MUNICIPAL ENGAGEMENT MEETING #2
NEXT-GENERATION WATERSHED MANAGEMENT PRACTICES FOR CONSERVATION DEVELOPMENT

June 30, 2022
Public Safety Building, Mansfield, MA

1

"We have disrupted the natural water cycle for centuries in an effort to control water for our own prosperity. Yet every year, recovery from droughts and floods costs billions of dollars, and we spend billions more on dams, diversions, levees, and other feats of engineering. These massive projects not only are risky financially and environmentally, they often threaten social and political stability. *What if the answer was not further control of the water cycle, but repair and replenishment?*"

-Sandra Postel, the Replenish, The Virtuous Cycle of Water and Prosperity

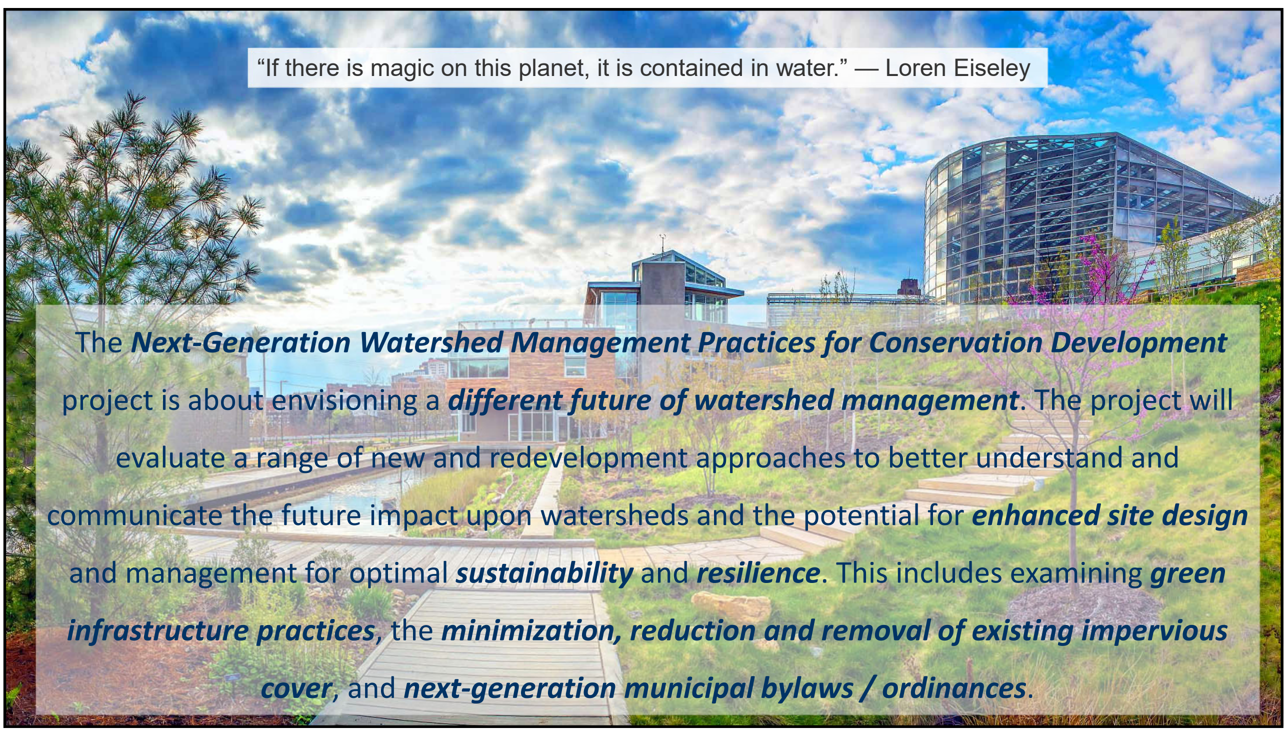
2

Agenda

1. **Introductions and Project Team (All, 5 min)**
2. **EPA Intro - How / Why We Got Here (Ray, 5 min)**
    a. Applied Research under the Clean Water Act
    b. The Problem of Impervious Cover
    c. Developing Practicable Approaches for a Sustainable and Resilient Future
3. **Project Context (Mark, 10 min)**
    a. Vision
    b. MS4 Overview
    c. Impacts of IC
    d. Cost burdens of Reduced Management
4. **Modeling Overview (Alvi, 20 min)**
    a. FDC Phase 1 and Phase 2
    b. Watershed Scale Modeling Results
    c. Discussion (10 min)
5. **Site Development Approach Goals (Rob, 30 min)**
    a. Example – Rollins Hill medium and high density
    b. Review Conceptual Site-Development Plans
        i. High Density Residential
        ii. Commercial Mixed-Use Redevelopment
        iii. Modeling Results (Alvi)
    c. Benefits of Increased Level of Controls
    d. Discussion (15 min)
6. **Next Steps (Mark, 10 min)**
    a. Information sheets
    b. Compendium
    c. Recharge Calculations
    d. Discussion (10 min)

3

3



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Sound Future Land Development & Stormwater Management

Are we on the path for Resiliency?

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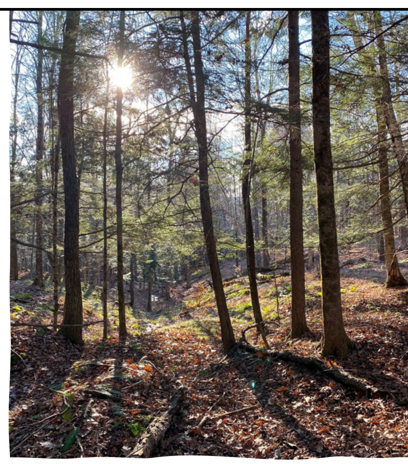
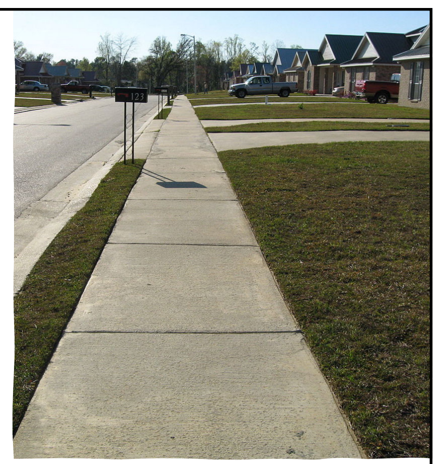




