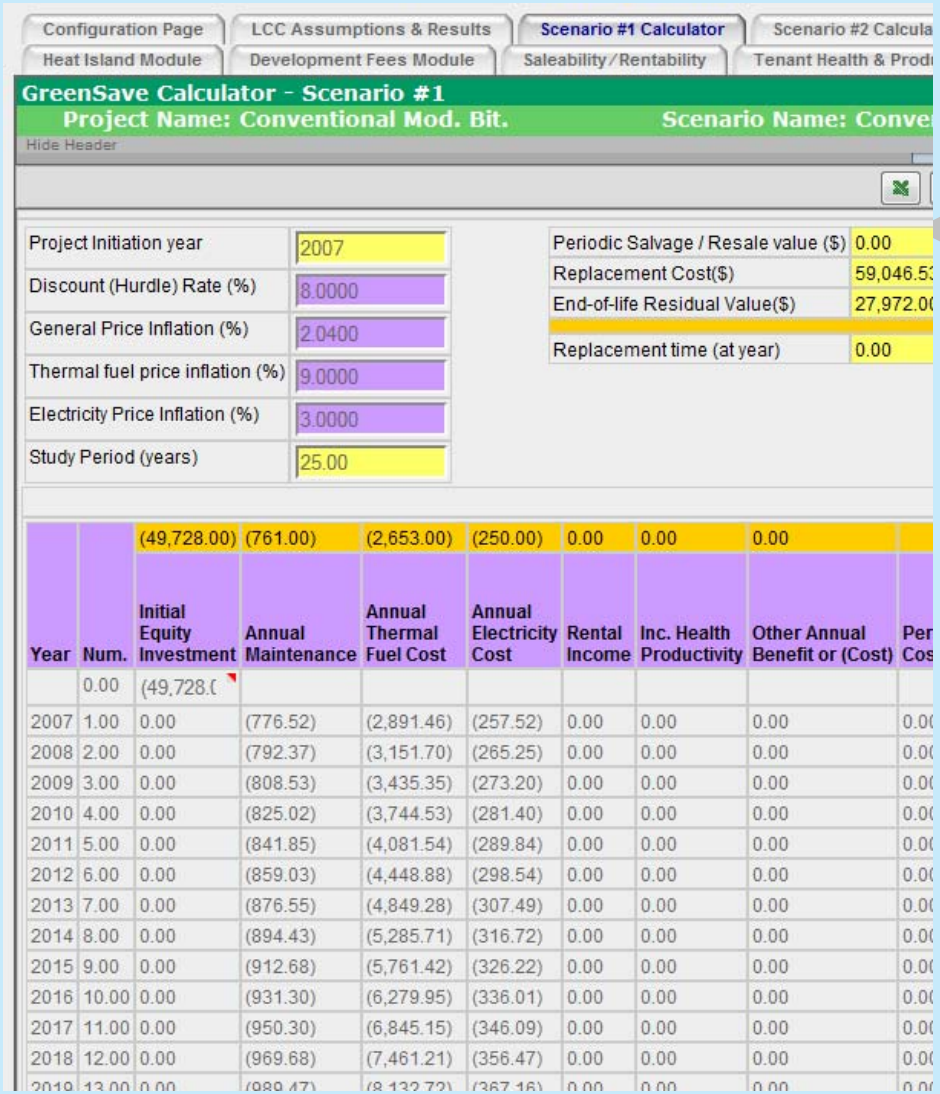
Hide Header

COMMON ASSUMPTIONS	INPUT DATA		
	Scenario 1	Scenario 2	Scenario 3
Project Name	Conventional Mod. Bit	PVC Single Ply Cool Roof	Extensive Green Roof
Date (MM-DD-YYYY)	06-01-2007	06-01-2007	06-01-2007
Completed by:	Jamie Meil	Jamie Meil	Jamie Meil
Company	Athena Institute	Athena Institute	Athena Institute
Contact phone number	613.722.8075	613.722.8075	613.722.8075
Contact email	jamie.meil@athenasmi.ca	jamie.meil@athenasmi.ca	jamie.meil@athenasmi.ca
Project Initiation year	2007	2007	2007
Study Period in years	25.00	25.00	25.00
Applicable discount (hurdle) rate (%)	8.0000	8.0000	8.0000
General price inflation factor (%)	2.0400	2.0400	2.0400
Thermal fuel energy price inflation factor (%)	9.0000	9.0000	9.0000
Electricity price inflation factor (%)	3.0000	3.0000	3.0000
INVESTMENT DATA			
Investment Name (description)	Conventional Mod. Bit	PVC Single Ply	Extensive Green Roof
Total Installed Capital Cost (excluding grants or subsidies)	$ 49,728.00	$ 41,440.00	$ 103,600.00
Annual Electricity Energy Cost	$ 250.02	$ 232.56	$ 232.47
Annual Heating Energy Cost	$ 2,653.00	$ 2,653.00	$ 2,600.00

- **Web-enabled tool (registration required)**
- **Life-cycle costing tool used to compare cost of green roof with conventional roof**
- **Option to publish data to Case Study database**
- **Modules with minimum and optional detailed data inputs**
  - **Roof durability**
  - **Energy use**
  - **Stormwater**
  - **Heat island**
  - **Development fees**
  - **Saleability/rentability**
  - **Tenant health and productivity**

GreenSave Calculator

Results



- **Compare up to three roofing configurations**
- **Results table includes:**
  - Annual cash flows by cost/savings element
  - Resultant total cash flow for individual years on both a nominal and discounted basis
  - Calculated life cycle cost results for investment over the expected life

Other Simple Models and Calculators

- LTCP-EZ (EPA, LimnoTech)
- TSA Design Tools (T.E. Scott and Associates)
- Site Evaluation Tool (SET) (Tetra Tech)
- Storm Water Runoff Volume Calculator (UC Davis Extension)
- Urban Forest Effects Model (UFORE) (USDA Forest Service)
- Street Tree Management Tool for Urban Forest Managers (STRATUM) (Center for Urban Forest Research)
- Rainwater Harvester Design Model (NC State Cooperative Extension)
- Bioretention Thermal Model (NC State Cooperative Extension)
- Watershed Treatment Model (Center for Watershed Protection)

- MORE?

More Complicated Models

Hydrologic Model

- Simulates flow of water over land surface

Hydraulic Model

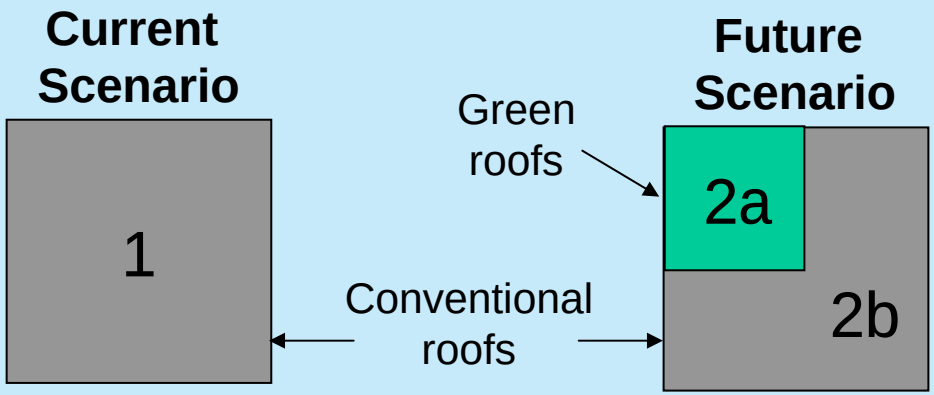
- Simulates flow of water through pipe network

- **EPA Stormwater Management Model (SWMM)**
- **EPA System for Urban Stormwater Treatment and Analysis INtegration (SUSTAIN)**
- **Model for Urban Sewers (MOUSE)**
- **Program for Predicting Polluting Particle Passage through Pits, Puddles, and Ponds (P8)**
- **Hydrological Simulation Program – Fortran (HSPF)**
- **Hydrologic Modeling System (HEC-HMS)**
- **Source Loading and Management Model (WinSLAMM)**
- **Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)**
- **Prince George's County (MD) Best Management Practice Decision Support System (PG BMP-DSS)**

More Complicated Models

- **Uses**
  - Evaluate watershed impacts of land use decisions
  - More accurately approximate stormwater benefits of green infrastructure
  - Can be used for single-event or continuous simulation
- **Limitations**
  - Data intensive
  - Require specific expertise to utilize

More Complicated Models



- **Create catchments based on land use or surface type**
- **Assign parameter values to each catchment**
  - Infiltration rates
  - Slopes
  - Dimensions/travel time
  - Surface roughness
  - Depression storage

- **Typical Data Needs**
  - Topography
  - Soil types
  - Meteorological records
  - Evapotranspiration rates
  - Built structures (roads, buildings, other impervious, etc.)
  - Pipe network and control structures
  - Flow meter data

Washington, DC

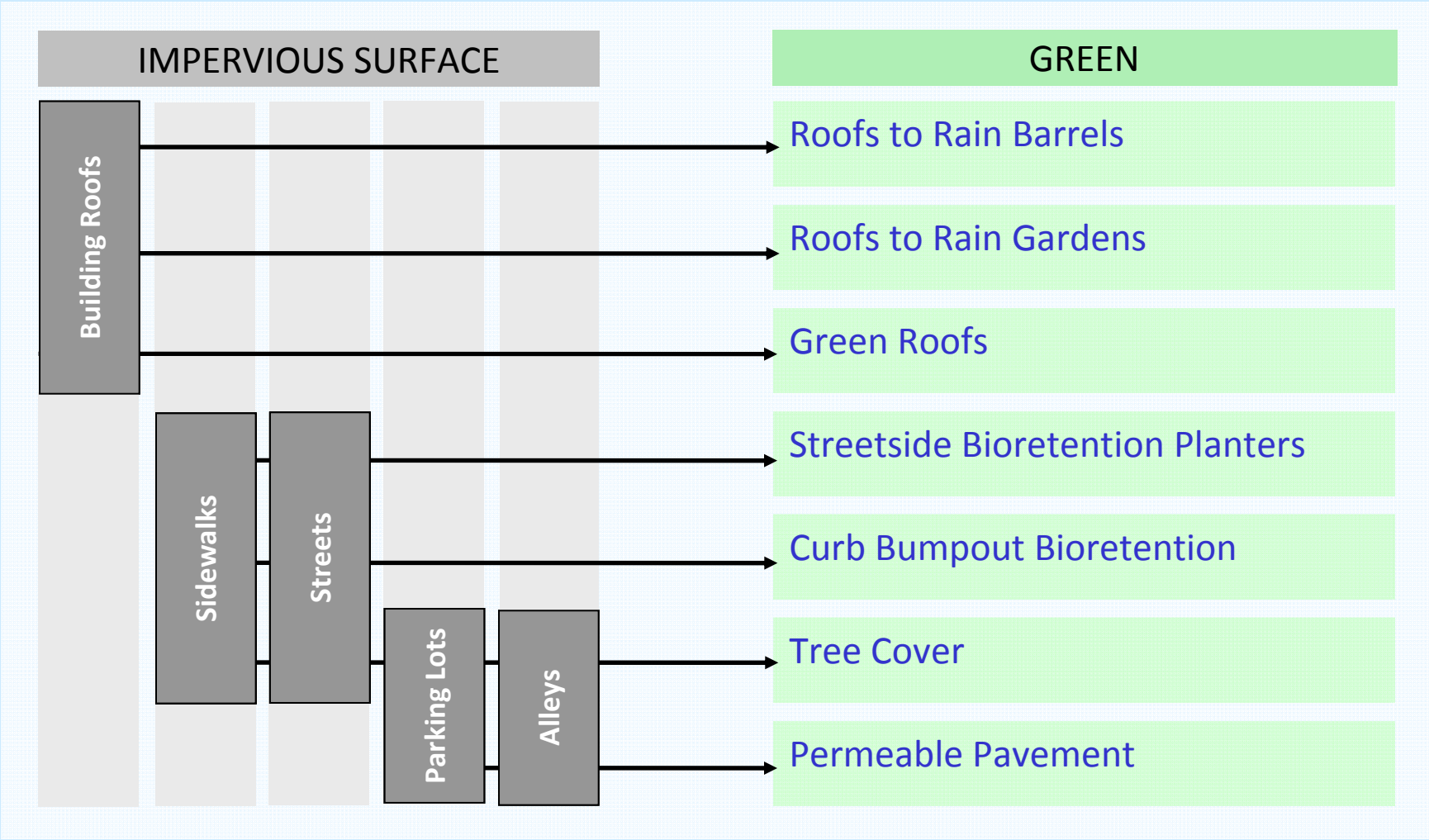
Green Build-out Model Overview

- **Objective**
  - Quantify the contribution that green infrastructure could make towards reducing storm-water runoff and volumes and frequencies of discharge to the District's rivers

- **Approach**
  - Developed conceptual plan for integrating green infrastructure into landscape
  - Performed detailed GIS analysis to identify opportunities for green infrastructure retrofits
  - Modified existing H&H model for the District (MOUSE)

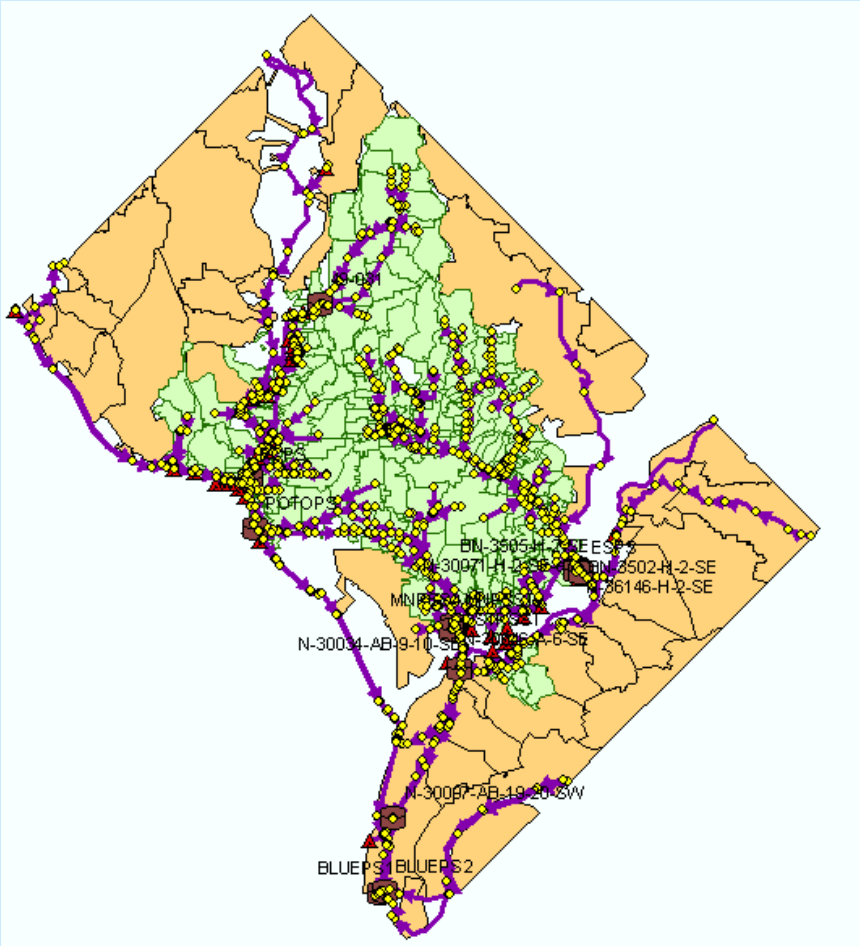
Washington, DC

Conceptual Plan and Opportunity Analysis



Washington, DC

Model Details

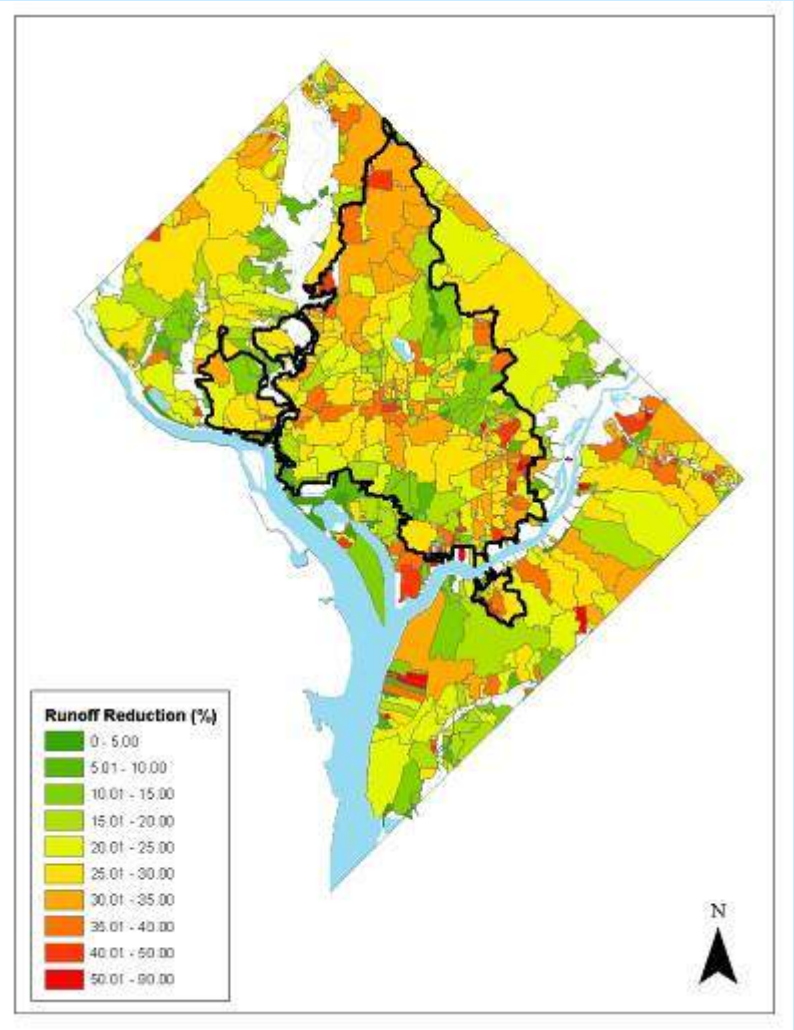


- **H&H model used by WASA for LTCP development**
- **Calibrated to actual flow data**
- **Add MS4 area to model**
- **Modify inputs to mimic green infrastructure**
  - Storage
  - Infiltration
  - Surface roughness
  - Potential evapotranspiration
- **Continuous simulation, hourly precipitation data, average year**

