

Green Infrastructure Benefits Exposed: Lessons From Municipal Implementation

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Green Infrastructure is . . .

. . . technologies that replicate and restore the natural hydrologic cycle and reduce the volume of stormwater entering the sewer system by:

- Infiltrate
- Evaporate
- Transpire
- Capture and reuse rainfall



There are 2 sides to the Stormwater problem

The necessary **technical** side:



System	TSS	TN	TP
Conv. Bioretention Average (4)	91%	36%	34%
Durham Bioretention (23% IBSC)	81%	27%	45%
Conv. Subsurface Gravel Wetland	96%	54%	58%
Subsurface Gravel Wetland (10% SGWSC)	75%	23%	53%





Hydrodynamic Separator



Isolator Row



Subsurface Infiltration



Filter Unit



Porous Asphalt



Pervious Concrete



Retention Pond



Stone Swale



Veg Swale



Gravel Wetland



Sand Filter



Bioretention Unit



Tree Filter

Social: Elements pertaining to efforts that relate to public involvement and civic support for a cultural approach or common social responsibility.



2 municipal examples of GI installments:

- Lancaster, PA (population: 60,000)
- Dover, NH (population 31,000)

The City of Lancaster: Overview

- Incorporated in 1742 as a borough and in 1818 as a City
- Served as the temporary National Capital during the Revolution
- ~60,000 residents in the 2010 census
- 7.34 square miles
- Historic building stock (median home age of 100 years)
- Surrounded by some of the most productive non-irrigated farmland in the U.S.
- Environmental Justice Community

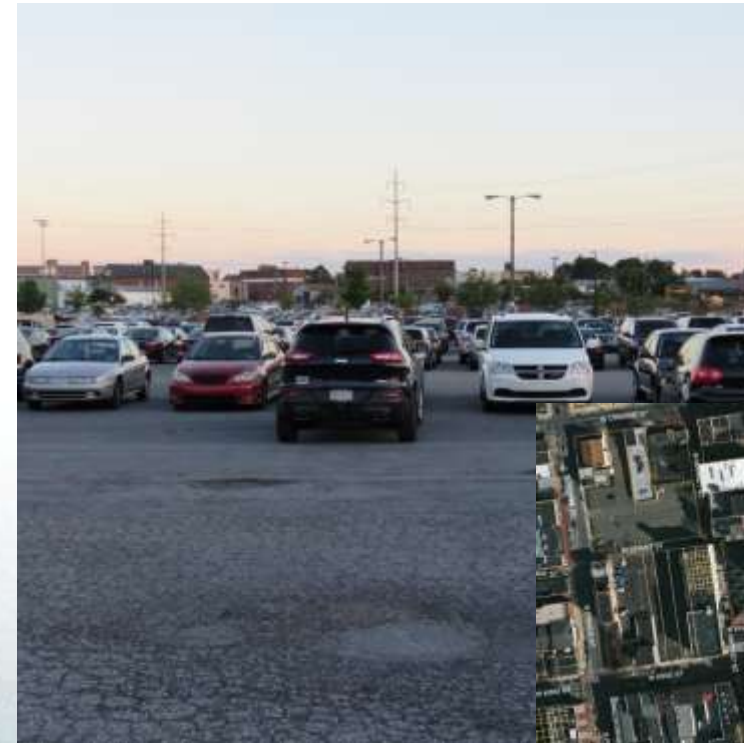


What's the Challenge?

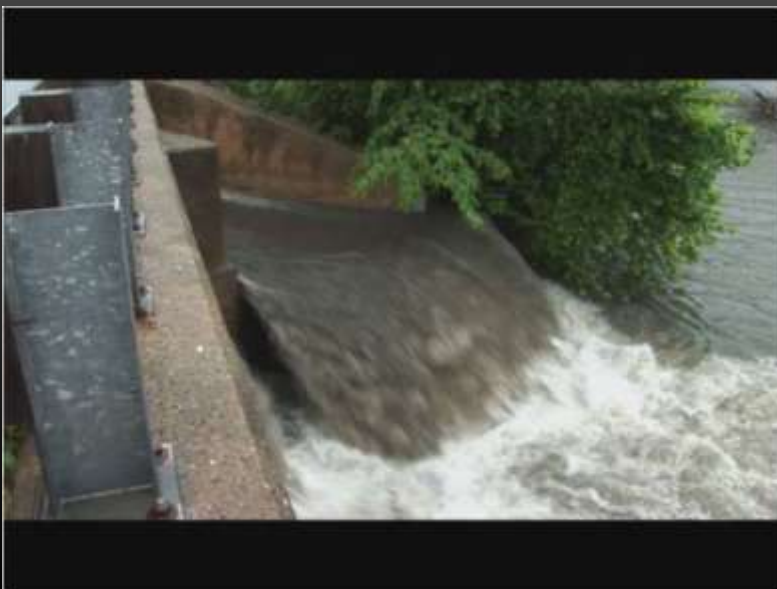
Source-USEPA

- Lancaster is one of about 770 cities nationwide with a combined sewer system, which releases about **750 million gallons** of untreated wastewater into the Conestoga River when overwhelmed during intense rainstorms.