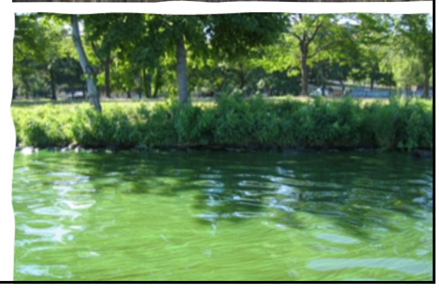
Applying Advances in EPA Region 1 Analytical Tools to Quantify

- Cumulative impacts of future IC
- Benefits of Resilient Site-Development Performance Standards
- Right sizing stormwater controls
- Future Cost Burden and Cost Avoidance Opportunities

6

Converting Natural Land to Impervious Cover: Site Scale

- **Increased** Annual Runoff Volume
  - ~+300% to +10,000% increase (0.5 to 1.1 Million-Gallons/acre/year)
- **Lost** Annual Groundwater Recharge
  - ~0.3 to 0.5 million-gallons/acre/year
- **Increased** Annual SW **Phosphorus** Load
  - ~+400% to +6,500% (1.5 to 1.9 pounds/acre/year)
- **Increased** Annual SW **Nitrogen** Load
  - ~+500% to +13,000% increase (11 to 13 pounds/acre/year)



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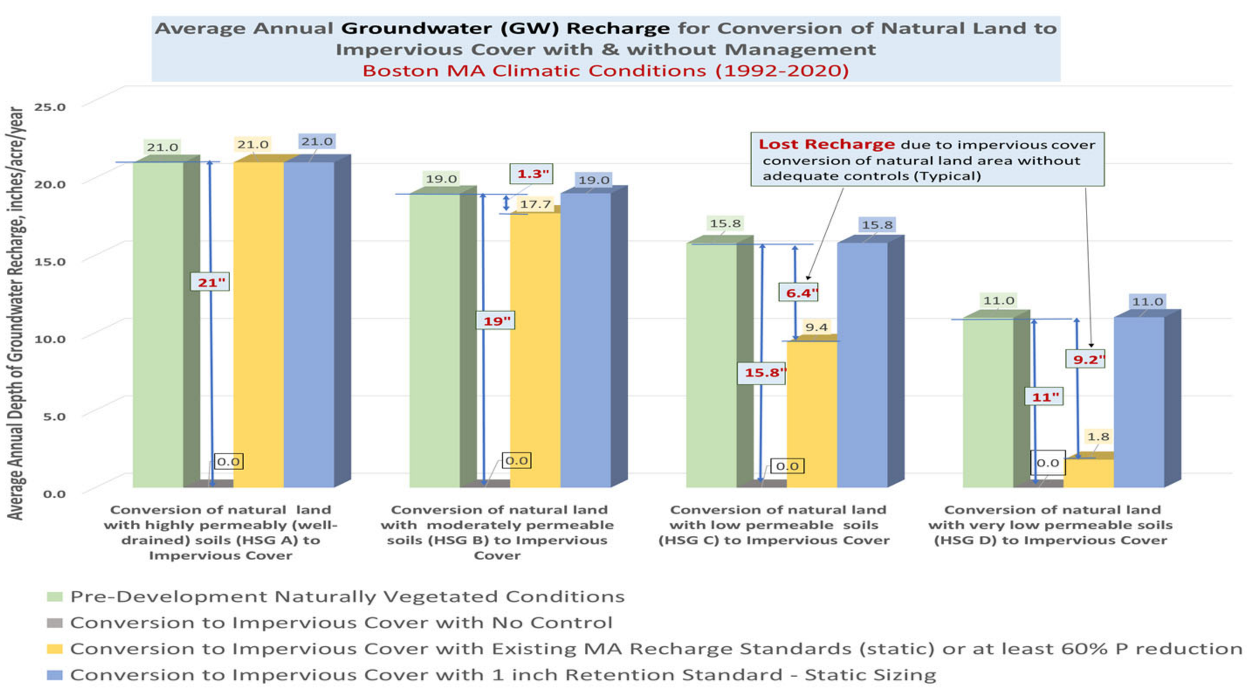

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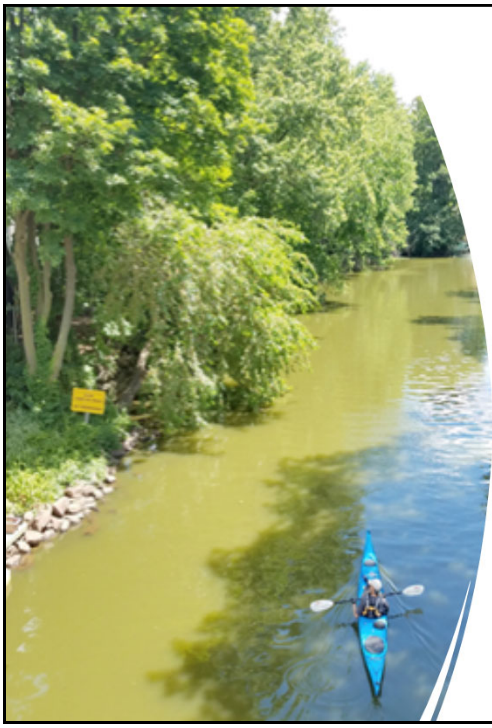
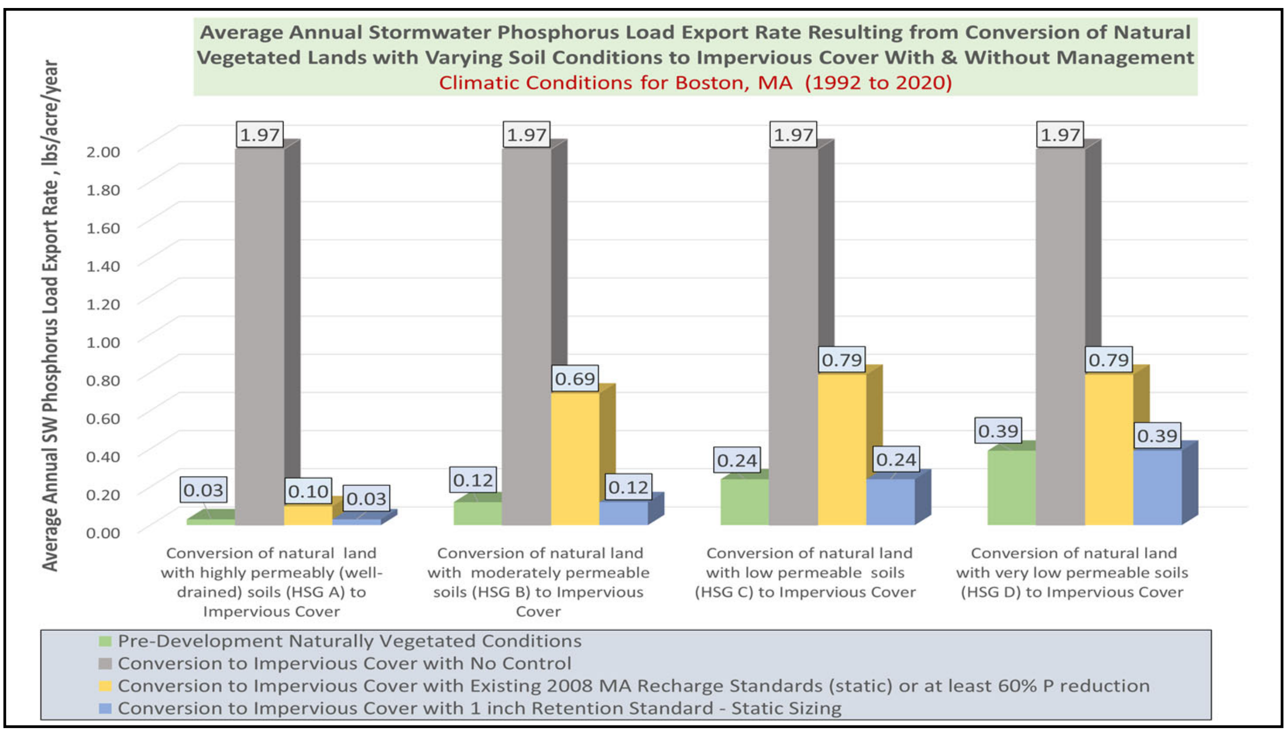