Washington, DC

Model Results

- **Annual reduction of runoff**
  - District wide - 4.3 billion gallons (26%)
  - Greater than 50% reductions in individual sewersheds
- **Annual reduction of discharges to rivers**
  - District-wide - 3 billion gallons (30%)
  - CSS area - 1 billion gallons (43%)



Cincinnati

MSDGC LID Assessment

- **Objective**
  - "Derive a preliminary estimate of LID control requirements and effectivenes over a range of reasonable LID implementation scenarios within MSDGC's CSO area"

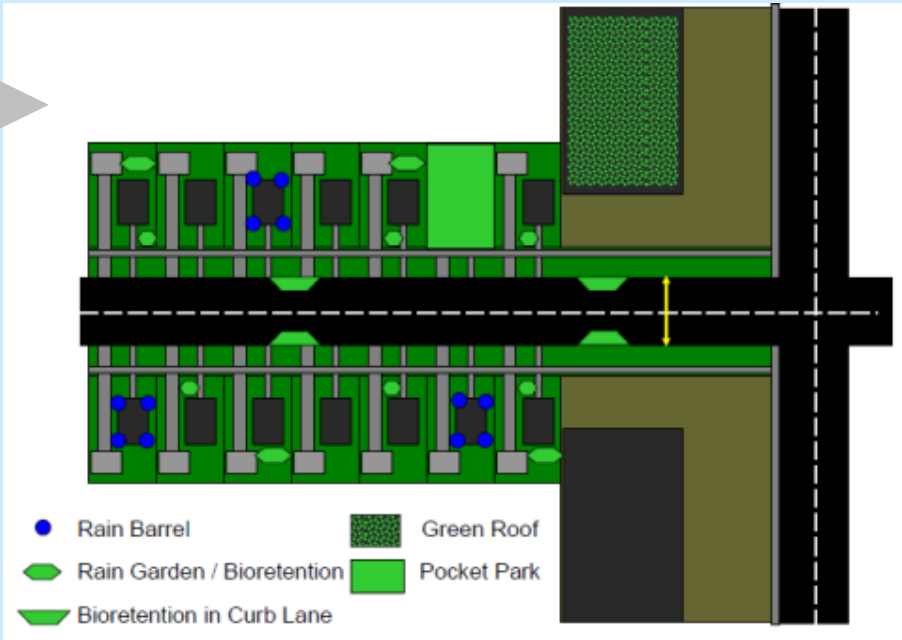
Photo: AP/Al Behrman

- **Approach**
  - Performed detailed land use characterization
  - Identified LID opportunities
  - Modeled representative CSO sewershed (Lick Run)
  - Applied modeled sewershed findings to entire CSO area

Cincinnati

LID Opportunities in Lick Run Sewershed

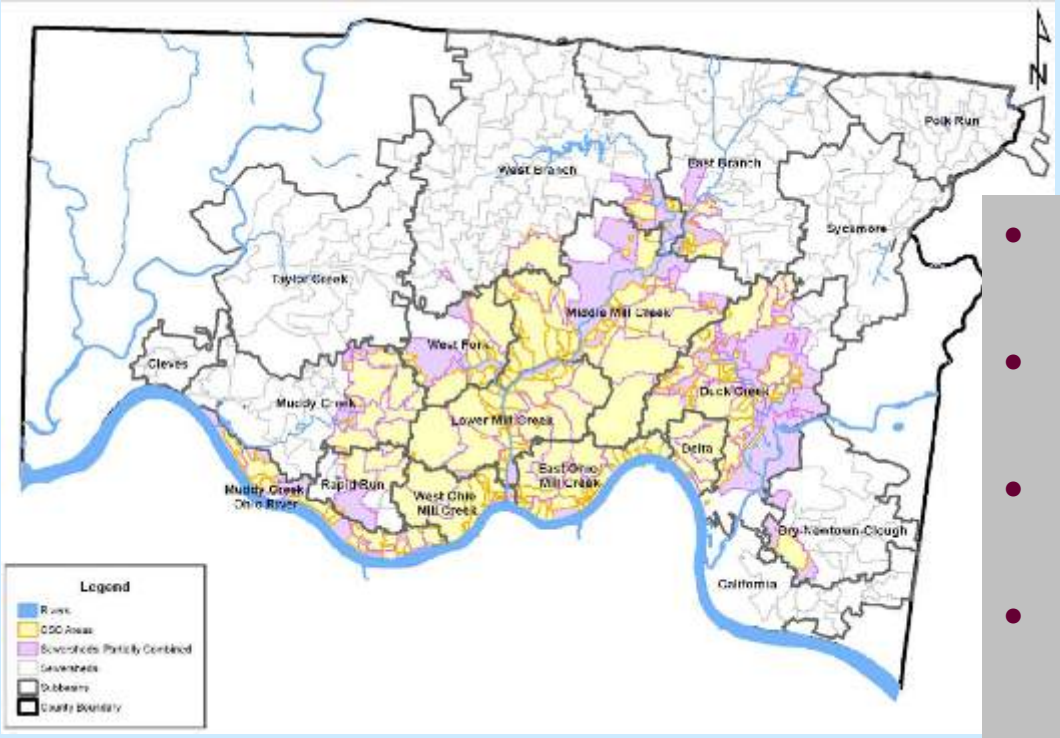
- **LID Opportunities**
  - Roof tops
    - Green roofs and roof top storage
    - Roof leader disconnection and bioretention
  - Parking/driveways
    - Bioretention
    - Permeable pavement
  - Streets
    - Curb-side bioretention
    - Infiltration swales



- **Land Use Characterization**
- **Scenario Development**

Cincinnati

Model Details



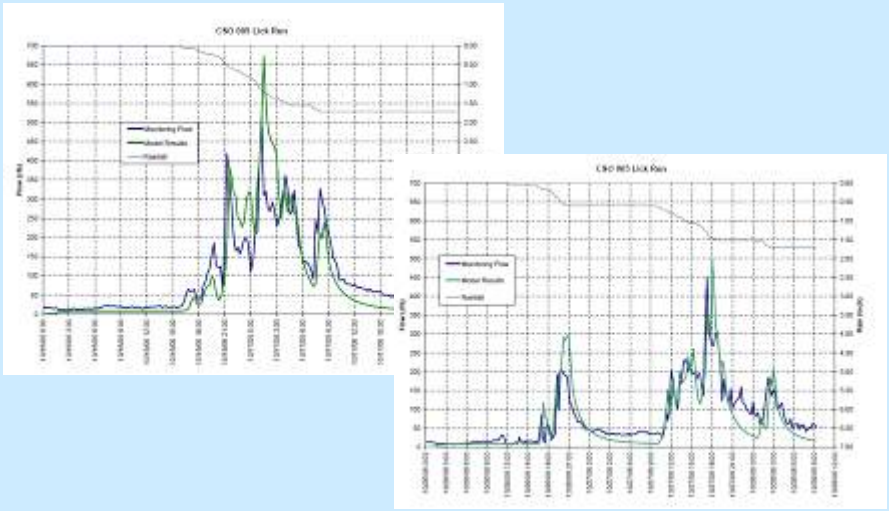
- **Used SWMM-based System Wide Model**
- **Modified subcatchments for base model and recalibrated**
- **Added subcatchments with green infrastructure practices**
- **Modeled three rainfall events and continuous simulation of typical year**
- **Spreadsheet evaluation to examine benefits across CSO area**

Cincinnati

Model Results

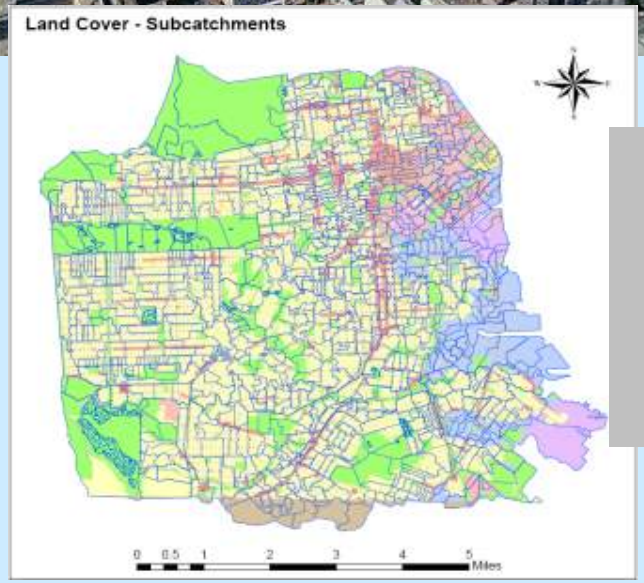
- **Lick Run Model Results**
  - Single event evaluations
    - 10% reduction in peak flow rates
    - 4 to 7% reduction in overflow volume
  - Typical year evaluations
    - Capture volume scenario = 8.9-12.6% reduction in overflow volume
    - Managed impervious surface scenario = 7.2 to 17.5% reduction in overflow volume

- **CSO Area**
  - Typical year evaluations
    - Low LID implementation = 1.5% to 13.5% runoff reduction
    - High LID implementation =3.4 to 30.6% runoff reduction



San Francisco

Green Evaluation with InfoWorks



- **Objectives**
  - Identify the extent that LID techniques could be implemented
  - Calculate the drainage improvements that could be achieved by installing LID facilities throughout the city

- **Approach**
  - Identified LID opportunities through GIS analysis
  - Modeled LID practices

San Francisco

LID Opportunity Analysis

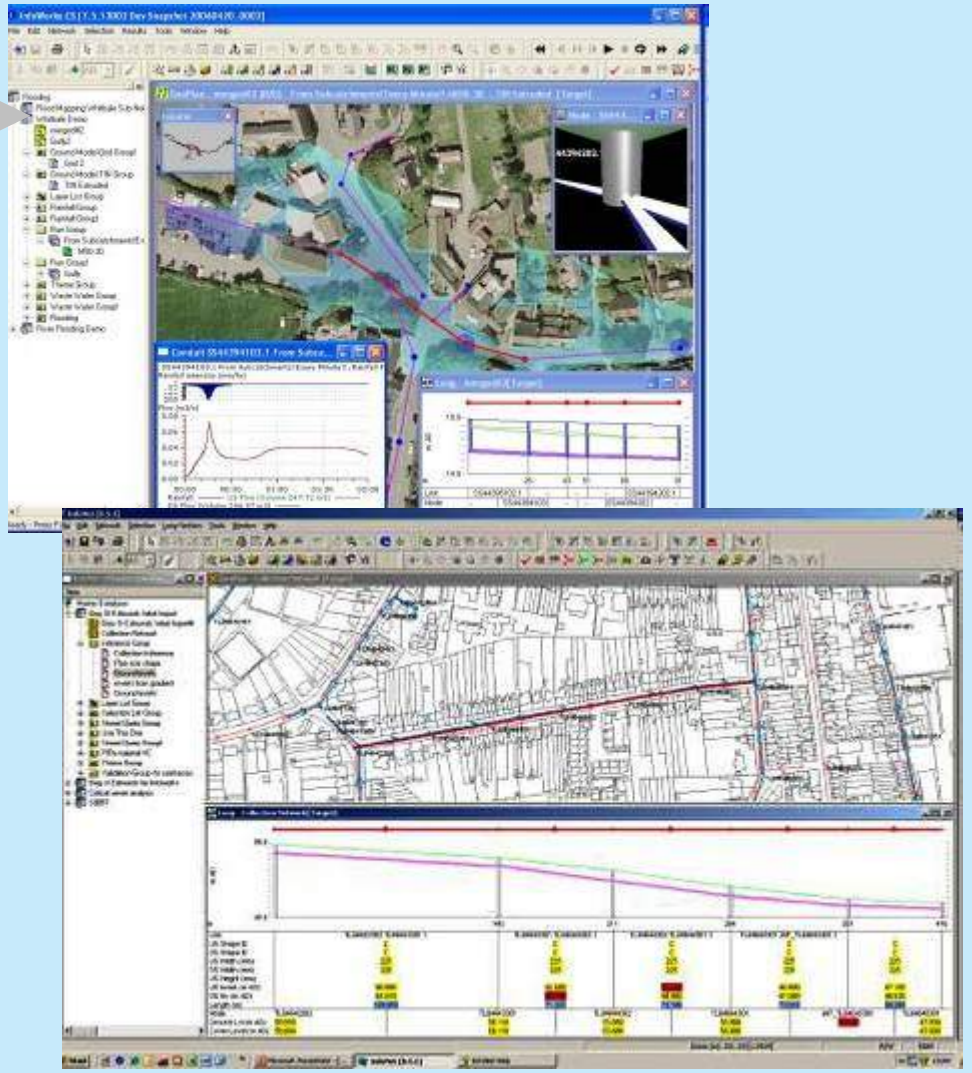
- **Performed infiltration potential analysis**
- **Created parking lot and rooftop coverage**
- **Applied siting constraints**

- **LID Opportunities**
  - Roof tops
    - Green roofs
    - Roof disconnection
  - Streets/sidewalks/parking lots
    - Tree planting
    - Lined bioretention
    - Permeable pavement