- 518 miles of streets and alleys
- 464 of 572 alleys are common alleys
- Over 500 acres of surface parking lots
- Over 17,000 private parcels of land
- 48% of land area covered by impervious surfaces (3.6 sq. mi.)
- 45% of city area in CSS (3.3 sq. mi.)
- 56% of CSS impervious (1.9 sq. mi., 1200 acres)
- CSS most built and populated part of city



The Problem...and Costs of Solutions are Significant



“**Lancaster is in violation** of the AO, and needs to address these deficiencies as soon as possible. Violation of the terms of the AO may result in **further EPA enforcement** action for violation of the order and for the underlying violations including, but not limited to, imposition of **administrative penalties**, 33 U.S.C § 1319(g), and/or initiation of judicial proceedings that allow for **civil penalties of up to \$37,500 per day**, 33 U.S.C § 1319 (b) and (d), for each day of violation.”

Previous
Solution

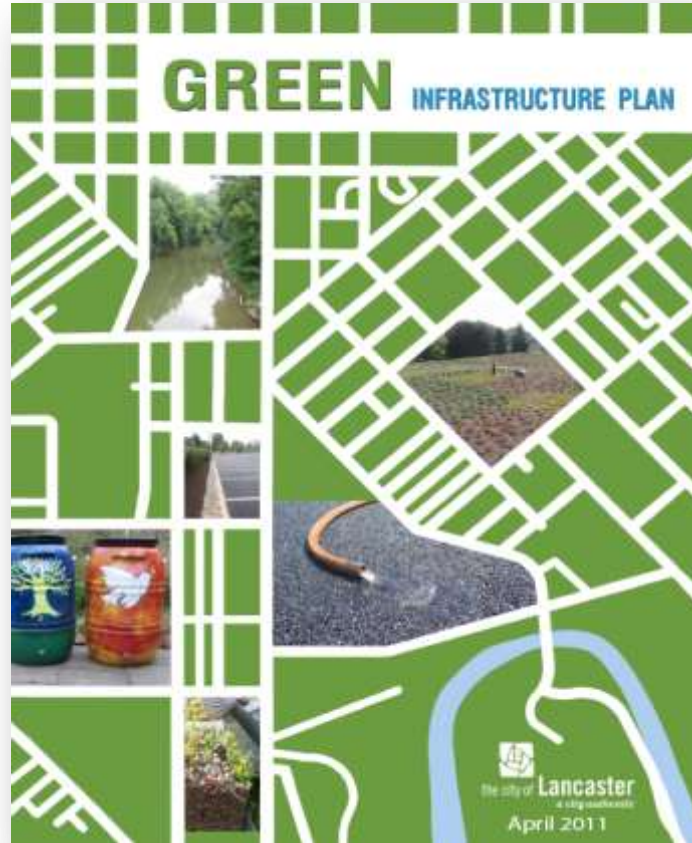
\$300 Million
Gray
Infrastructure

Proposed
Solution

\$140 Million
Green
Infrastructure

**Doing Nothing is
Not an Option!**

2010 Green Infrastructure Plan



To provide more livable, sustainable neighborhoods for City residents and reduce combined sewer overflows and nutrient loads

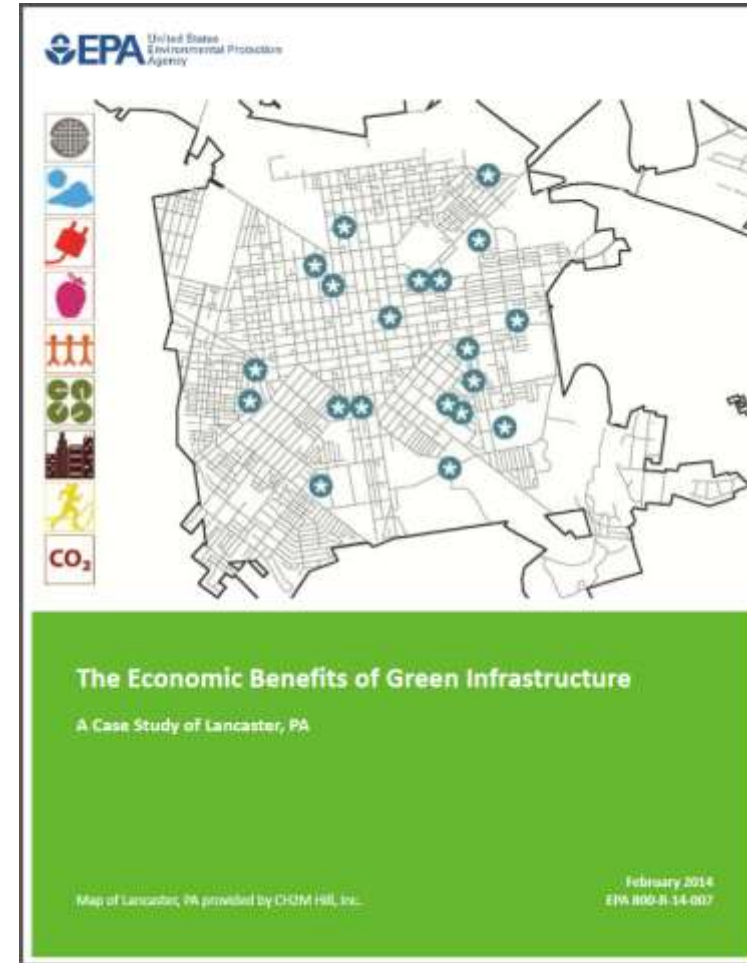
Key Plan Recommendations

1. **Implement a comprehensive demonstration program**
 - a) Review existing CIPs
 - b) GI Funding for Private
2. **Implement policy actions**
 - a) Revise details and specs
 - b) Revise Stormwater Ordinance for Redevelopment
 - c) Stormwater Utility
3. **Conduct extensive partnering and outreach**
4. **Develop technical tools/studies to support GI**
 - a) Models / Project Tracking, etc.