The Nutrient Challenge & SW Permitting

- **Nationally 45% to 65% of assessed waters are impaired by nutrients**
- **Stormwater is a major contributor of Phosphorus and Nitrogen**
- **Land conversion to impervious cover increases stormwater flow and nutrient delivery**
- **Changing climate leads to warmer waters and increased stormwater flow – exacerbating the issue**

9



10

Minimizing Future Retrofit Needs

- Next generation stormwater permits now require SW load reductions from existing development
- Municipal retrofit programs require substantial investment from the community
- Retrofit stormwater controls can cost up to 4x the equivalent control during new or re-development

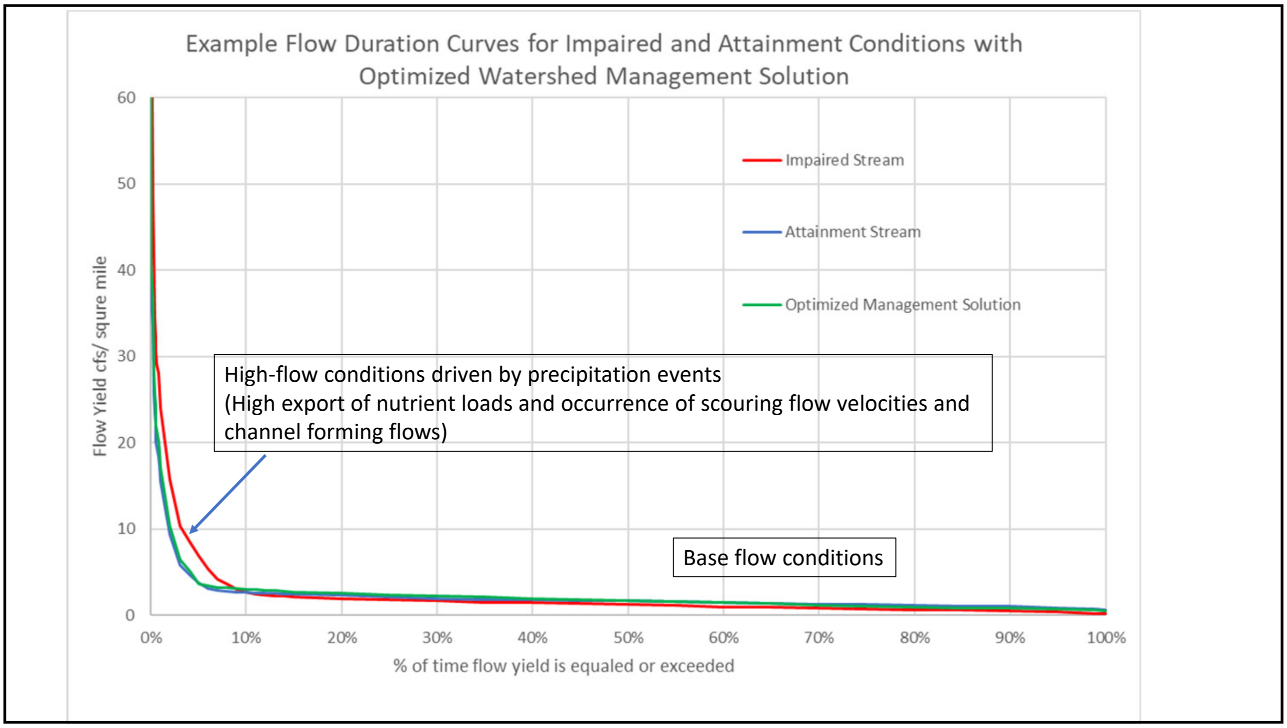
Protective Post Construction Stormwater Requirements For New and Re-Development are a MUST for Resiliency

11

Potential Cost Burden & Opportunity for Cost Avoidance – SW Nutrient Loading Management

Potential Future Stormwater Management Cost Burdens Associated with Converting Natural Vegetated Areas to Impervious Cover (IC Conversion)				
Nutrient	Management Scenario	Range of Increase in Average Annual Nutrient Load Export Rate from IC Conversion	Range in Stormwater Retrofit costs (yr 2020)**	Range in Potential Future SW Retrofit Cost Burden to offset increased nutrient loading from IC conversion ($/acre IC)
Phosphorus	No controls***	1.5 to 2.0 lbs/acre/yr	$25,000 to $60,000 per lb Phosphorus Captured	$62,000 to $79,000 per IC acre
	60% P Load reduction at time of development	0.6 to 0.8 lbs/acre/yr		$15,000 to $48,000 per IC acre
	1 Inch Retention standard with Recharge Targets	0 lbs/acre/yr	$0	$0
Nitrogen	No controls***	10.9 to 13.1 lbs/acre/yr	$2,200 to $7,500 per lb Nitrogen Captured	$48,000 to $58,000 per IC acre
	65% N Load reduction at time of development	3.8 to 4.6 lbs/acre/yr		$8,400 to $35,000 per IC acre
	1 Inch Retention Standard with Recharge Targets	0 lbs/acre/yr	$0	$0