San Francisco

Model Details

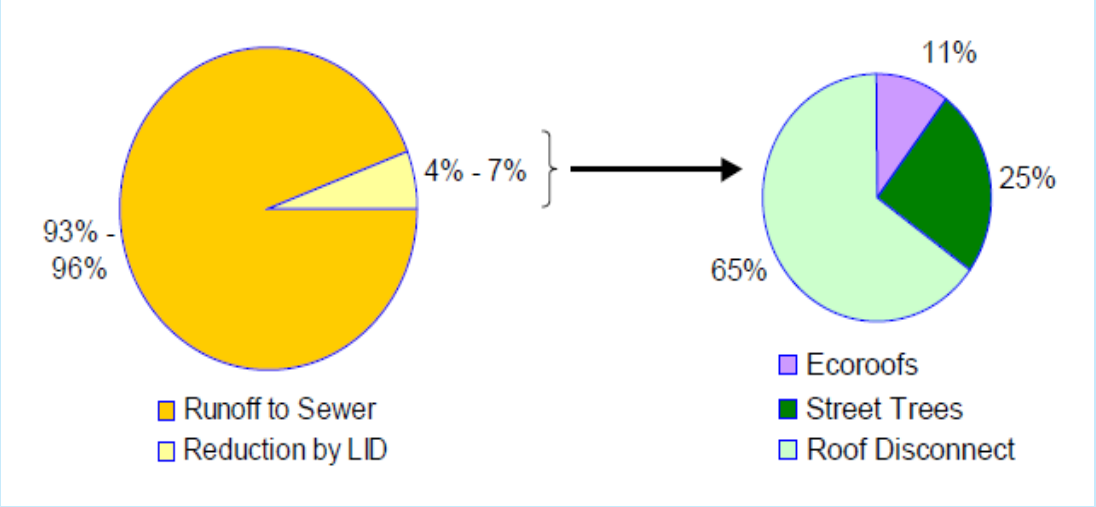
- Used existing InfoWorks collection system model
- High and low performance measures were used
- Model integration
  - Green roofs - modified roughness and depression storage
  - Rooftop disconnection - removed roof area
  - Trees - modified interception storage
  - Lined bioretention and permeable pavement – modified detention storage



San Francisco

Model Results

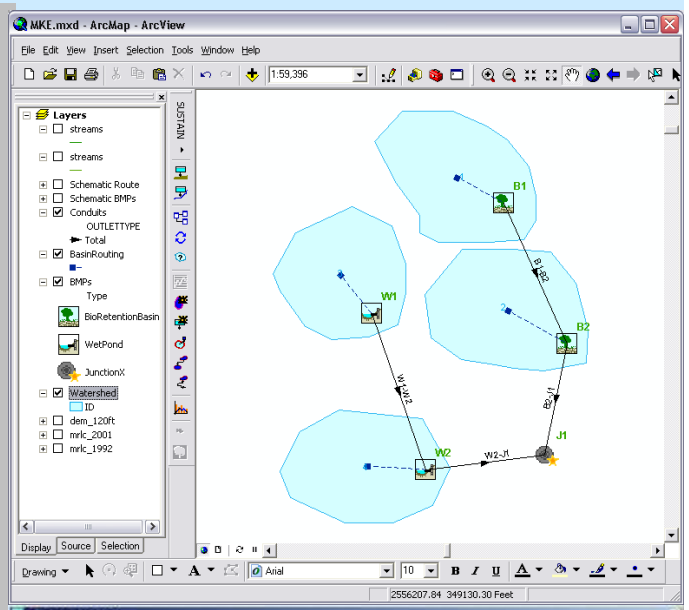
- **Runoff volume**
  - **Annual reduction of 400 to 700 MG (4 to 7%)**
  - **Green roofs = 5 to 6 gal per sq ft**
  - **Trees = 1,100 to 1,500 gal per tree**
  - **Roof disconnect = 7 to 14 gal per sq ft**
- **Peak flow rate**
  - **3-month, 24-hour = 11.3 to 15.1%**
  - **1-year, 24-hour = 10.7 to 14.6%**

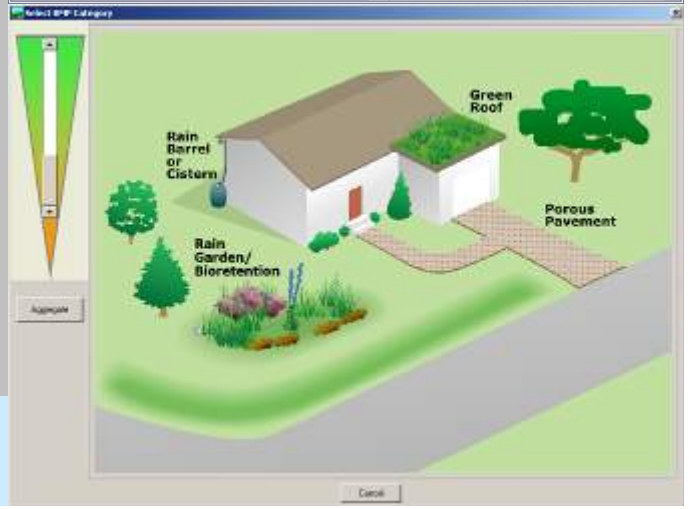


- **Lined bioretention and permeable pavement do not affect runoff volume but do affect peak flow rates**

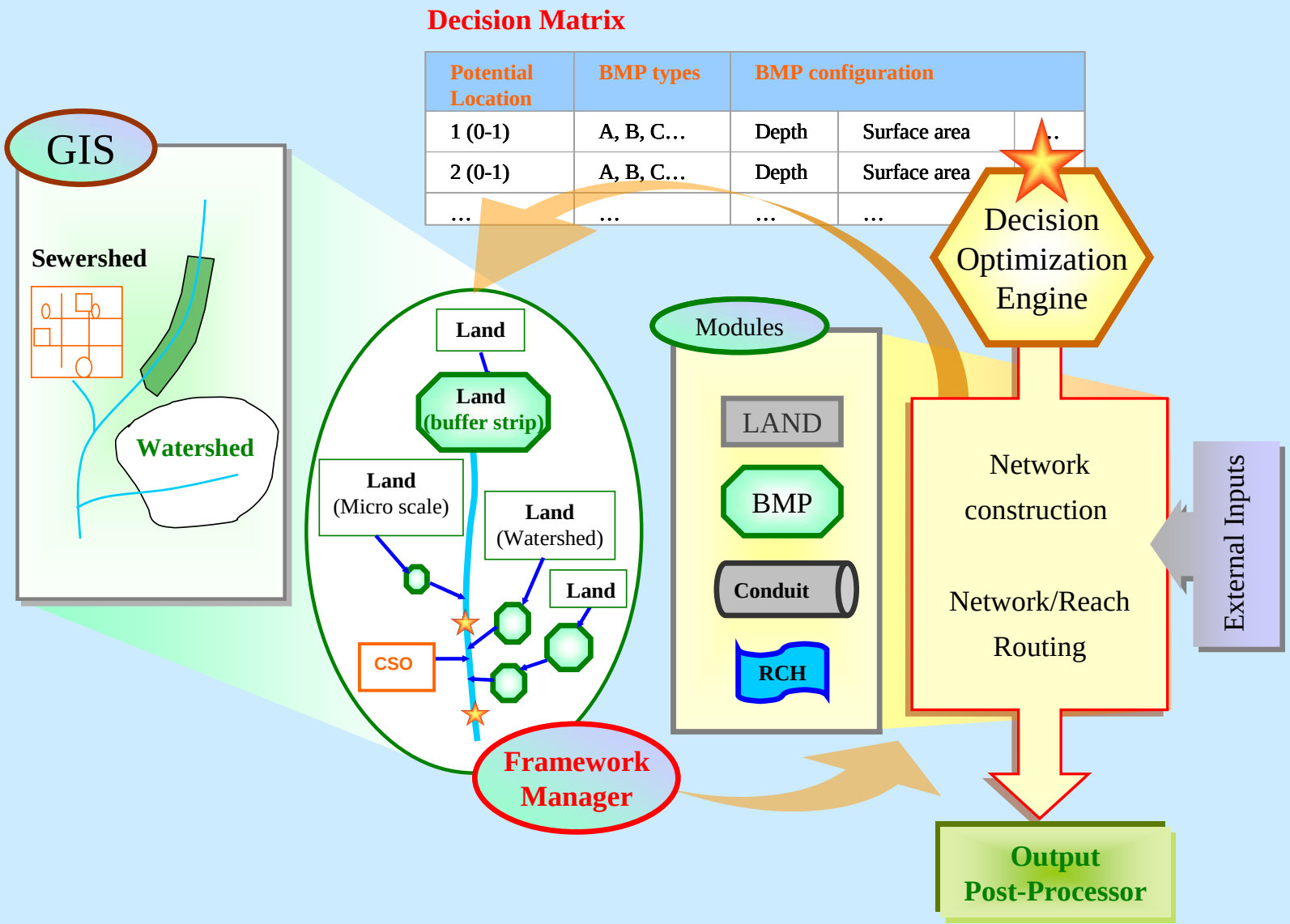
EPA System for Urban Stormwater Treatment and Analysis INtegration (SUSTAIN)

- A GIS-based framework designed to support decision-making
- Answers key questions
  - How effective are BMPs or green infrastructure techniques in reducing runoff and pollutant loadings?
  - What are the most cost effective solutions to meet water quantity and quality objectives?
  - Where, what type, and how large should they be?
- Will be released after June '09





SUSTAIN Framework Manager



Platform: ArcGIS 9.x

Conclusions

- Understand your objective
- Understand information and data requirements
- Use simplest method that can meet the objective
- Weigh whether increased accuracy is worth increased effort
- Do not forget assumptions underlying the model
- Understand significance of model results

Questions?

Contact information

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bbusiek@limno.com

LimnoTech

Water | Environment | Scientists | Engineers

Louisville: The Green City

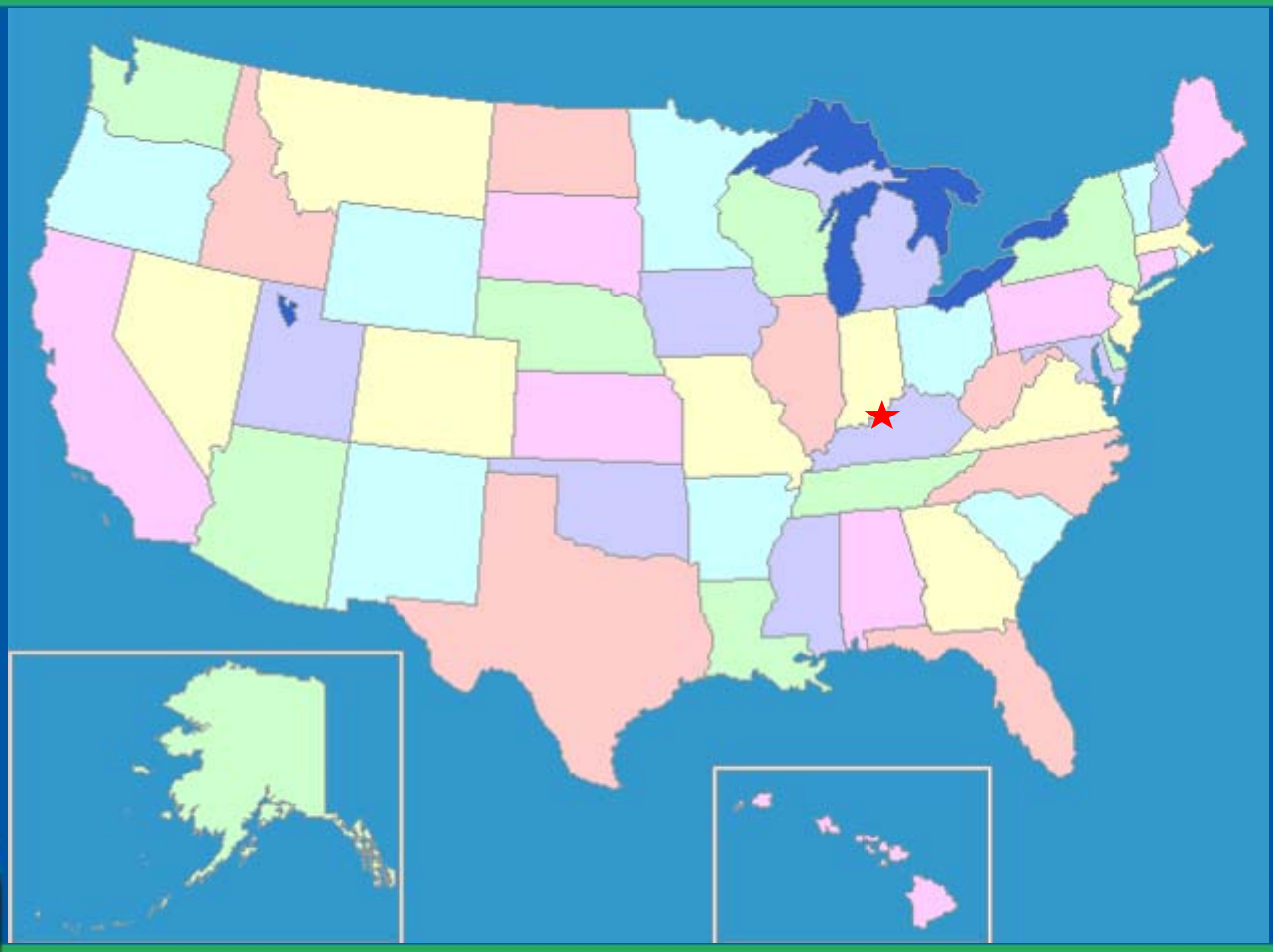
From Raindrops to Rivers:

A Vision for Integrating Green Solutions Into CSO Management

PROJECT WIN
Waterway Improvements Now

CLEAN, GREEN, GROWING COMMUNITY

Louisville, Kentucky



PROJECT WIN
Waterway Improvements Now

CLEAN, GREEN, GROWING COMMUNITY

Acknowledgements

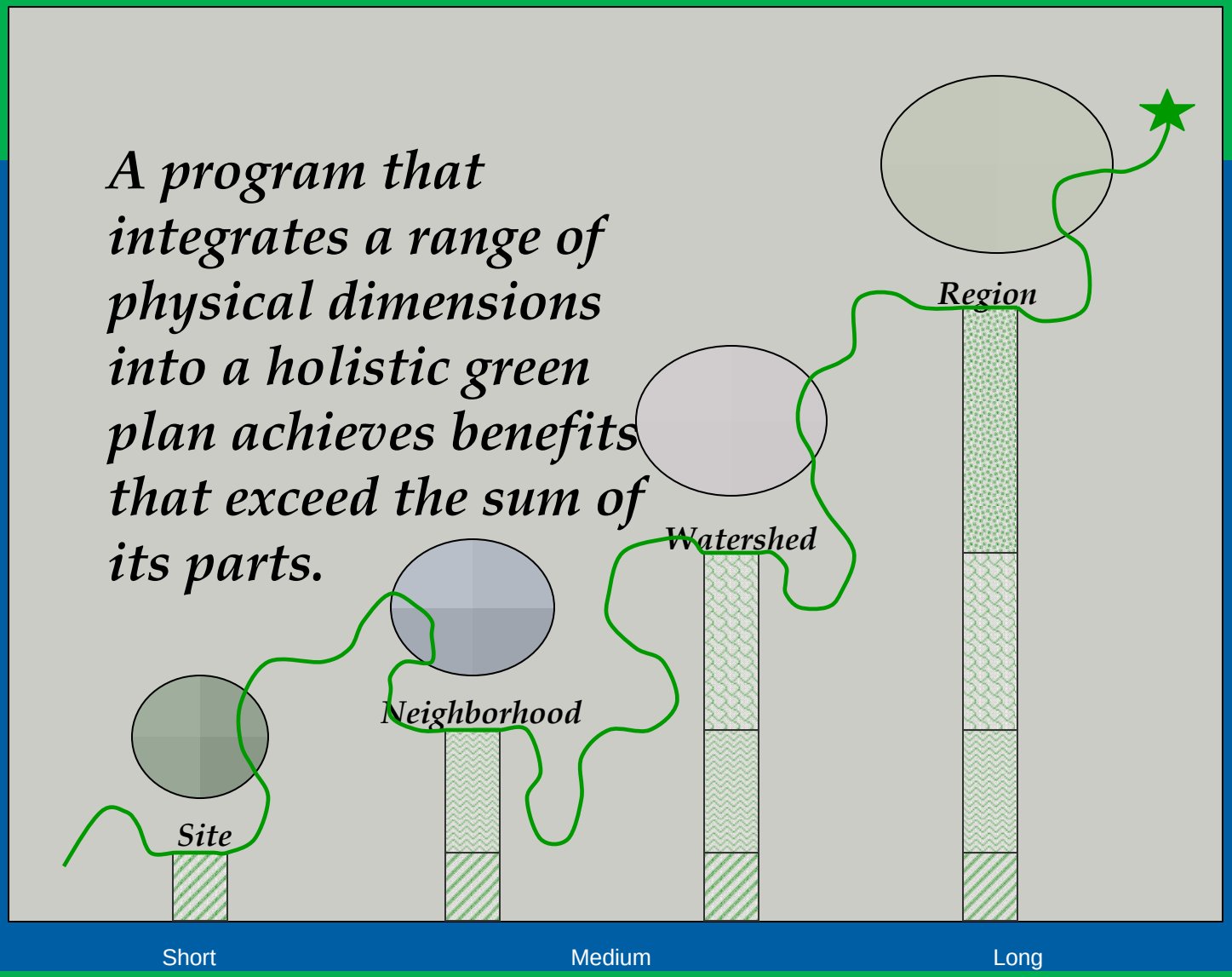
Hagerty Engineering, Inc.