Triple Bottom Line Benefits

2014 EPA report estimates the following benefits of implementing the GI Plan:

- \$4.2 million/year in energy, air quality, and climate-related benefits
- \$660,000 annually in reduced wastewater pumping and treatment costs (at current costs)
- \$120 million in avoided gray infrastructure (e.g., tanks, tunnels)
- For an GI investment of \$80 - \$140 million (depending on level of integration)



Brochures and Factsheets

WHAT'S THE BIG DEAL?

When it rains in Lancaster City, it falls on rooftops, streets, sidewalks and parking lots and then flows into the combined sewer system. Along the way, it picks up all kinds of pollutants from sidewalks, parking lots and streets like pet waste, fertilizers and pesticides, oil and automotive fluids.



Under normal circumstances stormwater and wastewater flow together to a treatment plant.



In heavy rains, the pipes overflow and polluted stormwater mixed with waste water flow into our rivers.

What you can do

Every property owner and resident can do their part! If you own a property with green space you may be able to install green infrastructure which can go a long way to reducing stormwater overflows and save you money on your stormwater fee.

5 MINUTES

- Take a shower instead of a bath
- Turn off water while brushing teeth
- Tell your friends!

5 HOURS

- Install a rain barrel
- Plant a native tree
- Disconnect your downspouts

5 DAYS

- Install a green roof
- Set up a cistern
- Plant a rain garden



To learn more please visit www.saveitlanchester.org

Or contact us directly:

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fschroeder@lancasterconservancy.org
717-392-7891 ext 207


SAVE IT!
YOUR WATER. YOUR MONEY. YOUR CITY.



Lancaster's Green Infrastructure:
Working towards a more sustainable city



What is stormwater?

Stormwater is rainfall or snowmelt that runs off surfaces such as rooftops, streets, sidewalks, and even compacted ground surfaces, either flowing directly into our sewer system or streams and rivers. As stormwater runs off those hard surfaces, it can pick up and carry away natural and man-made pollutants such as sediment, trash, oil and toxic chemicals, pesticides and fertilizers from lawns and gardens, and viruses and bacteria from pet waste.

Why is stormwater pollution a problem?

Most of Lancaster's sewage and rainwater flow into one system called a Combined Sewer System (CSS). During rain events the CSS can be overwhelmed with the flow of sewage and rain water creating a Combined Sewer Overflow (CSO), which discharges stormwater mixed with sewage directly in local rivers. These polluted overflows impact downstream water quality. Many Cities, including Lancaster, are required by law to reduce the frequency and volume of these events.

In parts of the Lancaster without a CSO, stormwater is often discharged directly into our surrounding creeks and rivers untreated. All stormwater pollution, regardless of its source, is harmful to fish and other aquatic life and habitats, and can make recreational areas unsafe and unpleasant. The impacts stretch from the Conestoga River and Little Conestoga Creek all the way to the Chesapeake Bay.

What is the stormwater fee?

A small fee was enacted in 2014 that is based on the amount of hard surfaces and rooftops from each property that actually generate stormwater runoff. The fee is being placed into a dedicated fund used only for the stormwater management program: the improvement and maintenance of existing systems and additional new green infrastructure. Rebates and credits are available to property owners who increase the amount of water captured on their properties through green infrastructure.



Initial Efforts Focused on Early Action and Continuous Improvement

- Maximize existing infrastructure (pumping station upgrades, screening, etc.)
- Modify current/proposed capital projects to incorporate GI
- Secure funding for demonstration projects
- Develop plan to scale up for city-wide implementation
- Review all City ordinances to incorporate/require GI for redevelopment
- Develop stormwater website
- Conduct community education/outreach
- Develop incentives for private sector participation (i.e. stormwater utility)

Innovative Public-Private Partnership enables private investments in CWA progress

- \$7M SRF PENNVEST Loan to fund implementation of GI on public & private property
- 45 initial GI/BMP sites
- City pays up to 90% of GI Costs
- Property owner pays remainder and signs on to long-term maintenance agreement
- SW Utility implementation also motivating additional private investment in CWA controls



Significant Grants and Loans Supported Rapid Implementation and Continue to Support GI Program