12



13

Summary & Take Away Information

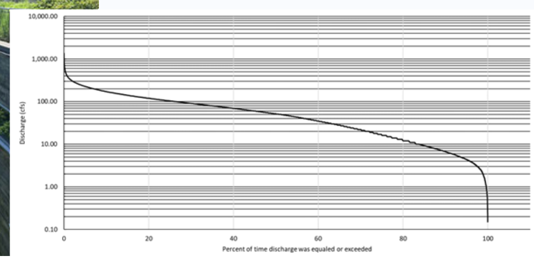
- Conversion of Natural Vegetated Areas to IC has **serious long-term implications** for future ecological health, economics, & community resilience
- Current land development management frameworks need thorough reevaluations to ensure sustainable water resource **protection & avoidance** of potential future cost burdens
- Application of EPA R1 Tools and information are shedding light on what are appropriate **Resilient Performance Standards at the site scale** to avoid impacts, minimize future cost burdens and increase community resiliency in the face of climate change

14

EPA Region 1's Flow Duration Curve work is a two-phase project

Investigate the impacts of Conservation Development (CD) practices on watershed hydrology and stream health. Improving the way we design, develop, and re-develop our communities

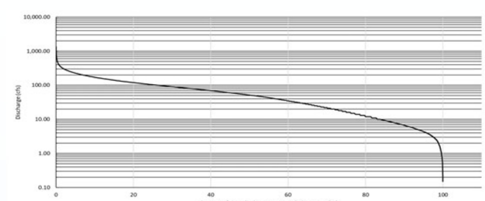
Understand the sustainability and resilience of alternative approaches to development



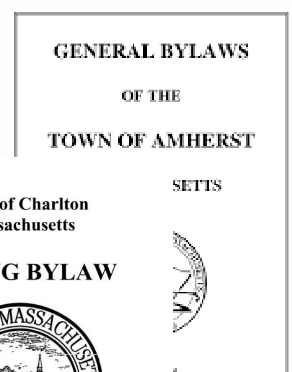
15

Sustainability

- Environmental



- Social



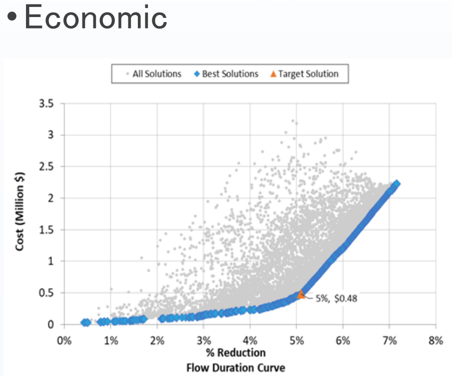
GENERAL BYLAWS

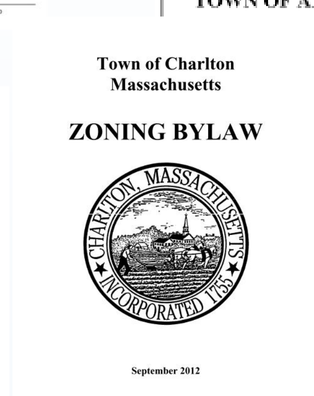
OF THE

TOWN OF AMHERST

SETTS

- Economic





Town of Charlton
Massachusetts

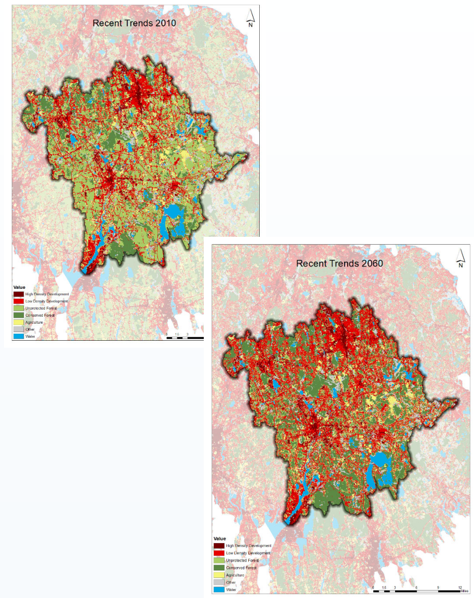
ZONING BYLAW

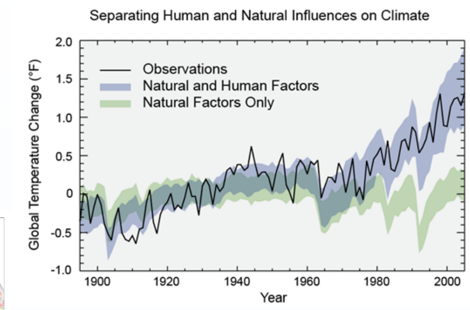
September 2012

16

Resilience

- Future land use
- Future Climate

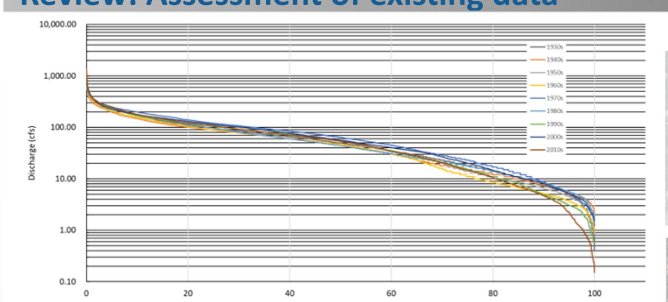




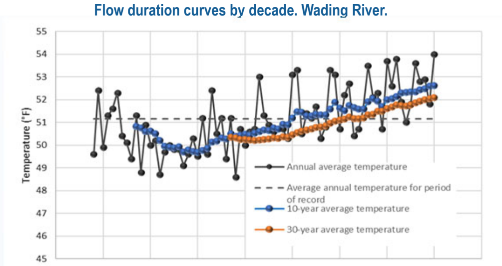
17

17

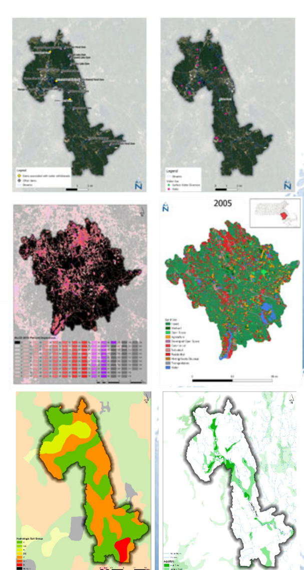
Review: Assessment of existing data



Flow duration curves by decade. Wading River.