CLEAN, GREEN, GROWING COMMUNITY

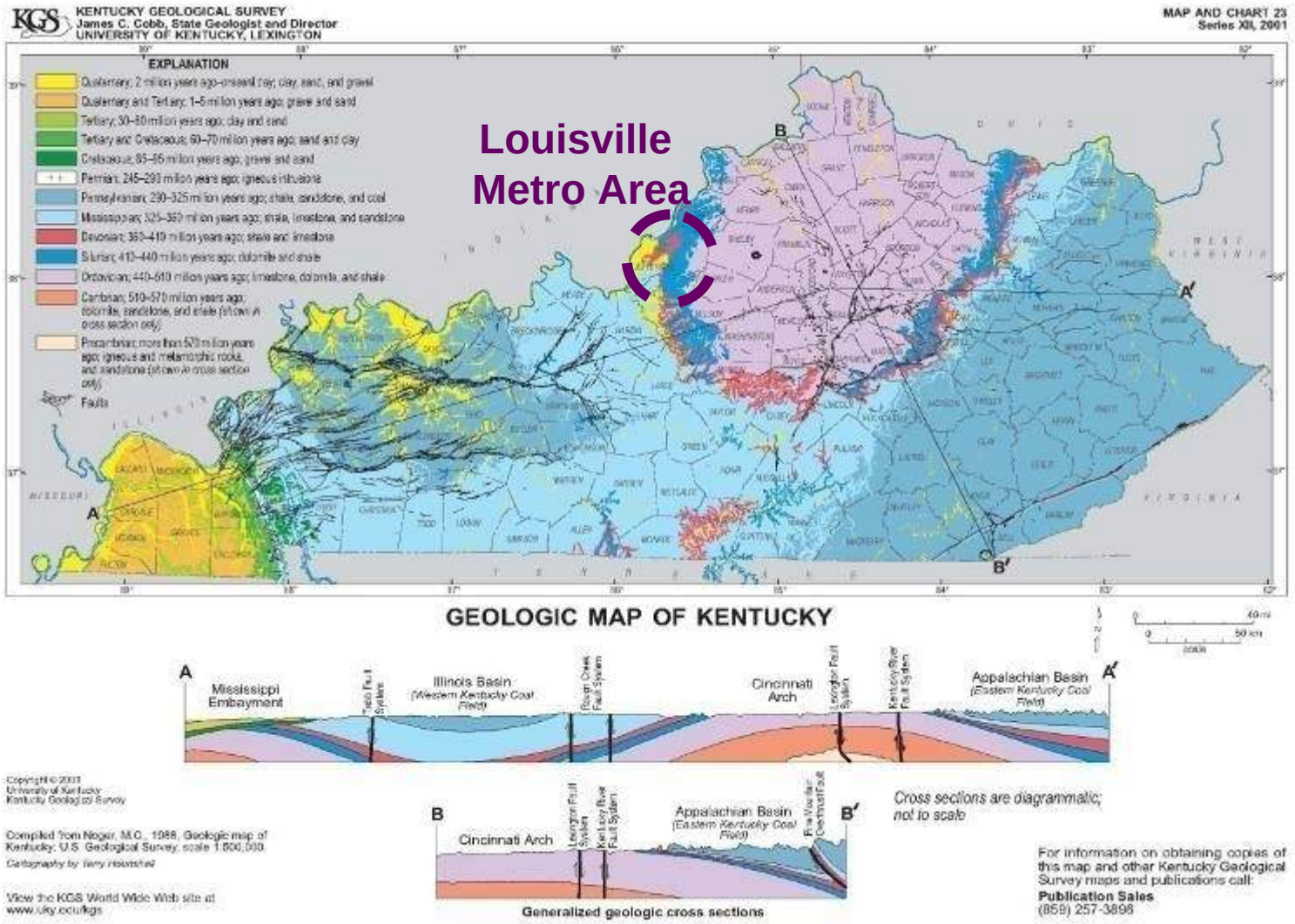
Green Program Objectives

- **Augment traditional "gray" engineering solutions**
  - Comprehensive CSS evaluation drives site specific solutions
  - Focus on quantity (i.e reduce runoff)
- **Assist in achieving regulatory compliance**
  - **Sewer overflow Consent Decree**
- **Cost effective**
  - green commitments based on a "business case"
- **Provide supplemental benefits**
  - habitat, air quality, urban beautification
  - public amenities (i.e community connectivity)
  - builds upon the current planning and priority initiatives of Metro Government