Count	Funding Source	Date of Award	Type	Awarded Amount	Matching Funds	Project Title	Project Type
1	PA Dept of Conservation & Nat. Resources	2009	Grant	\$70,000		Green Infrastructure Plan for the City of Lancaster	Planning
2	National Fish & Wildlife Foundation	2010	Grant	\$400,000	\$520,000	Implementation of GI Projects in the City of Lancaster	Design/Construction
3	PA Dept of Community & Economic Dev.	2010	Grant	\$768,333	\$384,167	City of Lancaster Green Infrastructure Project	Design/Construction
4	PA Dept of Environmental Protection	2011	Grant	\$225,000		Lancaster City Green Streets	Design/Construction
5	PennVEST	2011	Loan	\$7,000,000		Lancaster City Green Investments	Design/Construction
6	PA Dept of Environmental Protection	2011	Grant	\$770,000		Implementation of GI Projects in the City of Lancaster	Design/Construction
7	PA Office of the Budget	2011	Grant	\$1,500,000		Implementation of GI Projects in the City of Lancaster	Design/Construction
8	Keith Campbell Found. for the Environment	2011	Grant	\$25,000		Case Study approach to GI Projects in the City of Lancaster	Planning
9	National Fish & Wildlife Foundation	2011	Grant	\$400,000		Lancaster City: Institutionalizing Green Infrastructure	Planning
10	PA Dept of Environmental Protection	2012	Grant	\$263,120		City of Lancaster Green Alleys	Design/Construction
11	PA Dept of Environmental Protection	2013	Grant	\$250,000		N. Marshall Street Green Street	Design/Construction
12	Chesapeake Bay Trust	2014	Grant	\$100,000		N. Marshall Street Porous Sidewalks	Design/Construction
13	Pennsylvania Low Volume Roads Grant	2015	Grant	\$80,000		MS4 Green Alleys	Design/Construction
14	US Army Corps of Engineers	2015	Grant	\$50,000	\$50,000	GIS Mapping of Storm System	Planning
TOTAL:				\$11,901,453	\$954,167		

The Green Infrastructure Benefit Calculator Projects Future Benefits for CSO and MS4 Areas

Table 5-11 – Green Infrastructure Calculator for long-term (approximately 25-year) period

Impervious Area Type	Impervious Area		Green Technology	Impervious Area Managed		Annual Runoff / Runoff Reduction			
	Contributing Area (acres)	Percent Impervious		Percent of Impervious Area Managed	Area Managed (acres)	Total Annual Runoff (MG/yr)	Assumed Runoff Reduction (%)	Average Runoff Reduction (MG/yr)	Runoff Reduction (MG/yr)
Roads / Alleys	529	100%	Green Streets	30%	159	518	1.0	86%	132.4
Parks	241	8%	Park Improvements / Greening	85%	17.0	19	1.0	86%	14.2
Sidewalks	124	100%	Disconnection, Porous Pavement	35%	43.3	120	1.0	86%	36.1
Parking Lots	648	100%	Porous Pavement, Bioretention	20%	130	628	2.0	97%	121.3
Flat Roofs	218	100%	Vegetated Roofs / Disconnection	15%	32.7	212	1.0	86%	27.3
Sloping Roofs	654	100%	Disconnection/Rain Gardens	25%	164	635	1.0	86%	136.5
Street Trees	N/A	N/A	Enhanced Tree Planting	N/A	45.1	44	0.3	49%	21.5
Public Schools	175	29%	Green Schools	75%	38.4	50	1.0	86%	32.0
Various (Ordinance)	1274	100%	First-flush Ordinance	50%	637	1236	1.0	86%	531.6
Total					1,265	3,752			1,053
					55%				

Pollutant	Average Stormwater Concentration* (mg/L)	Average CSO Discharge Concentration* (mg/L)	Pollutant Reduction from Stormwater (lb/yr)	Pollutant Reduction from CSOs (lb/yr)	Total Est. Pollutant Reduction (lb/yr)
Total Suspended Solids (TSS)	1.2	3.5	1,435	24,297	1,437,000
Total Phosphorus (TP)	0.7	1.5	2,033	59,564	27,800
Total Nitrogen (TN)					61,600

*Based on the midpoint pollutant concentrations in USEPA's CSO Report to Congress, 2001

**25-Year Plan to manage over 1,200 Acres of Impervious Area
Capture over 1 Billion Gallons of Stormwater Runoff over the long term**





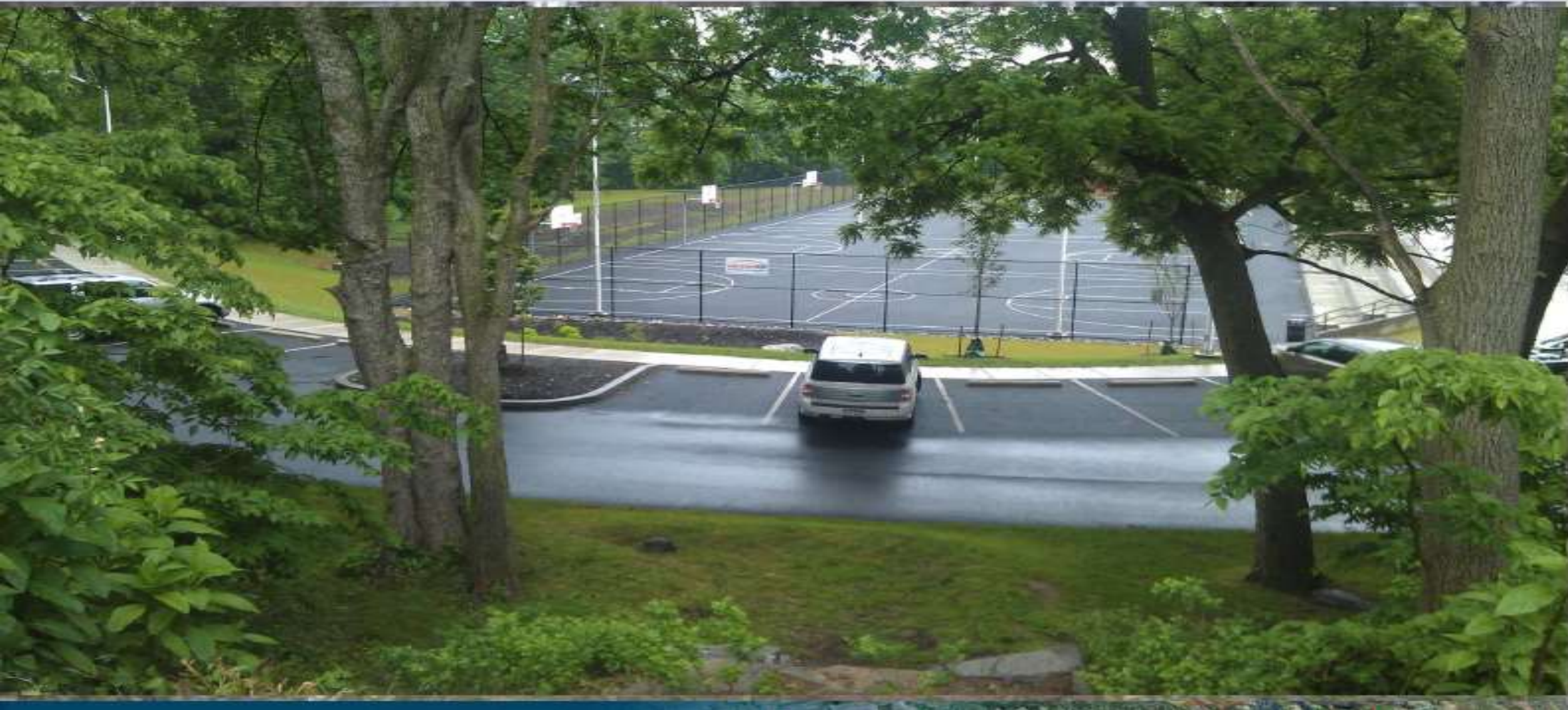
Garden of Distinction recognition from Pennsylvania Horticultural Society