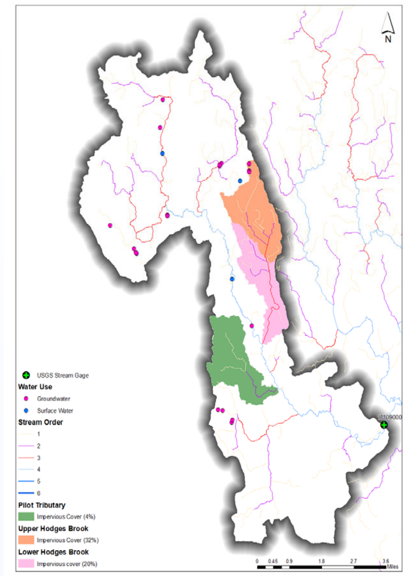
Annual average temperature trends (T.F. Green Airport).

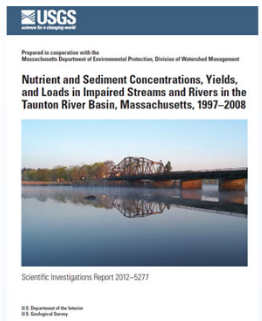


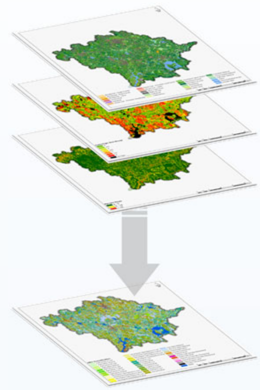
18

18

Review: Model Configuration



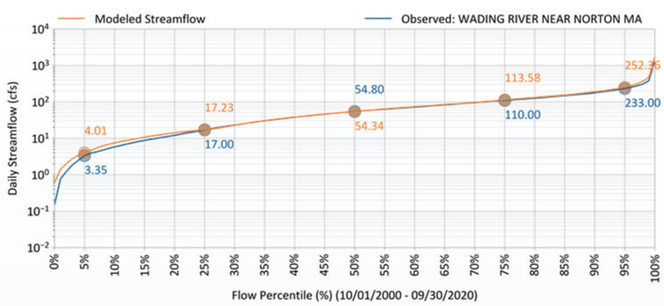




19

19

Review: Model Calibration and Validation



Flow Duration Curves: Predicted vs Observed

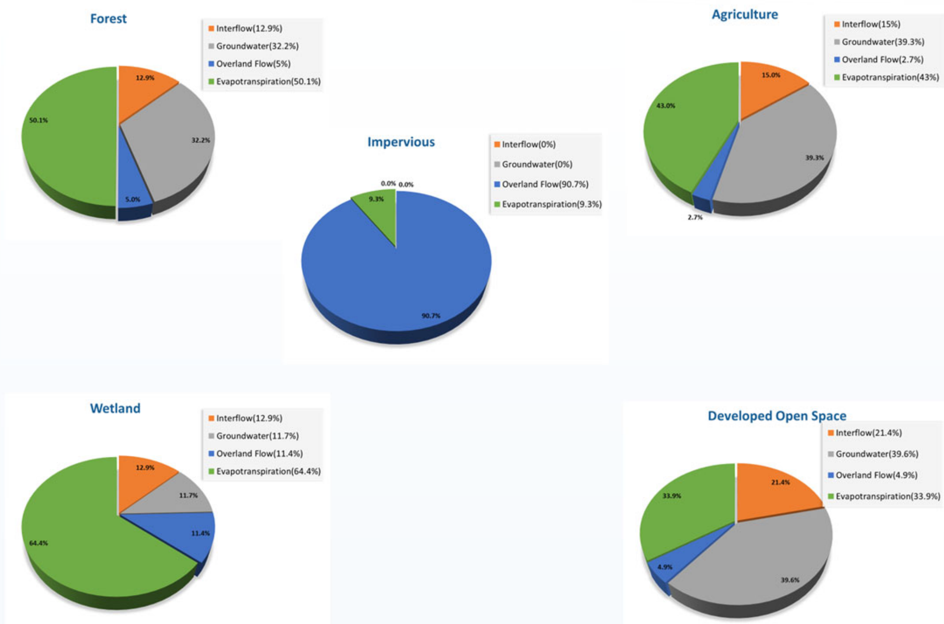
Hydrology Monitoring Locations	Performance Metrics (Seasonal)															Performance Metrics (Flow Regime)														
	PBIAS					R-squared					Nash-Sutcliffe E					PBIAS					R-squared					Nash-Sutcliffe E				
	All	Winter	Spring	Summer	Fall	All	Winter	Spring	Summer	Fall	All	Winter	Spring	Summer	Fall	All	Top 10%	Storms	Low 50%	Baseflow	All	Top 10%	Storms	Low 50%	Baseflow	All	Top 10%	Storms	Low 50%	Baseflow
WADING RIVER NEAR NORTON MA	-	-	+	-	-											-	-	-	-	-										

Very Good | Good | Satisfactory | Unsatisfactory

- Overpredicts | + Underpredicts

20

Review: Water Balance



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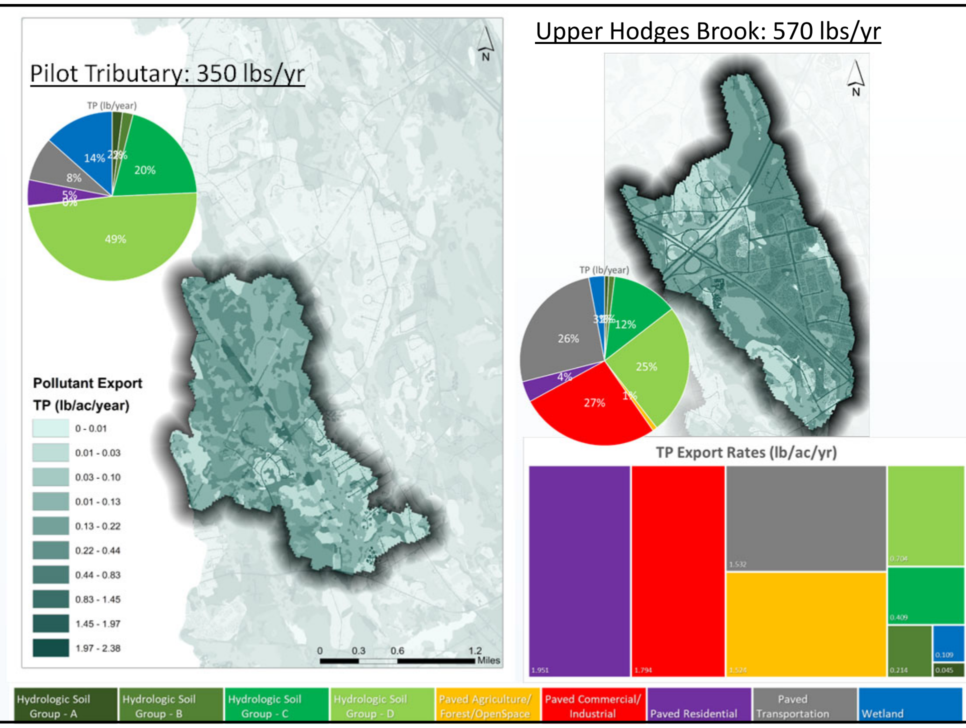