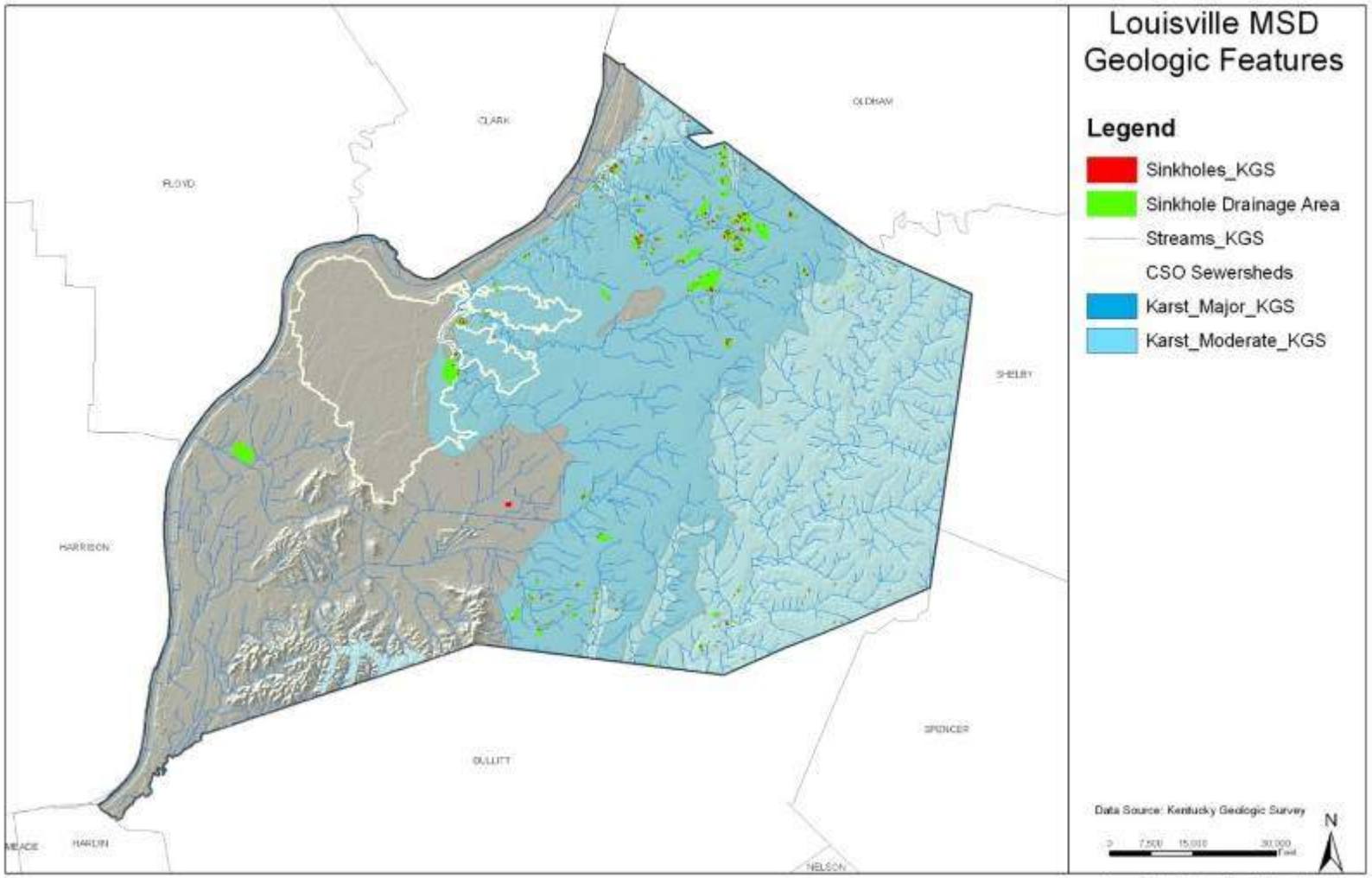
Green Infrastructure Strategy



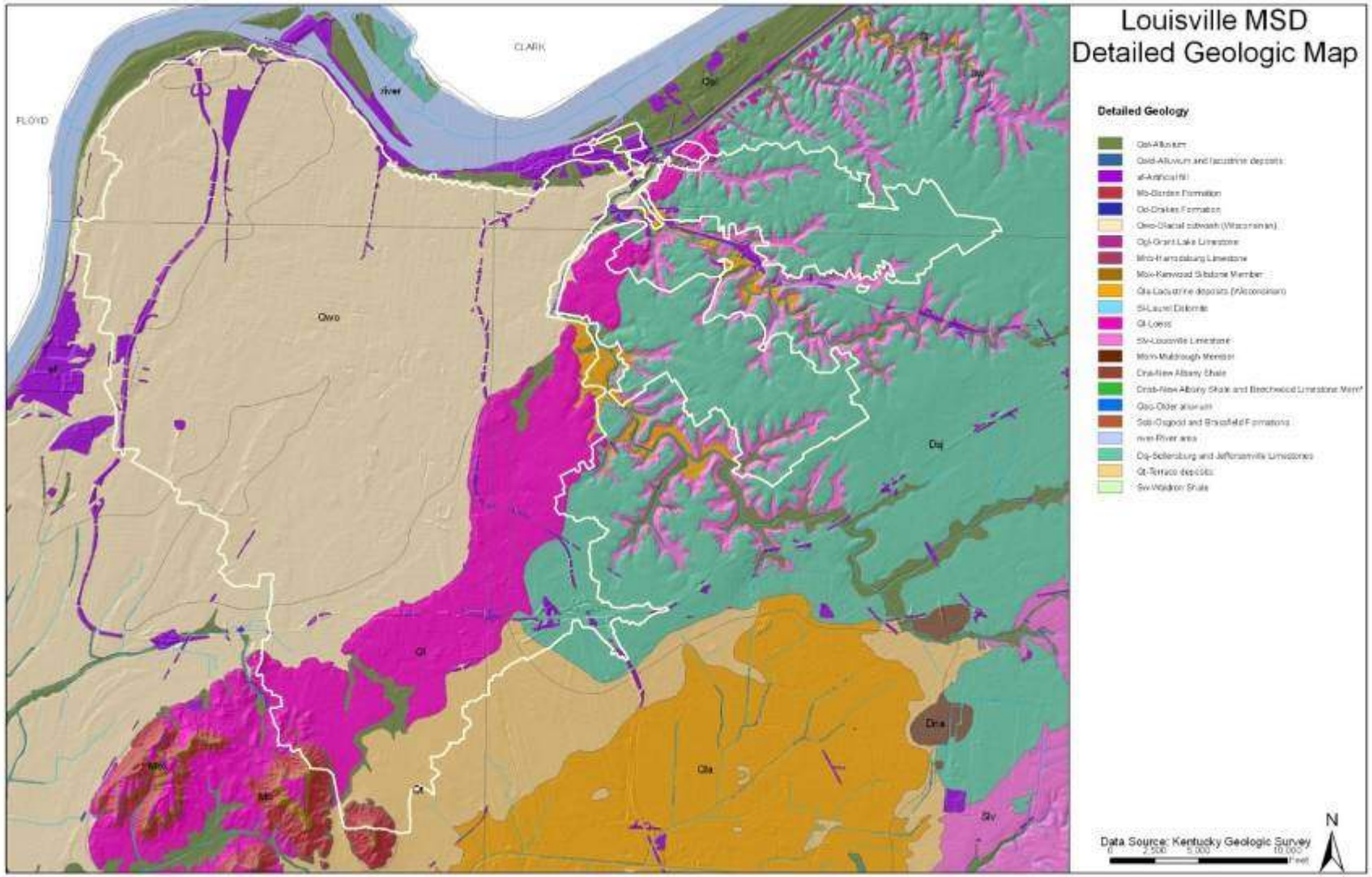
State Geology



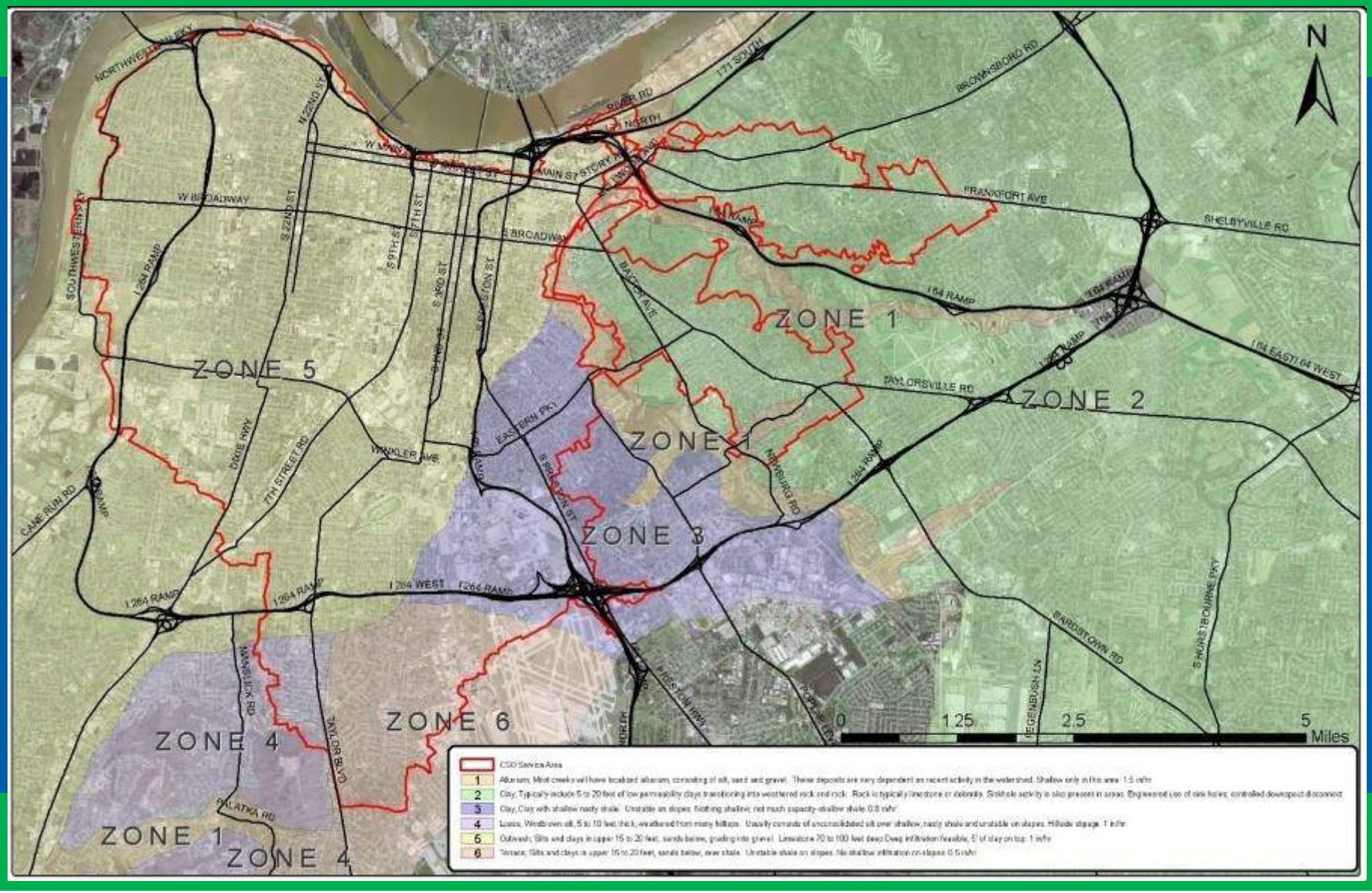
Metro/County Karst Geology



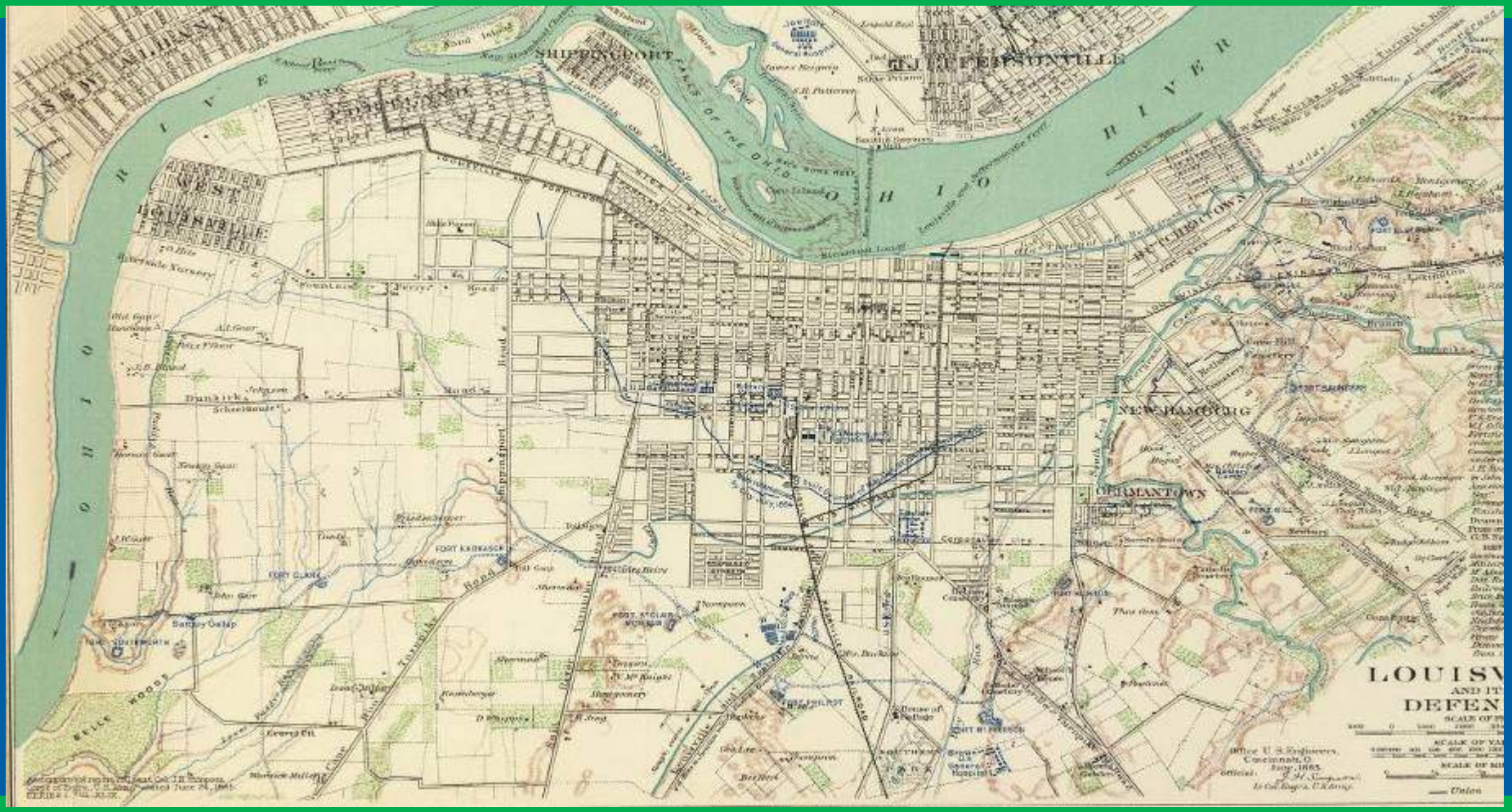
CSO Area Geology



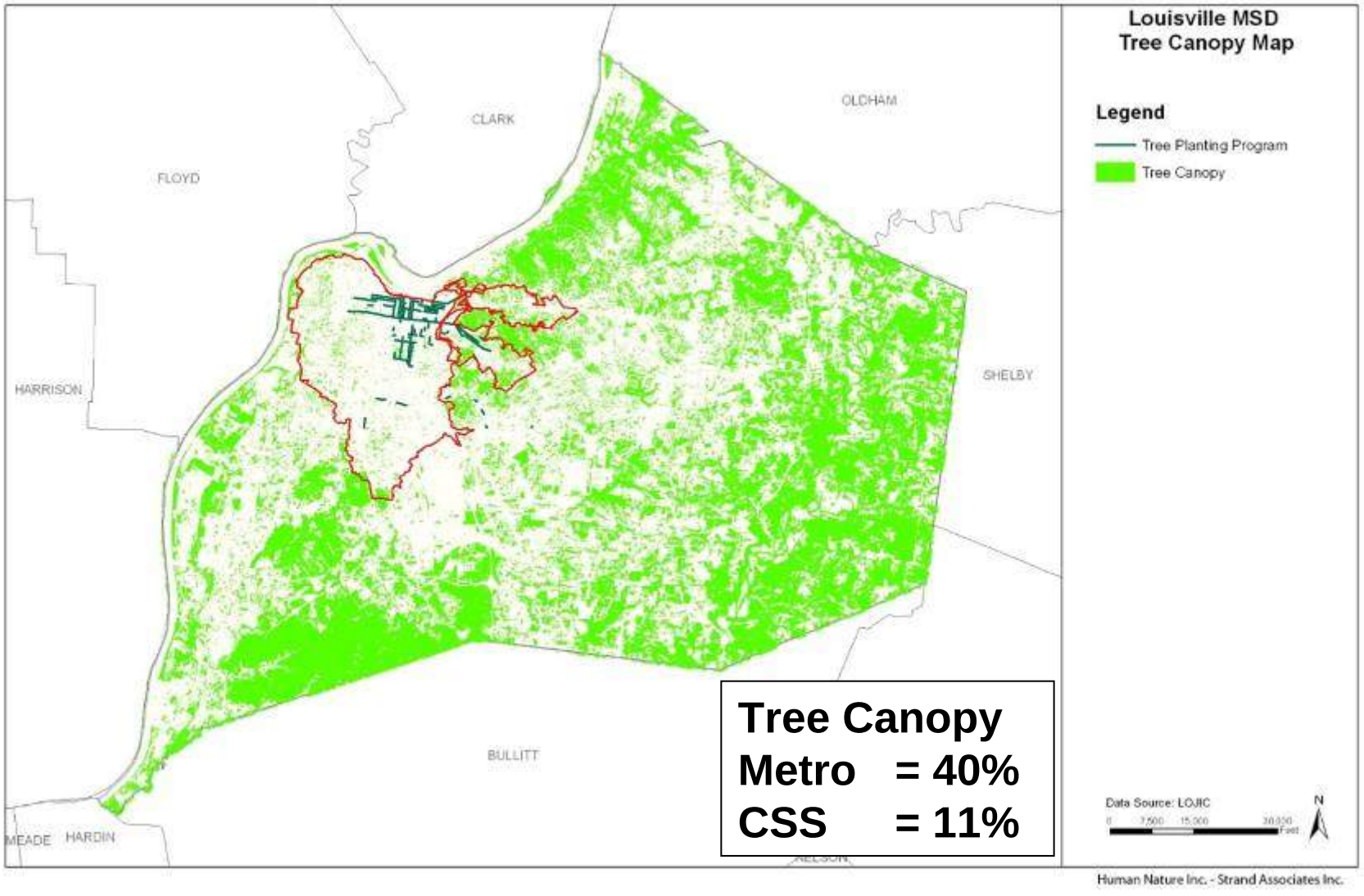
Metro/County Geology and Soils



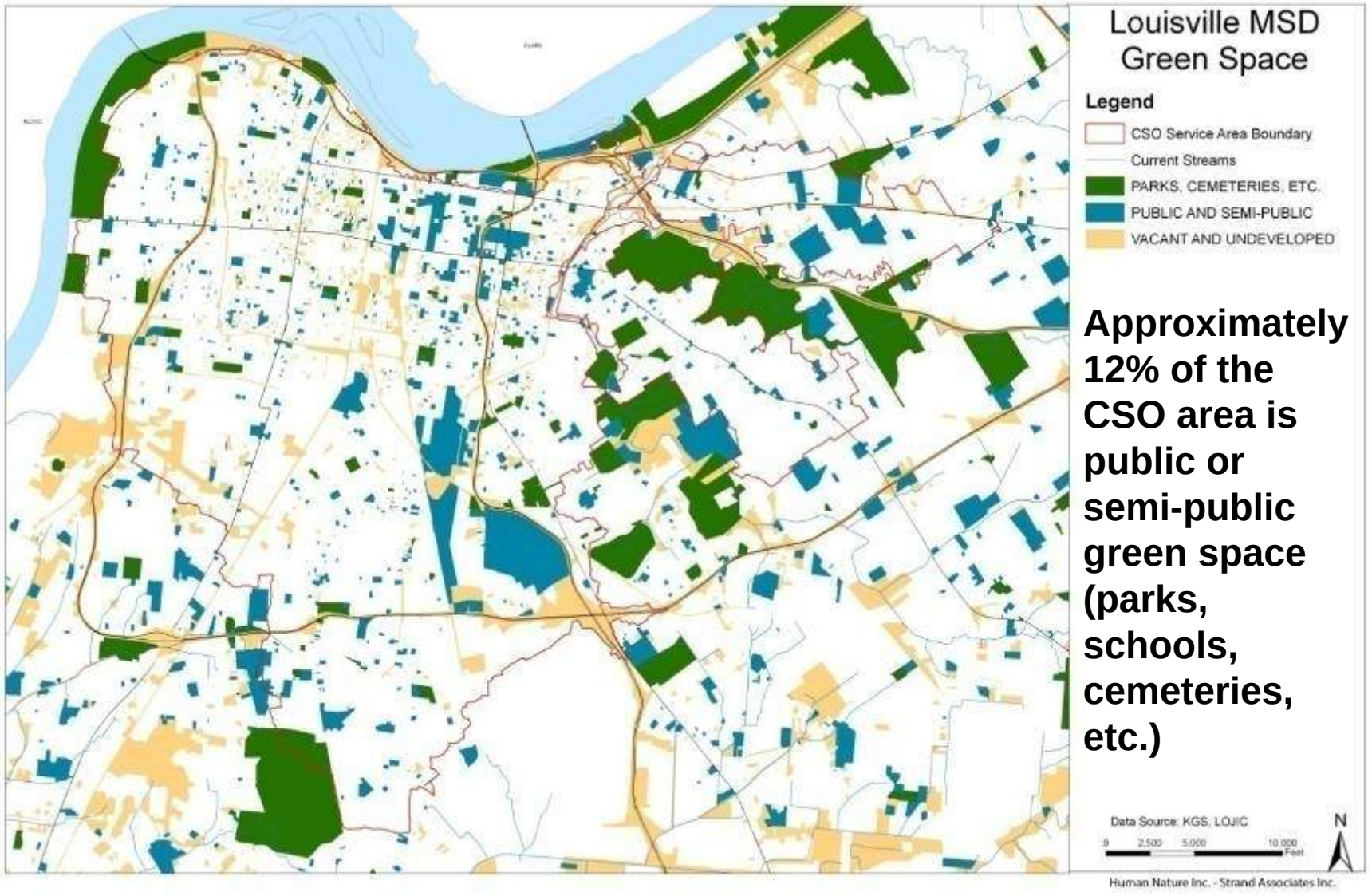
CSO Area Historic Streams



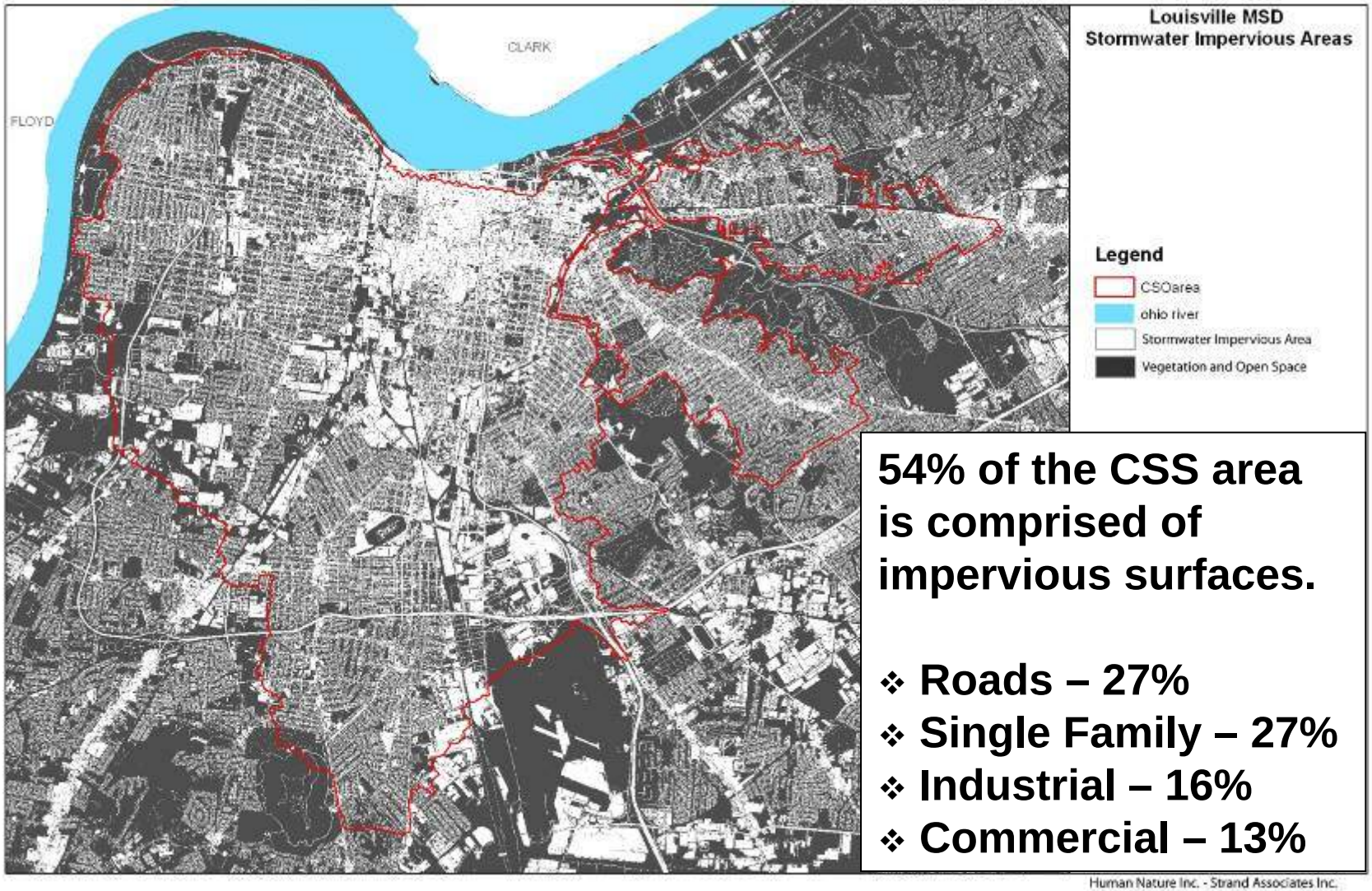
Metro/County Canopy Coverage



CSO Area Greenspace



Impervious Area in CSS

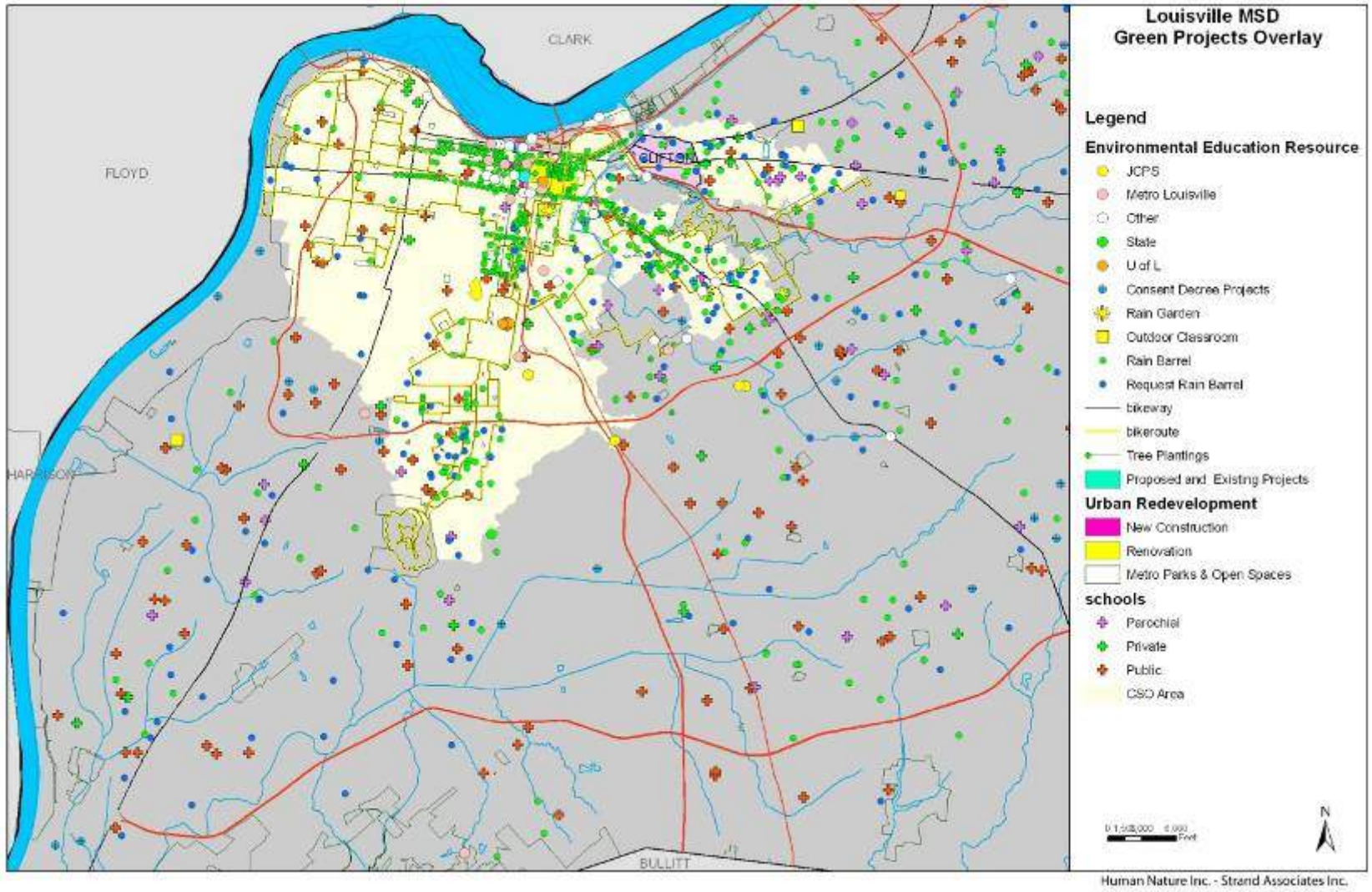