Brandon Park



Brandon Park



Dauphin Street Parking Lot



452,000 Gallons / year reduction in runoff volume

Penn Ave Parking Lot



538,000 Gallons / year reduction in runoff volume



731,000 Gallons / year reduction in runoff volume

Mifflin Street Parking Lot



281,000 Gallons / year reduction in runoff volume

Summary of City-Owned Parking Lot Retrofit Projects

Parking Lot	Drainage Area	GI Area	Capture Volume	Capital Costs with Contingency
Plum Street	23,402	4,680	511,000	\$89,862
Dauphin	20,582	4,516	411,000	\$61,822
Penn	22,758	4,219	455,000	\$60,749
Mifflin	13,242	1,324	265,000	\$27,013
TOTAL			1,642,000	\$239,446

COST PER GALLON = \$0.14/gallon



Alley 148 Greened for 10% Additional Cost

Before (July 2011)

After (February 2012)

Component	Conventional Unit Cost (\$/square foot)	Green Unit Costs (\$/SF)
Pavement Removal/Excavation	\$1.08	\$1.08
Crushed Stone w/ geotextile	\$0.35	\$1.39
Pipes/Cleanouts/etc.	---	\$0.82
8-inch reinforced concrete	\$18.89	\$18.89
Permeable Pavers	---	\$19.44
Total Weighted Average	\$20.32	\$22.37
Additional Green Cost (\$/SF)	---	\$2.05
Additional Green Cost (%)	---	10%



~\$20.30/SF for conventional reconstruction (8-inch reinforced concrete)

~\$22.40/SF for green alley retrofit (permeable pavers with infiltration trench)

195,000 Gallons / year reduction in runoff volume



Lancaster Brewing Company (Plum and Walnut)

- Dangerous Intersection Conditions
- Adjacent to National Register Historic Building
- Gateway into the City's downtown



The Lancaster Brewing Company “Beer Garden” is Coming!

Thanks to the “City of Lancaster” for the Walnut Street Project!

1. The project will capture stormwater run-off from Walnut and Plum Streets by allowing water to soak into the ground in “Water Collection Areas”. The City of Lancaster will save money with this “natural” treatment of stormwater while saving our friends down stream from us.
2. The intersection will get a huge improvement with safe crosswalks!

3. There will be a right turn on red from Plum onto Walnut Street - to keep the flow of traffic moving just like it does now.
4. Lancaster Brewing will get an awesome new brick patio with outdoor seating for you to enjoy a cold one and meal with friends!
5. The project is slated to start mid-summer with a fall completion.

Take a brochure from our friends from Live Green Lancaster to learn more about Green Projects around Lancaster

City of Lancaster “Green Infrastructure Project” for Stormwater Collection



**1.7 Million Gallons / year reduction in runoff volume
< \$0.20 / gal**

Rendering by **McCormick**
Engineers & Planners
Since 1946 **Taylor**



700 Gallon Cistern Functions As Public Art and Irrigates Planters



LBC Educational Placemat

HEY KIDS!

Ever wonder where all the rain and snow goes after a storm?

Water that rains down washes over streets, lawns, parking lots and off of roofs, like the one over your head, and eventually into storm drains (the grates you see on sidewalks and streets). Along the way, the water gets really dirty from things like litter, pet waste, chemicals, oils and car fluids.

While some of it can be cleaned up at a treatment center, some of that dirty water ends up in our creeks, ponds and lakes like the Conestoga River, and eventually flows all the way to the Chesapeake Bay!

Each year, 750 million gallons of polluted water from Lancaster City ends up in the Bay. That's a lot of dirty water! What if we could keep it clean?!