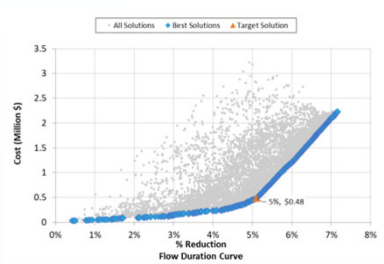
22

22

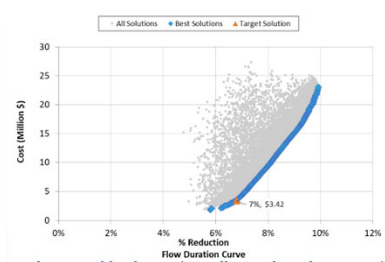
Optimization: Opportunity Screening

Land Use	Within 200 feet of impervious surface	Landscape Slope (%)	Within FEMA Hazard Areas	Within Surface Water Protect on Zone	Within 100 feet of Stream/ Coastline	Within Wetland	Within 25 feet of Structure?	Hydrologic Soil Group	Management Category	SCM Type(s) in Opti Tool
Pervious Area	Yes	<= 15	Yes	Yes	Yes	Yes	Yes	All	SCM with complicating characteristics	--
			No	No	No	No	No	A/B/C	Surface Infiltration	Surface Infiltration Basin (e.g., Rain Garden)
								D	Biofiltration	Biofiltration with underdrain option
		> 15	--	--	--	--	--	--	SCM with complicating characteristics	--
	No	--	--	--	--	--	--	--	No SCM opportunity	--
Impervious Area		<= 5	Yes	Yes	Yes	Yes	Yes	All	SCM with complicating characteristics	--
			No	No	No	No	No	A/B/C	Subsurface Infiltration	Infiltration Trench
								D	Shallow filtration	Porous Pavement
		> 5	--	--	--	--	--	--	SCM with complicating characteristics	--

Optimization: Cost Effectiveness Curves

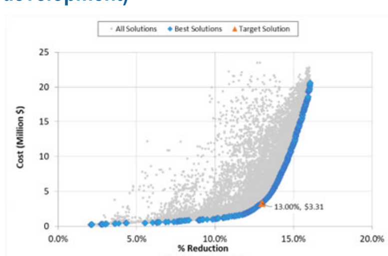


Pilot Tributary (low development)



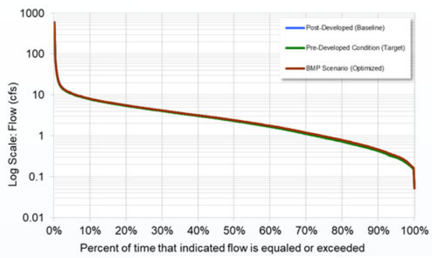
Lower Hodges (medium development)

CECs: used average year

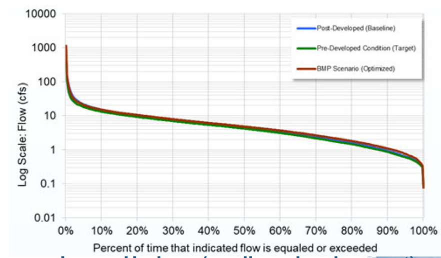


Upper Hodges (high development)

Optimization: Opti-Tool FDCs

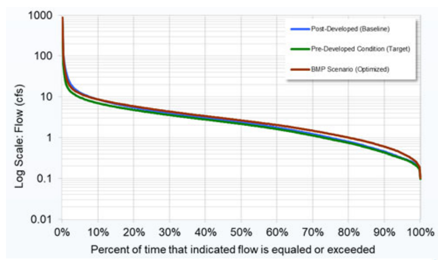


Pilot Tributary (low development)



Lower Hodges (medium development)

FDCs: used 20 years of data



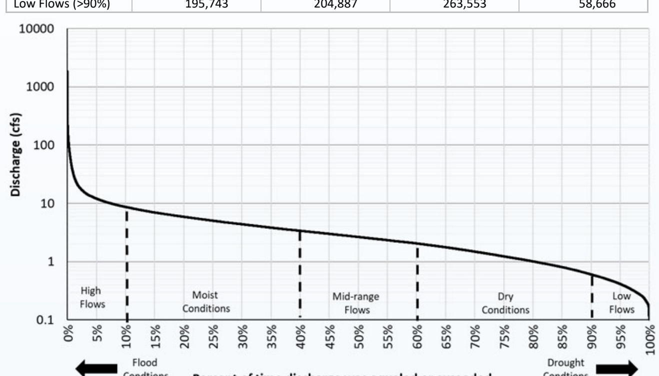
Upper Hodges (high development)

25

Optimization: Opti-Tool Results By Flow Regime

Average daily flow by flow regime (gallons per day) for Upper Hodges sub-watershed.

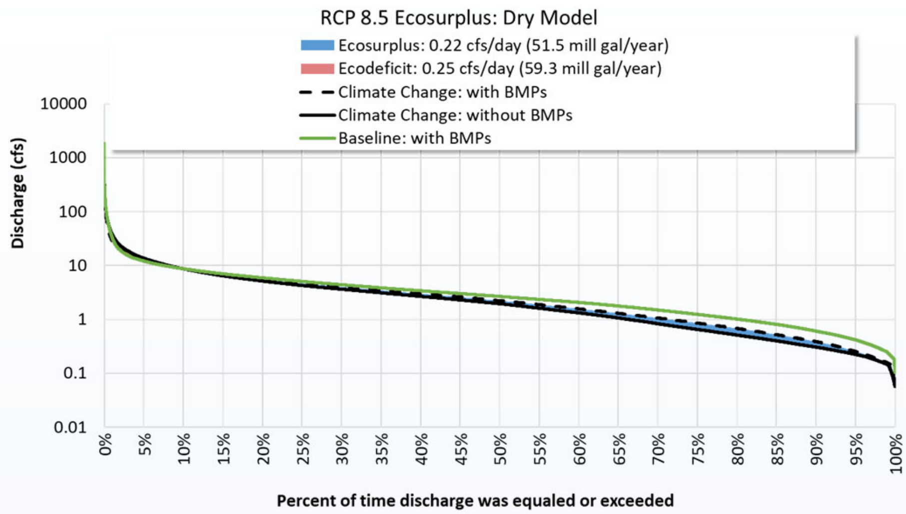
FDC Flow Regime	Pre development	Existing Conditions	SCM Implementation	Difference between Existing Conditions and SCM Implementation
High Flows (<10%)	10,328,678	15,542,489	14,047,584	-1,494,905
Moist Conditions (10% - 40%)	2,821,690	3,249,150	3,452,334	203,184
Mid-range Flows (40% - 60%)	1,418,780	1,545,519	1,730,688	185,169
Dry Conditions (60% - 90%)	625,365	676,662	821,837	145,174
Low Flows (>90%)	195,743	204,887	263,553	58,666



Adapted from U.S. EPA, 2007.