54% of the CSS area is comprised of impervious surfaces.

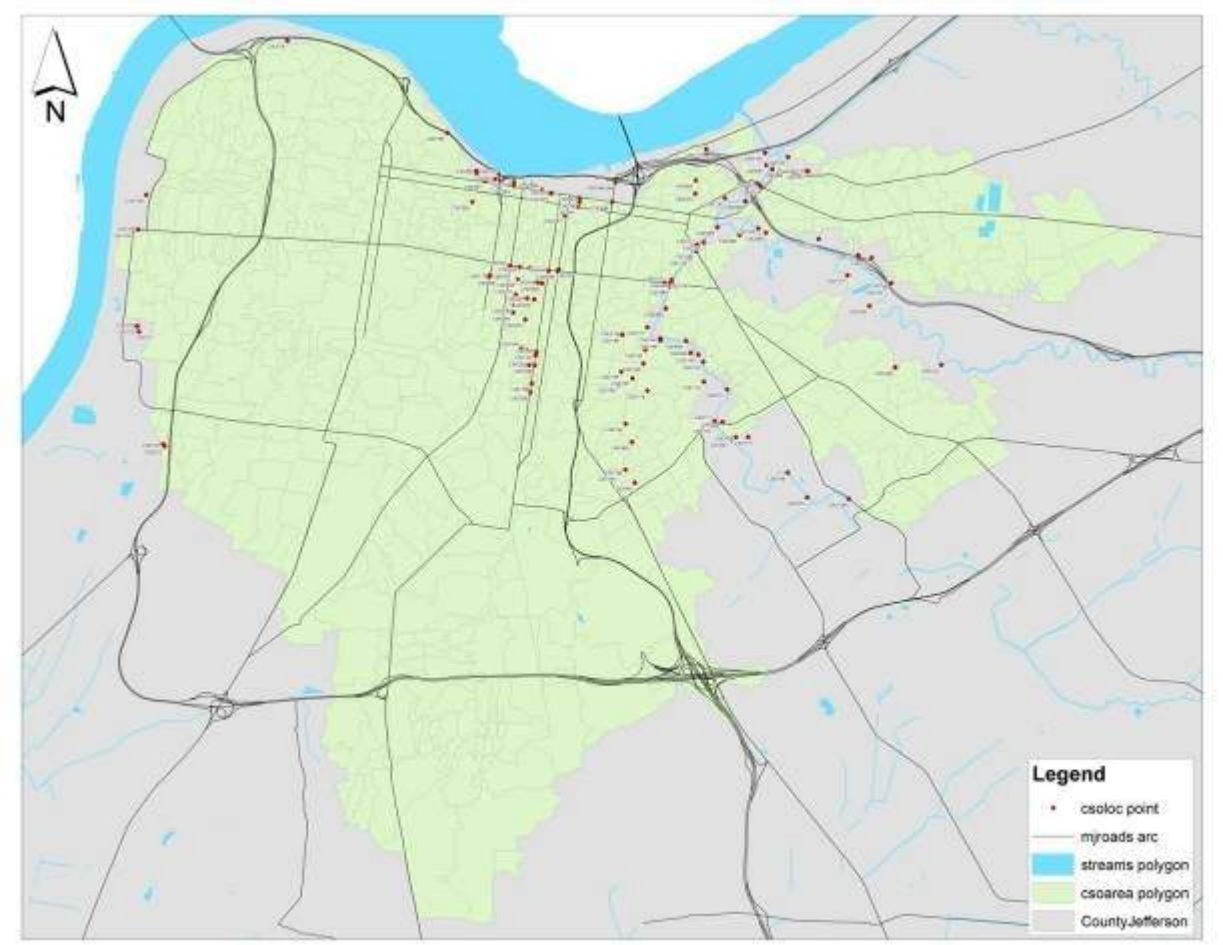
- **Roads – 27%**
- **Single Family – 27%**
- **Industrial – 16%**
- **Commercial – 13%**

Human Nature Inc. - Strand Associates Inc.

Current Green Projects/Programs

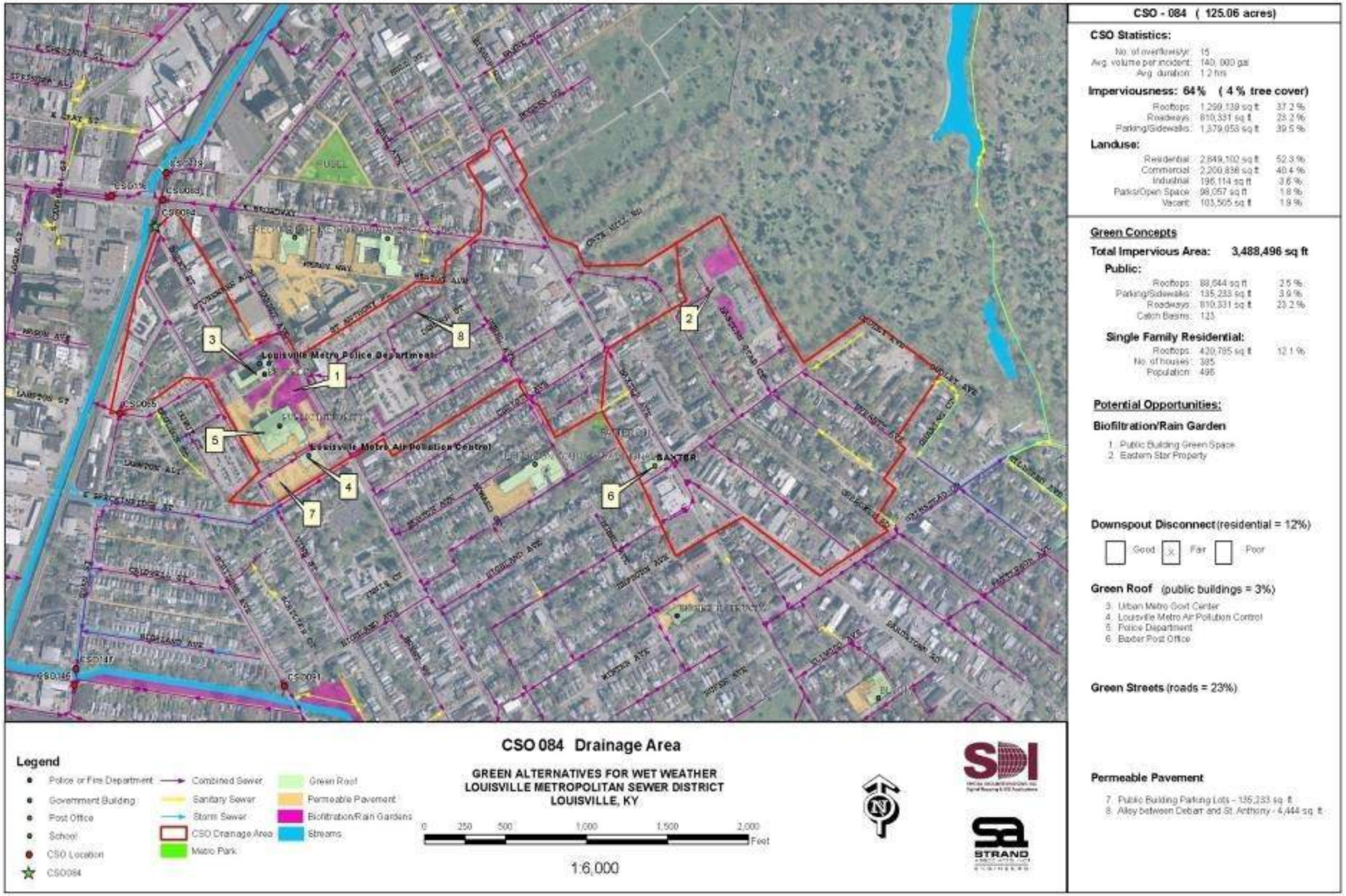


CSO Sewershed Evaluations

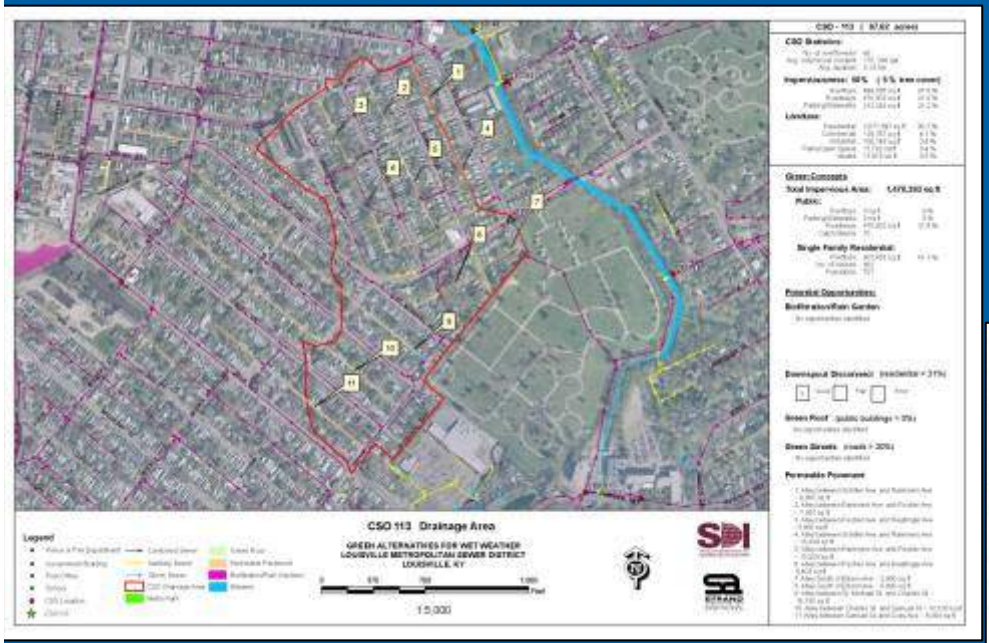


- Impervious area distribution
- Land use distribution
- Public green space
- Alleys and ROW
- Public parking lots and buildings
- Number of catch basins
- Residential properties