TURN THIS CISTERN INTO YOUR OWN PIECE OF ENVIRONMENTAL ART:

(don't forget to draw all the plants the cistern will help water!)

There are lots of ways we can all help recycle water.

And one of those ways is *right here where you are eating*— the cool Public Artwork outside this restaurant, called "Lancaster's Gateway Bundle."

When rain falls or snow melts on the roof, it flows right into the giant "bucket" (called a cistern) attached to the building. The cistern catches that water before it flows through the drains into the rivers. It can hold 750 gallons of water (that's enough to fill your bathtub over 30 times!)

And guess what? Not only do we keep that dirty water from going into our rivers and streams, that water can be used to water the plants in the restaurant's garden outside.

HELP THE RAINDROP FIND ITS WAY TO THE RAIN GARDEN

NOW THAT'S COOL!

Lancaster's Gateway Bundle

SAVE IT!
YOUR WASTE. YOUR MONEY. YOUR CITY.
www.spellkancaster.org

Lancaster
RESTAURANT

A+M

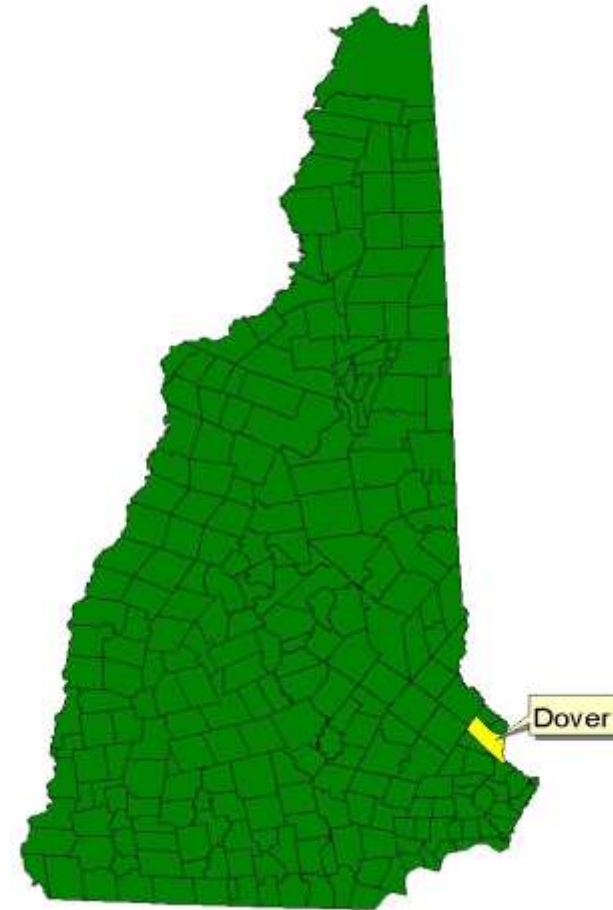
gsm
INDUSTRIAL
Metal Fabrication & Installation Contractor
A local company

GREEN INFRASTRUCTURE ADVISORY COMMITTEE

- Included representatives from:
 - business owners,
 - citizens,
 - institutions,
 - environmental groups,
 - state government,
 - Lancaster City government, and
 - Lancaster County government.
- Met 6 times between April and September 2012 on funding options and policy issues

Dover, New Hampshire:

- Population 30,665
- Old Textile Mill Community
- Two major rivers; Bellamy and Cochecho, which flow into the Great Bay
-
- Split fresh water and tidal
- Sewer Separation project during the 1970's - mainly installed new sanitary mains



Berry Brook Project:

- Discovered problems with the brook
- Had to relocate stock yard - water stock moved to Community Services headquarters
- Loss of city's inventory building
- City Staff tasked with constructing small rain garden at the elementary school



Social: Elements pertaining to efforts that relate to public involvement and civic support for a cultural approach or common social responsibility.



Participants at the Beginning:

- City of Dover Staff
- UNH Stormwater Center
- NH Department of Environmental Services
- Environmental Protection Agency



New Definitions to Learn:

BMP – Best Management Practice

LID – Low Impact Development

OMDB – Over My Dead Body

RG – Rain Garden

NDP – No Damn Plants



GW – Gravel Wetland

MHA – Must Have Access

MS4 – More Sh#@ 4 me

BACB – Big Ass Catch Basin

SWMP – Stormwater Management Plan

RMP – Right Maintenance Plan



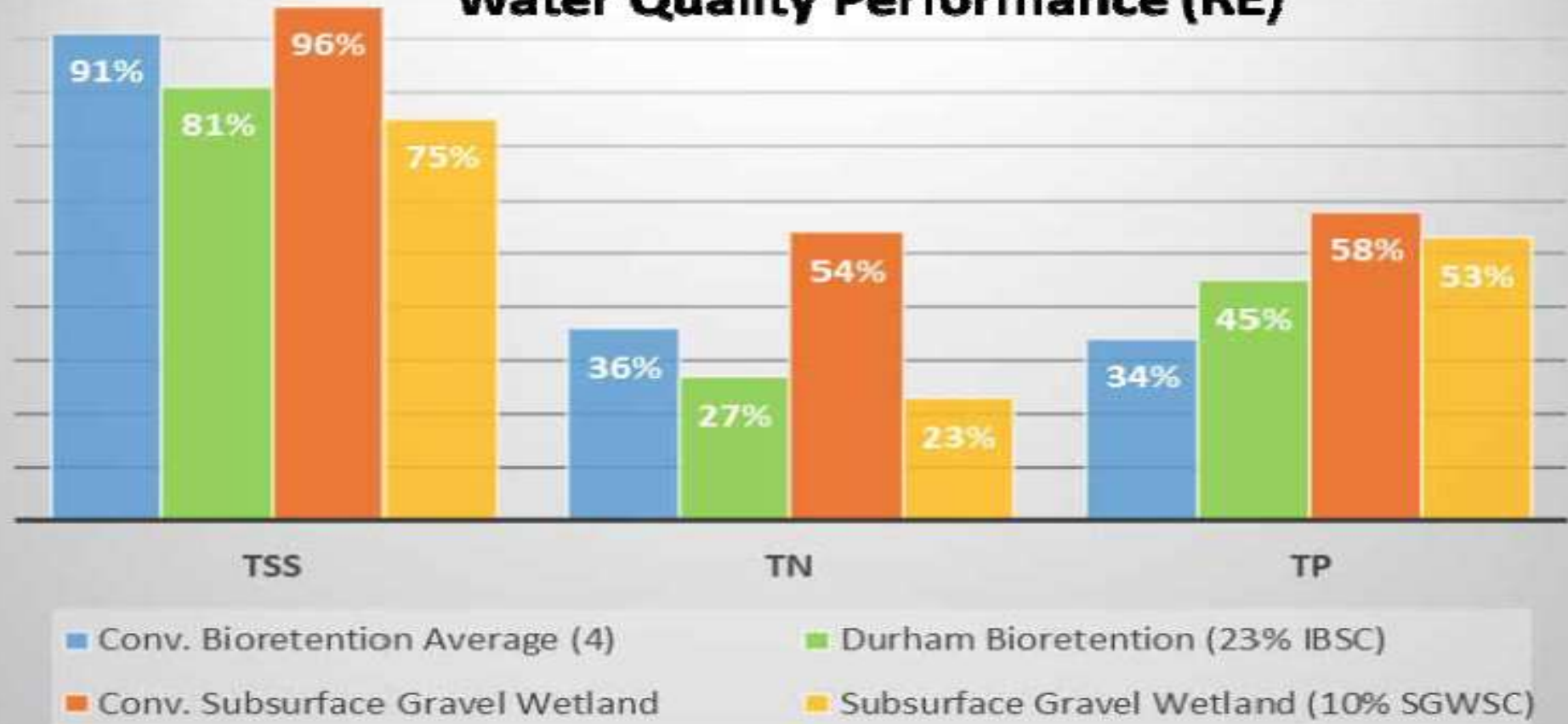






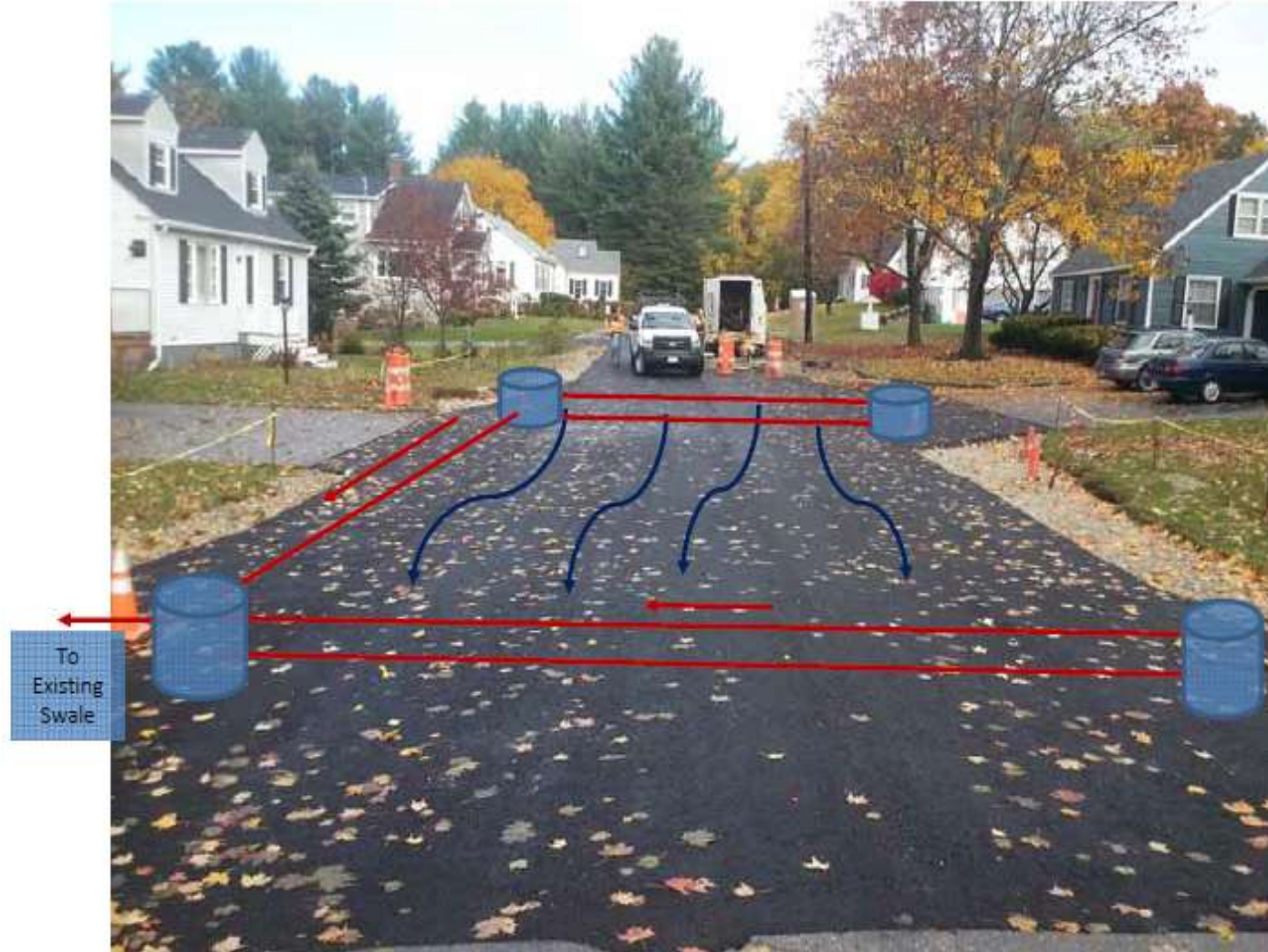


Water Quality Performance (RE)



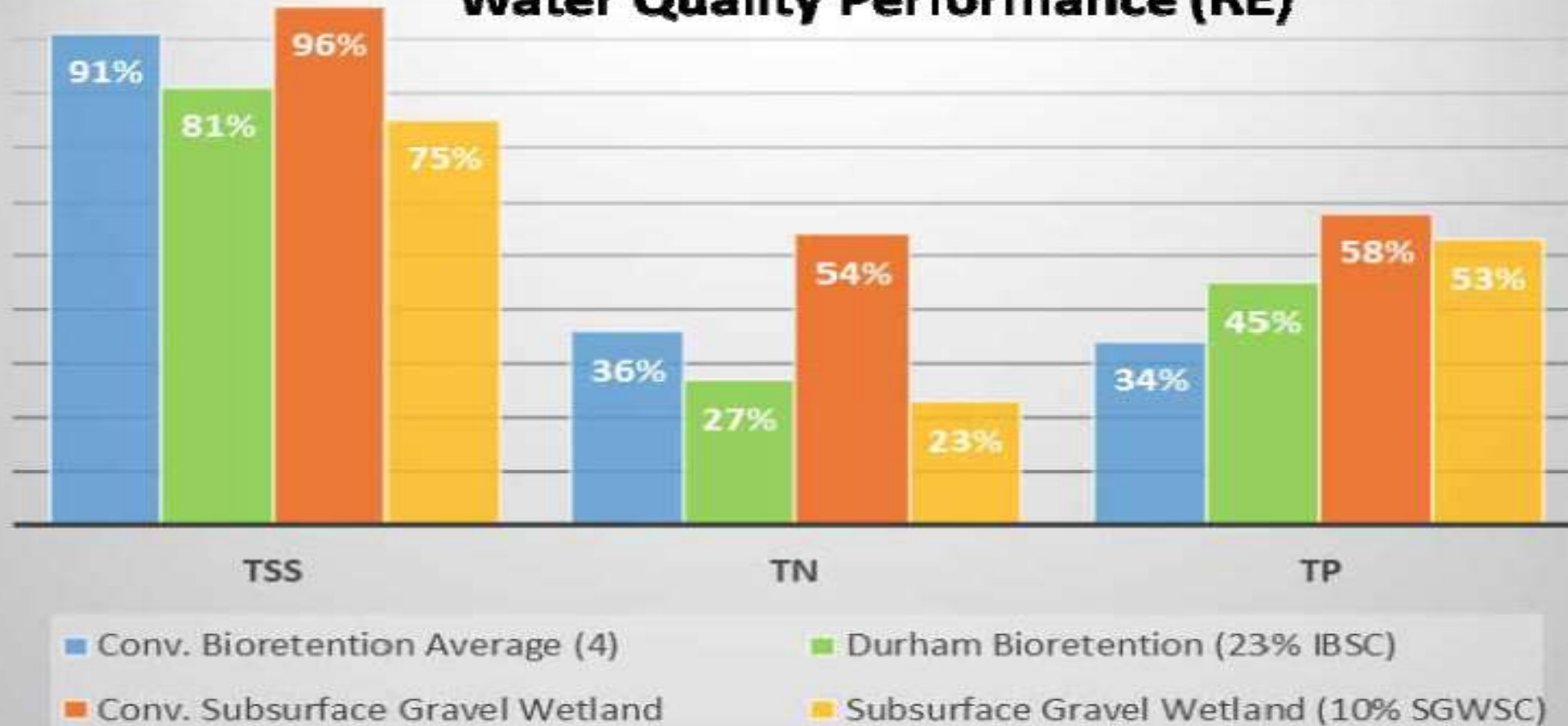
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GI: Subsurface Gravel Filter





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Old Stormwater Thinking:

- Create a direct path to river or brook
- Add pipe or culverts to remove any ponding near roadway
- Full drainage project includes many catch basins with large pipes directly to river or brook



New Stormwater Thinking:

- Employee Involvement
- Resident Involvement
- Catching Sediment and Trash
- Capture and Treat Stormwater close to source
- Reduce Impervious Area
- Try new systems and ideas... but always keep in mind maintenance impact



Thank you!

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