26

Optimization: Resiliency to Climate Change



27

27

Change in Land Use – Land Cover for 2060 Future Condition in Taunton River Watershed

Opti Tool Land Use Classification	Baseline 2016 (acre)	Future 2060 (acre)	Change (acre)	% Change
Paved Forest	9	9	0	0%
Paved Agriculture	128	158	30	23%
Paved Commercial	4,858	6,873	2,015	41%
Paved Industrial	2,745	3,892	1,147	42%
Paved Low Density Residential	9,951	20,717	10,766	108%
Paved Medium Density Residential	489	1,133	644	132%
Paved High Density Residential	2,856	4,041	1,186	42%
Paved Transportation	11,852	21,709	9,857	83%
Paved Open Land	4,138	8,377	4,239	102%
Developed OpenSpace	40,955	76,120	35,165	86%
Forested Wetland	66,463	66,463	0	0%
Non-Forested Wetland	9,734	9,734	0	0%
Forest	144,393	78,832	-65,561	-45%
Agriculture	25,255	25,768	513	2%
Water	17,628	17,628	0	0%

Increase in impervious cover = +29,883 acres (+81%)
Decrease in Forest land = -65,561 acres (-45%)

28

Change in Hydrology and WQ for 2060 Future Development

Major Land Use Classification	Annual Average Change				
	Runoff (MG/yr)	GW Recharge (MG/yr)	ET (MG/yr)	TN (lb/yr)	TP (lb/yr)
Paved Forest	0	0	0	0	0
Paved Agriculture	36	0	4	339	44
Paved Commercial	2,487	0	255	30,707	3,615
Paved Industrial	1,416	0	145	17,484	2,058
Paved Low Density Residential	13,290	0	1,361	153,634	16,182
Paved Medium Density Residential	795	0	81	9,192	1,269
Paved High Density Residential	1,463	0	150	16,905	2,823
Paved Transportation	12,168	0	1,246	101,133	15,101
Paved Open Land	5,232	0	536	48,661	6,646
Developed OpenSpace	14,095	17,376	16,307	59,202	5,516
Forested Wetland	0	0	0	0	0
Non-Forested Wetland	0	0	0	0	0
Forest	-15,485	-29,331	-44,628	-56,406	-11,193
Agriculture	174	220	303	2,916	485
TOTAL	**35,674**	**-11,734**	**-24,240**	**383,765**	**42,545**

Units: MG – million gallons, lb – pounds, yr – year

Note: A standard water tower can hold 1 million gallons of water and a typical large dump truck can carry about 28,000 pounds.

29

Conclusions

The impact that development has on a FDC can vary depending on the intensity of development.

In the study watersheds, developed watersheds, including those that manage stormwater through impervious surface disconnection, tended to have higher flows across the FDC compared to pre-development conditions.

However, baseflows fell below pre-development conditions when the amount of connected impervious surfaces was substantially increased. There appears to be a threshold somewhere between the forested and highly developed watershed conditions where baseflows may increase or decrease. Effect of infiltration ET opportunities.

The results improve our understanding of the extent to which SCMs restore predevelopment streamflows and improve watershed functions

While SCM implementation can mitigate some of the impacts of impervious surfaces, it may be difficult to attain pre-development watershed functions without landscape-level changes that promote additional evapotranspiration.

SCM Implementation can mitigate some of the impacts of climate change, especially projected lower baseflows, by promoting groundwater recharge.

30

ROLLINS HILL
STRATHAM'S FIRST ECO FRIENDLY COMMUNITY

CONSERVATION DEVELOPMENT

- 105-acre conservation development
- Designed to integrate homes with the landscape and provide protection for water quality and habitat.
- Permeable pavements, raingardens, and rooftop infiltration are used to recharge groundwater.
- Homes near to vernal pools include porous driveways to reduce the need snow and ice management, and 12" of rich loam for all landscaping so plantings and lawns will thrive and reduce the need for fertilizer and pesticides.

31

ROLLINS HILL
STRATHAM'S FIRST ECO FRIENDLY COMMUNITY

MARKET VALUE

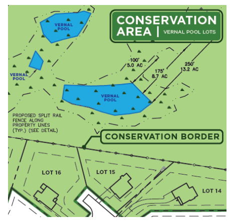
- Sustainable development makes sense
- Exceptional and added value by Going Green
- Use of porous asphalt roadways enabled ~5 additional lot, a 12% increase
- Reduced time for environmental permitting and design
- Beautiful aesthetics with limited clearing, working around natural resources (wetlands, cedar swamps)
- Simplified permitting, porous asphalt made the project possible.
- Over 55+ community managed by HOA and Maintenance vendor

32

ROLLINS HILL
STRATHAM'S FIRST ECO FRIENDLY COMMUNITY

CONSERVATION LANDS AND VERNAL POOL PROTECTION

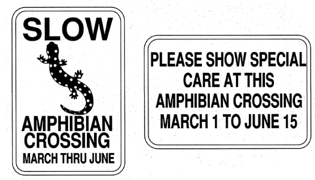
- 105-acre development
- 55 acres in conservation
- ACOE Vernal Pool Recommendations[1]
  - Directional buffer
  - Critical terrestrial habitat
  - 100' - No disturbance
  - 175'- Limited clearing
  - 250'- Land use restrictions



AMPHIBIAN TUNNEL

LIMITED LOT CLEARING

CRITTER CROSSING ROAD SIGNAGE



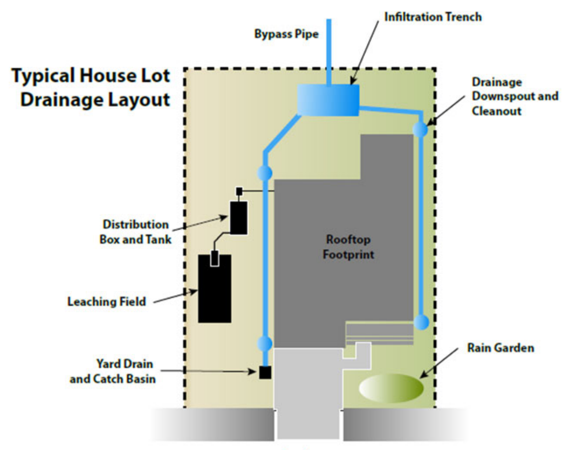
[1]US Army Corps of Engineers, New England District. 2015. Vernal Pool Best Management Practices.