Sewershed Evaluations



Site Specific Strategies

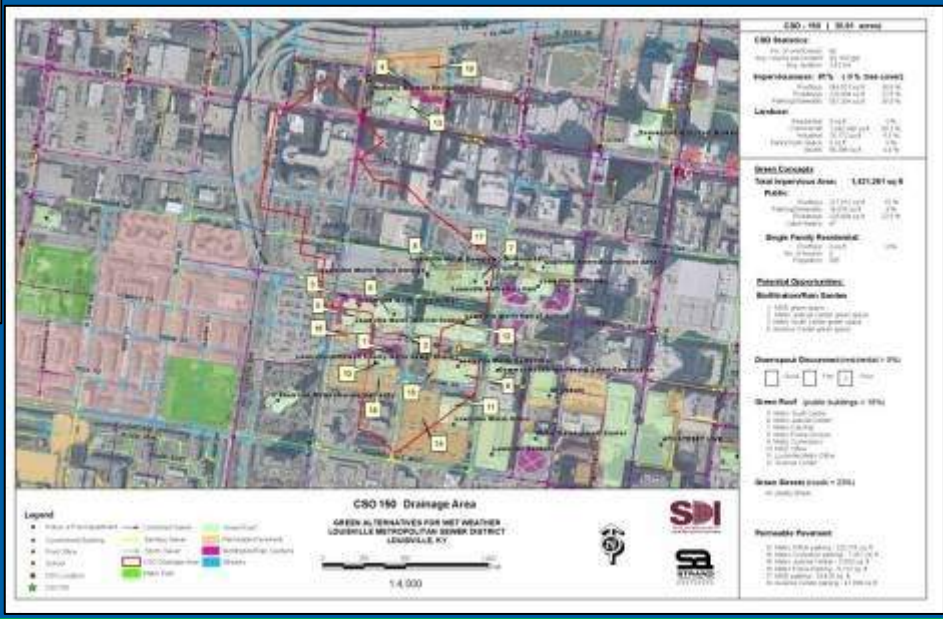


91% of Land Use = Residential

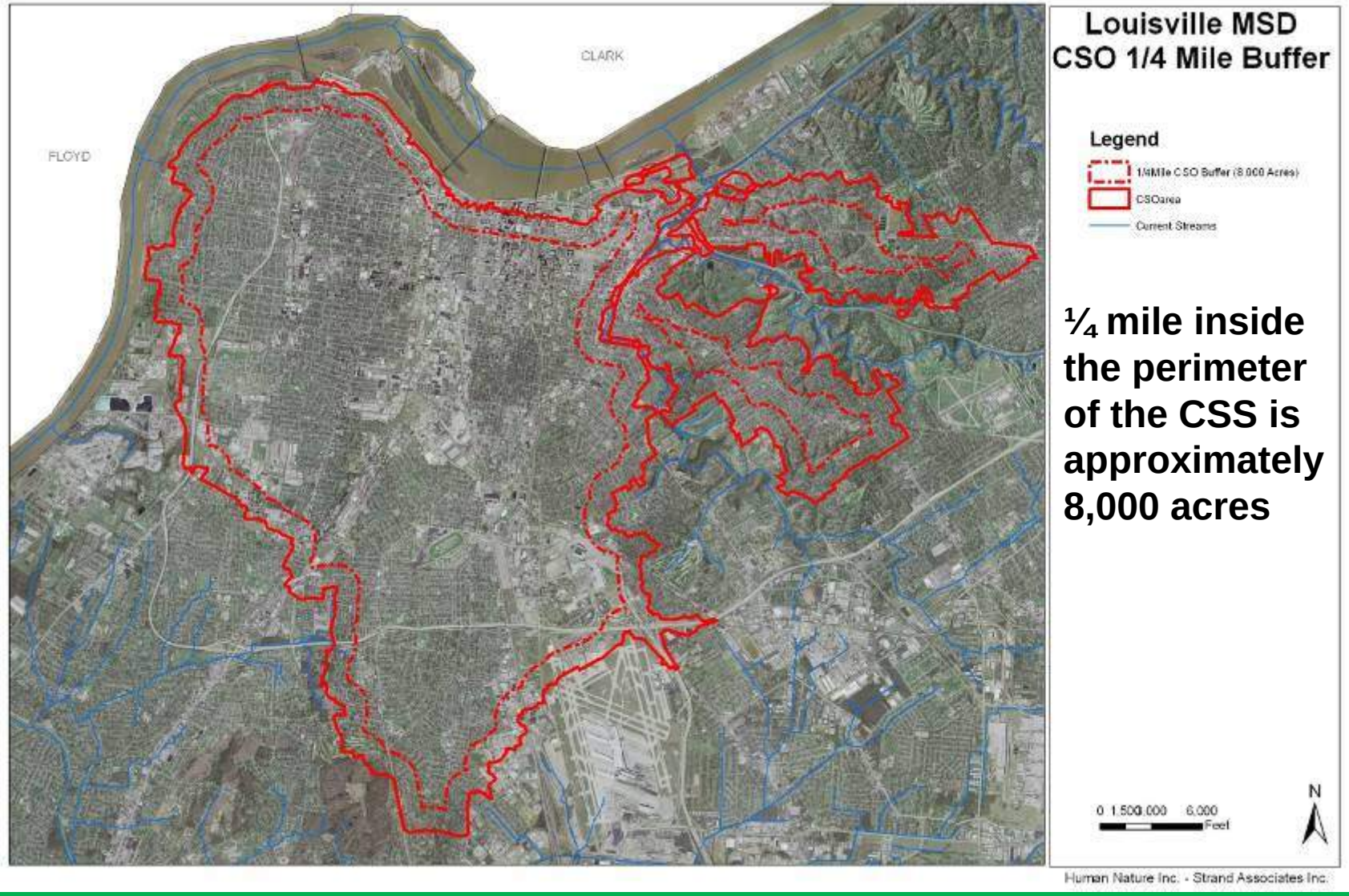
- Rooftops are 41% of the Impervious Area

95 % of Land Use = Commercial/Industrial

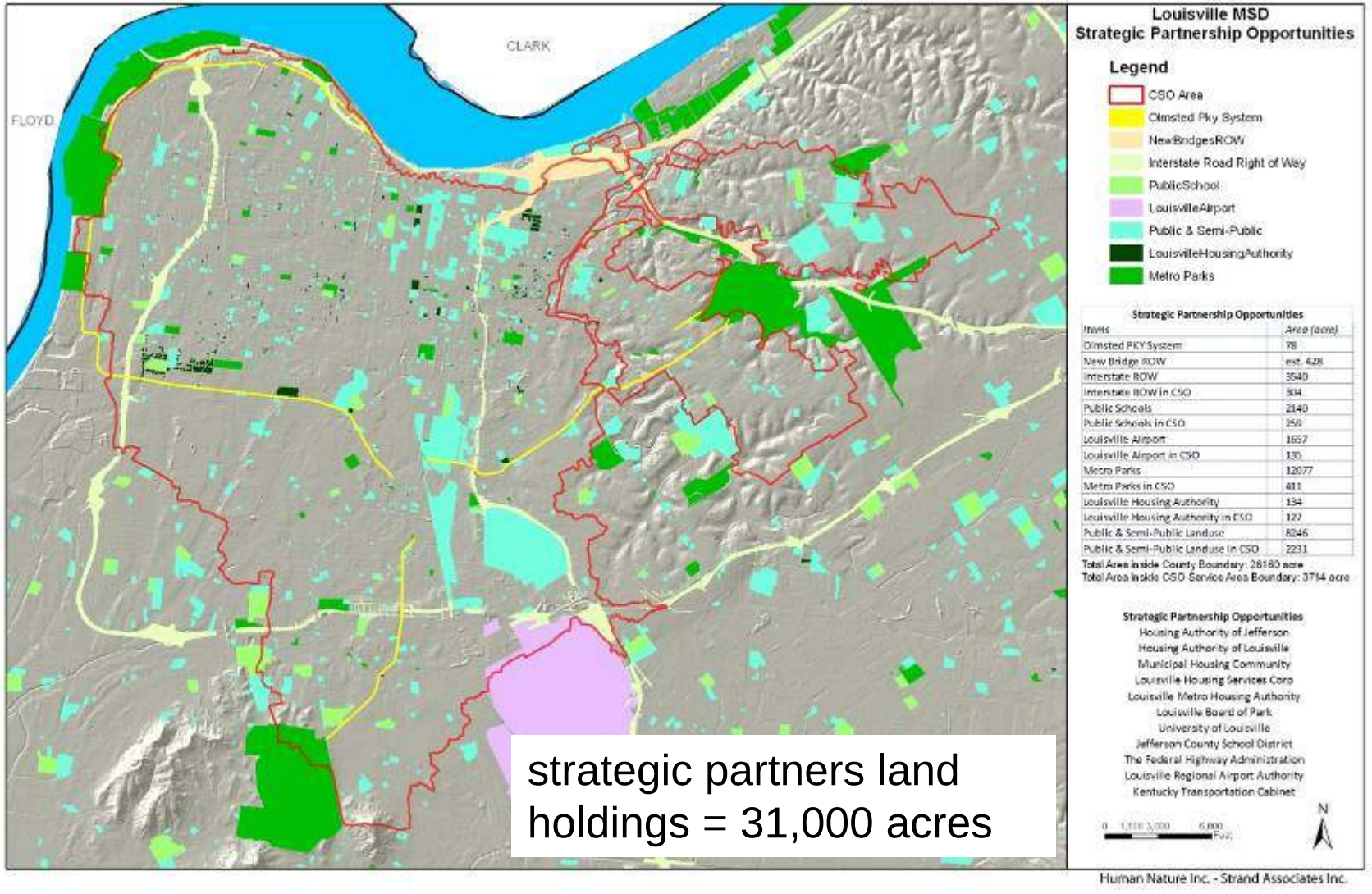
- Impervious Area
  - Rooftops 39%
  - Parking Lots 39%



CSO PERIMETER OFF-LOADING



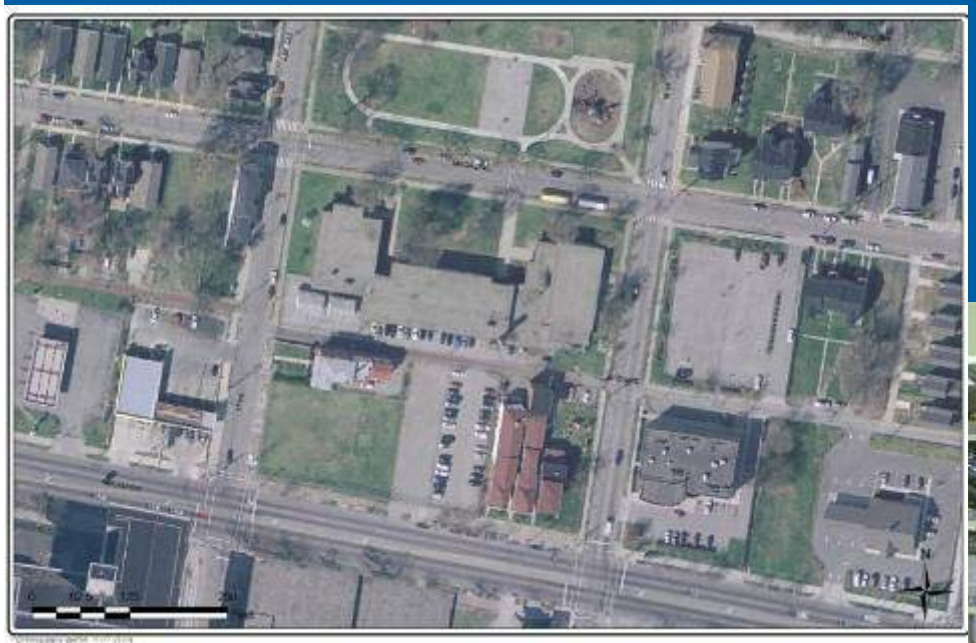
Strategic Partnerships



strategic partners land holdings = 31,000 acres

Strategic Partnerships

JEFFERSON COUNTY PUBLIC SCHOOLS

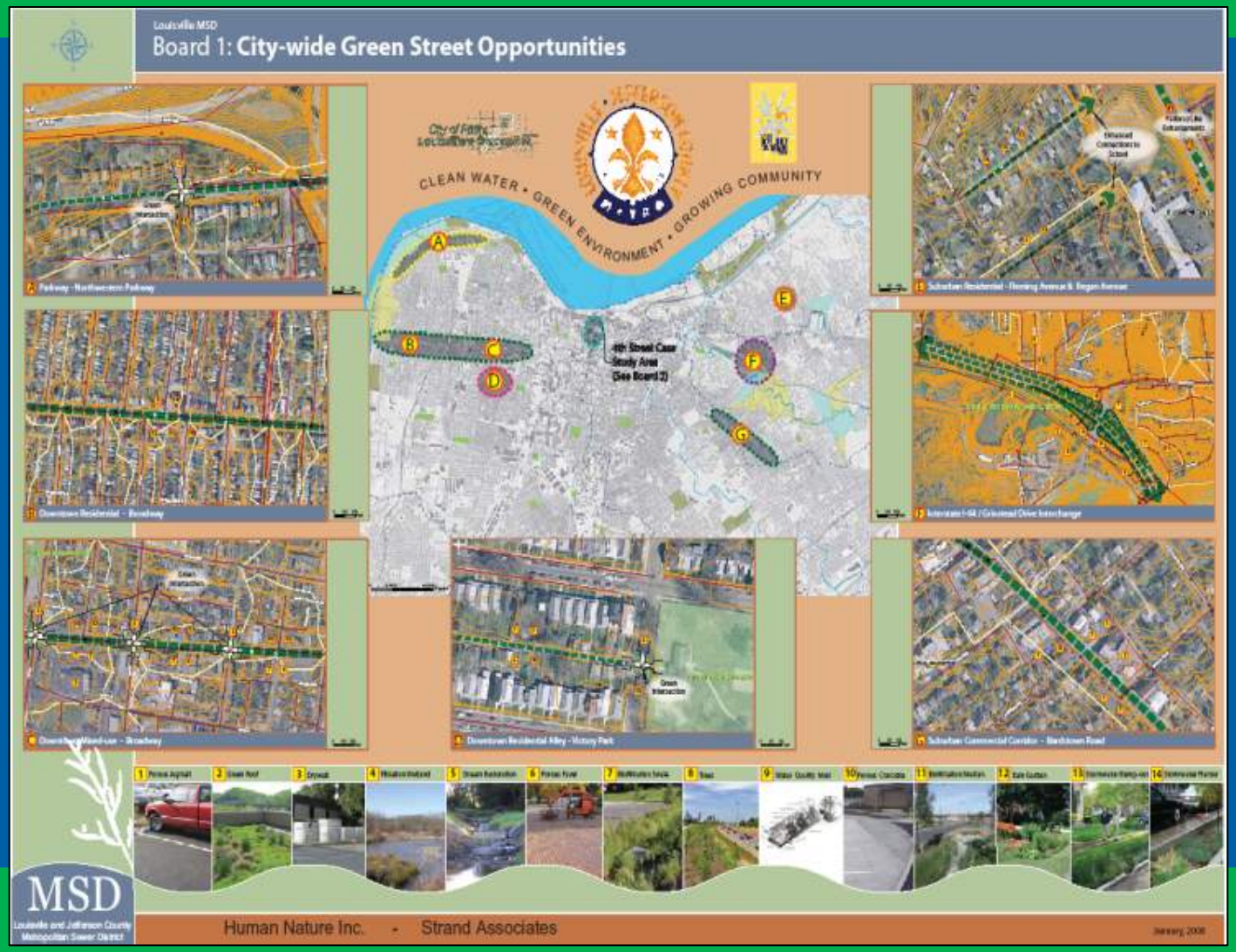


Current Site

Proposed Green Concept Plan

Strategic Partnerships

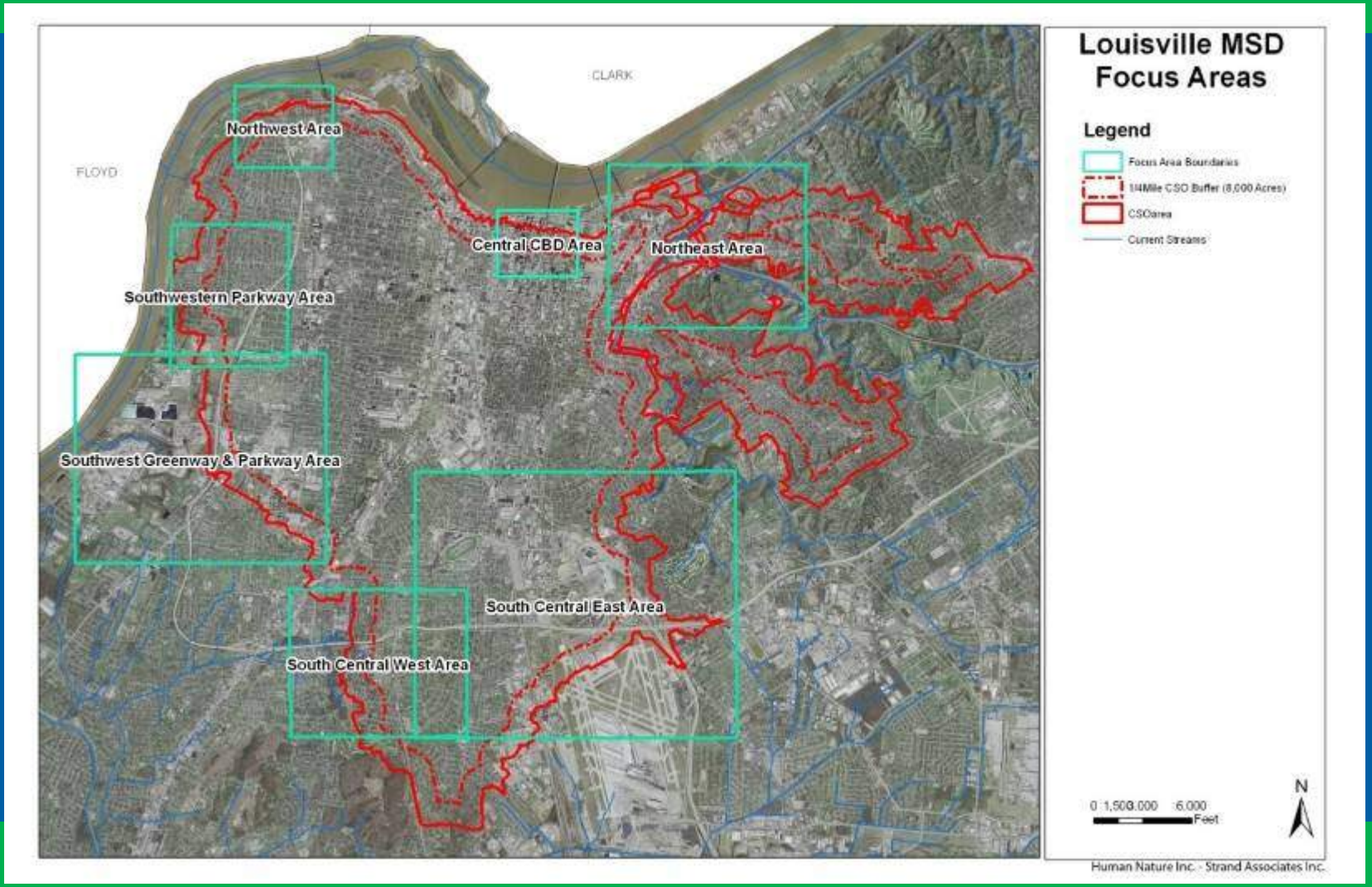
METRO PUBLIC WORKS



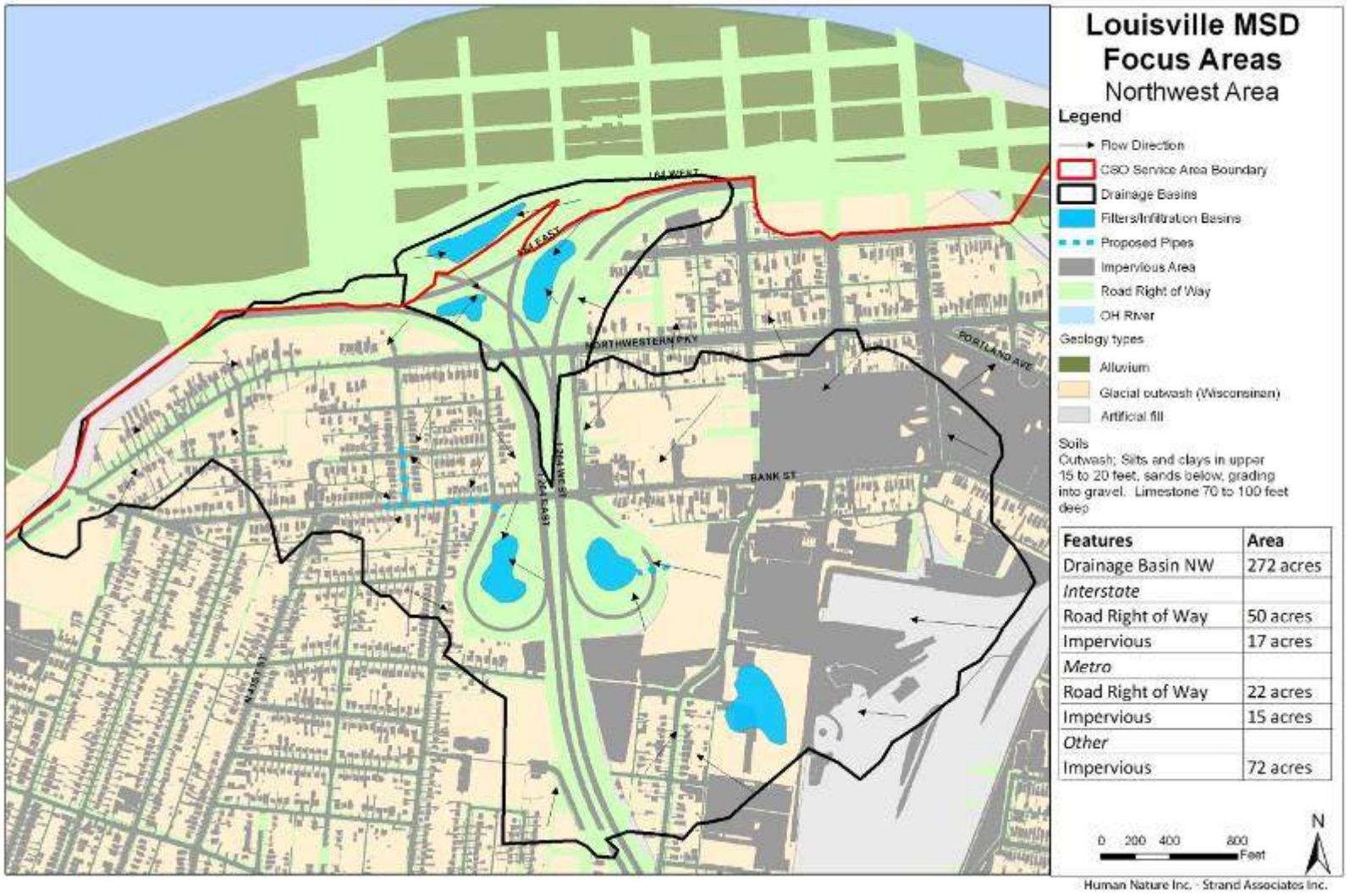
Strategic Partnerships

Kentucky Transportation Cabinet

Regional Evaluation Identifies Focus Areas



Northwest Focus Area

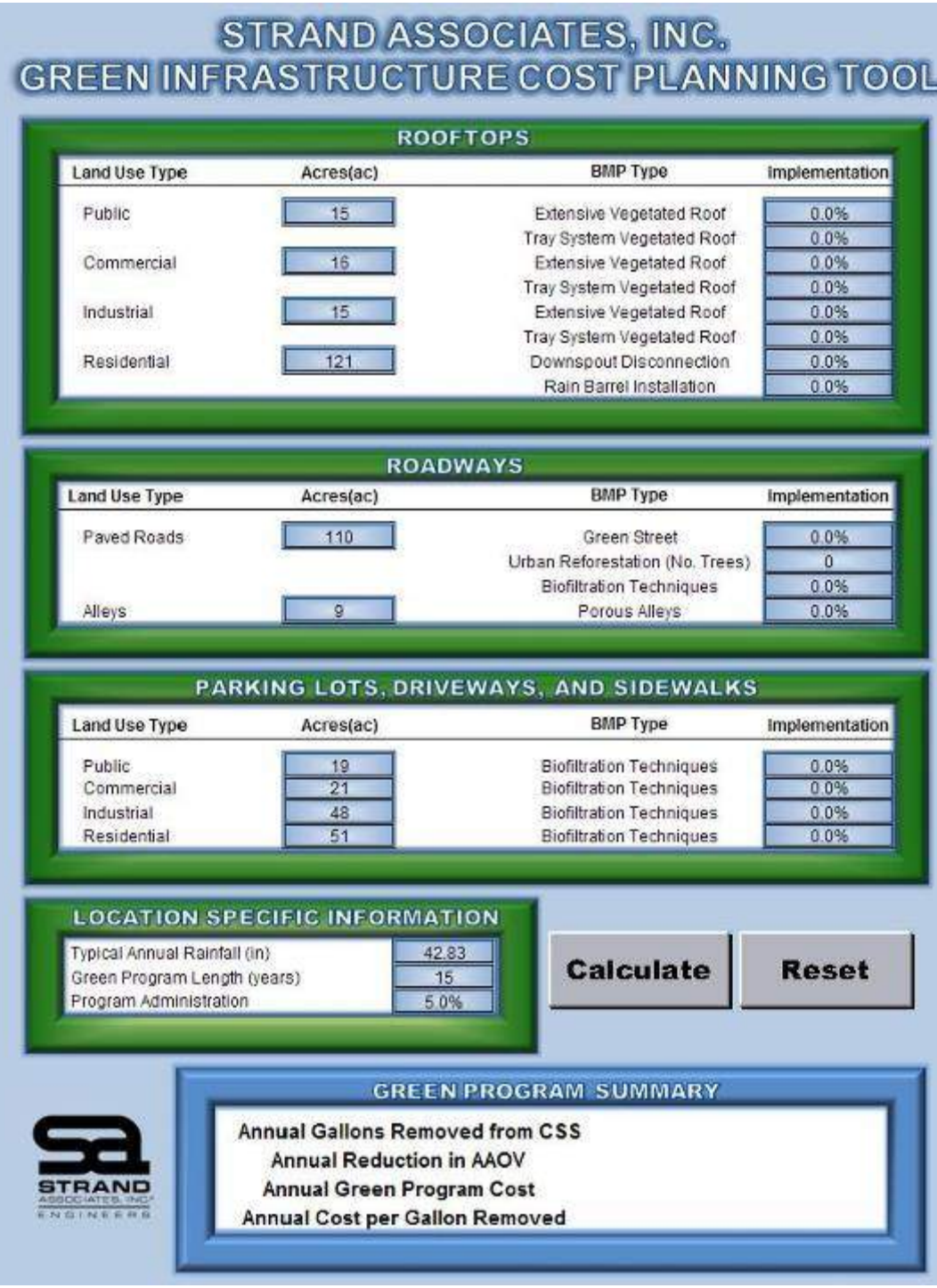


Proposed GI Program Elements

System Wide Implementation

Program Components

- Downspout Disconnection Program
- Vegetated Roof Program
- Residential Rain Garden Program
- Rain Barrel Program
- Urban Reforestation



Green Cost Tool: Community Specific Considerations

- Unit benefit costs
- Programmatic costs
- BMP type
- Drainage areas
- Performance
  - Rainfall
  - Soils
  - Geology
- Annual vs. design storm
- Program duration

Downspout Disconnect Program

- Limited to target areas as soils permit
- Utilized scoring matrix based on participation/ effectiveness factors
- Projected SW reduction = 124MG @ 10% implementation level

LOUISVILLE MSD GREEN EVALUATION				
		Residential Downspout Disconnection Program Matrix		
Participation	High	15%	30%	40%
	Medium	10%	20%	30%
	Low	5%	10%	15%
		Low	Medium	High
		Effectiveness		

Vegetated Roof Program

- Determine effectiveness of green roofs at reducing runoff ($/gallon)
- Proposing to establish a green roof incentive program.
- Projected SW reduction = 45MG @ 4% implementation level

Residential Rain Garden Program

- Target Neighborhood Groups
- Augment effectiveness of downspout disconnect
- Address street runoff where public green space is available
- Projected SW reduction = 52 MG @ 0.5% implementation level

Rain Barrel Program

- Service area wide
- Augment effectiveness of downspout disconnect where appropriate.
- Used to promote awareness and personal responsibility
- Develop two standard details:
  - One that overflows to surface
  - One that overflows to CSS

Urban Reforestation Program

- Leaves and branches intercept rainwater
- Dissipates rainwater by evapo-transpiration
- Increases soil infiltration
- Reduce volume of stormwater and increases time of concentration runoff

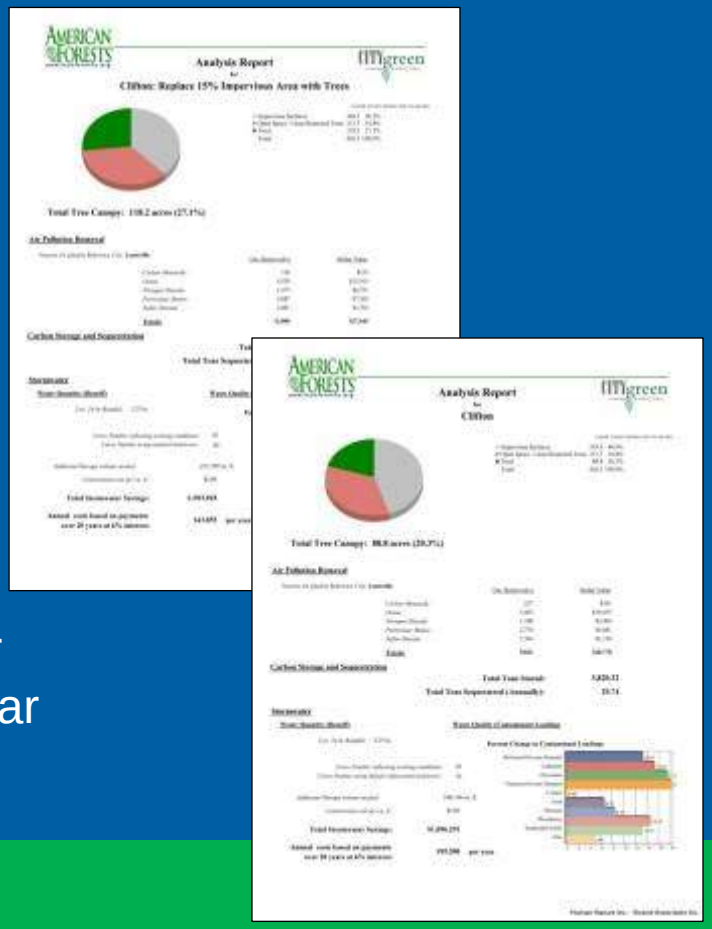
Urban Reforestation Program

Recommended Tree Canopy Coverage and Benefits

CSO Area
- Current canopy coverage 11%
- Increase Tree Canopy by 15%

Additional Stormwater Reduction =
7,166,019 cubic feet
(or over 53 million gallons)

Additional Benefits;
- Carbon Stored 196,364 tons
- Carbon Sequestered annually 1,528 tons per year
- Air pollution removal 463,724 lbs removed per year



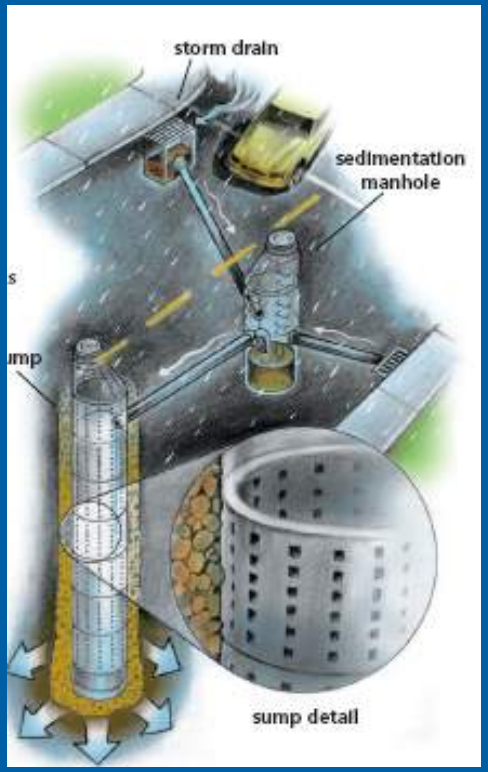
Green Infrastructure Demonstration Projects

Project Components

- Rain Gardens
- Dry Wells
- Green Alley
- Green Streets
- Green Parking Lots
- Off-loading to natural systems

Dry Wells

- Identify demonstration project locations
- Develop standards for three locations:
  - residential
  - single inlet
  - multi-inlet
- Establish a cost/gallon relationship



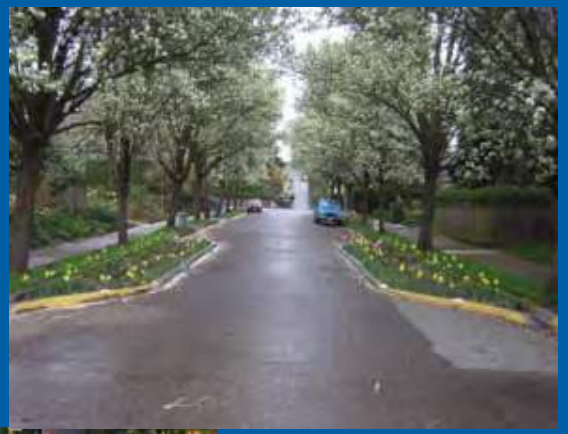
Green Alleys

- Identify demonstration sites
- Develop 2 standard designs
- Coordinate with Public Works
- Projected SW reduction = 24 MG @ 10% implementation level

Chicago, IL

Green Streets

- Identify 2 demonstration sites
- Coordinate with Public Works
- Develop standard detail for Louisville
- Projected SW reduction = 246 MG @ 1% implementation level



Portland, OR

Green Infrastructure Vision

QUESTIONS?

John Lyons, P.E.

Participation Certificate

- If you would like to obtain participation certificates for multiple attendees, click the link below
- You can type each of the attendees names in and print the certificates

http://www.epa.gov/npdes/webcasts/certificate/gi_models&calcs.pdf