33

ROLLINS HILL
STRATHAM'S FIRST ECO FRIENDLY COMMUNITY

LOT LAYOUT AND DRAINAGE

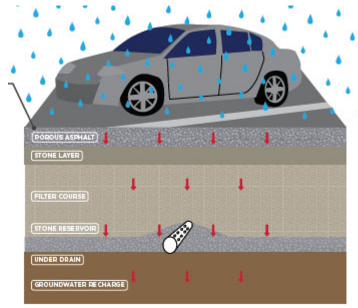
- Lots designed to be nearly zero discharge
- Raingardens
- Drip edge infiltration and infiltration trench
- Porous asphalt roadways
- **Conservation measures** to protect habitat for high value natural resourc like Atlantic Cedar, vernal pools, frogs and other critters.



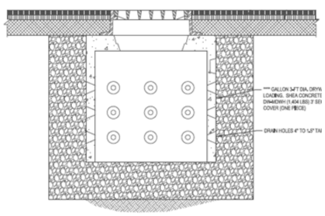
34

ROLLINS HILL
STRATHAM'S FIRST ECO FRIENDLY COMMUNITY

POROUS PAVEMENTS



POROUS ASPHALT DIAGRAM



REDUNDANT DRAINAGE - DRY WELLS

- 3,864 LF, 2.1 acres of porous asphalt roadways
- 9 porous asphalt driveways (Phase II)
- ATPB (asphalt treated permeable base)
  PG76-28, 23% voids, binder course
- Porous asphalt – PG76-28 18% voids, wearing course

35

ROLLINS HILL
STRATHAM'S FIRST ECO FRIENDLY COMMUNITY

INFILTRATION

ROADWAY INFILTRATION TRENCH CONNECTED TO PRETX

ROADWAY INFILTRATION POST- CONSTRUCTION

36

BIOFILTRATION

ROLLINS HILL
STRATHAM'S FIRST ECO FRIENDLY COMMUNITY

BIORETENTION CUL-DE-SAC

BIOSWALE AND PRETX POST-CONSTRUCTION

37

HOUSE LOT INFILTRATION

ROLLINS HILL
STRATHAM'S FIRST ECO FRIENDLY COMMUNITY

DOWNSPOUT SELF CLEANING GRATES

INFILTRATION TRENCH FOR ROOFTOP RUNOFF

38

ROLLINS HILL
STRATHAM'S FIRST ECO FRIENDLY COMMUNITY

LOW /NO CHLORIDE

- **<u>POROUS ROADWAY AND DRIVEWAY RESTRICTIONS on the Use of Chloride/Deicing Chemicals</u>:** Roadway snow removal will be conducted by a NHDES certified Green SnowPro Salt Applicator Certification with environmentally friendly winter maintenance practices with a goal of low chloride and deicing chemical usage

NEW HAMPSHIRE CERTIFIED GREEN SnowPro

WINTER MAINTENANCE GUIDANCE FOR POROUS ASPHALT

Regular winter maintenance is critical to the effective and safe operation of porous asphalt. Winter maintenance of porous asphalt is different and typically requires 1) less salt in total throughout the winter, 2) more salt during individual snow events, and 3) no salt in the days and weeks between events to manage for black ice.

This page provides guidance on maintenance activities that are typically required for porous asphalt, along with a suggested frequency for each activity. Individual systems may have more, or less, frequent maintenance needs, depending upon a variety of factors including: the occurrence of large storm events; regional hydrologic conditions; and traffic conditions.

GENERAL MAINTENANCE

1. Plow after every storm. Special plow blades may be used to prevent scarring but are not necessary. Raised blade is not recommended
2. Up to ~75% net salt reductions for porous asphalt have been documented. USE RECOMMENDATIONS WITH CAUTION!!!
3. Excess salt application maybe needed during challenging storm events. Salt reductions typically occur between storm events with no black ice formation.
4. Salt reduction amounts are site specific and are affected by degree of shading and hours of operation.
5. Apply anti-icing treatments prior to storms. Anti-icing has the potential to provide the benefit of increased traffic safety at the lowest cost and with less environmental impact.

39

ROLLINS HILL
STRATHAM'S FIRST ECO FRIENDLY COMMUNITY

LOW /NO CHLORIDE

STANDARD ASPHALT DRIVEWAY AND POROUS ASPHALT ROADWAY 2/9/2022

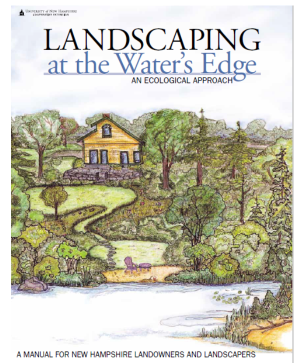
POROUS ASPHALT DRIVEWAY AND POROUS ASPHALT ROADWAY 2/9/2022

40

ROLLINS HILL
STRATHAM'S FIRST ECO FRIENDLY COMMUNITY

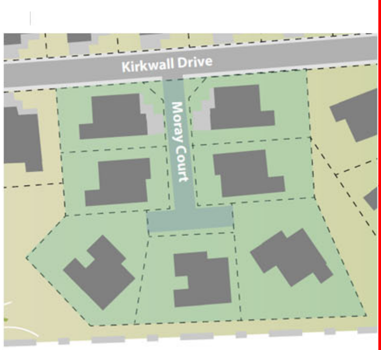
FERTILIZER AND PESTICIDE RESTRICTIONS AND LOAM AUGMENTATION

- Fertilizer and pesticide limited, except for establishing initial landscaping within the first season of growth.
- Long-term landscaping will follow practices for water quality protection in *Landscaping at the Water's Edge, an Ecological Approach (2007)*.
- A list of professional landscapers for homeowners for the evaluation of soils, fertilizing and pest management.
- Fertilizers used on the property must contain no phosphorus unless a soil test indicates that additional phosphorus is needed for growth.
- Loam augmentation, placement of 12" of high quality soils comprised of topsoil, compost, and fertilizer if necessary, tested by Soils lab for N, P, pH, organic matter



41

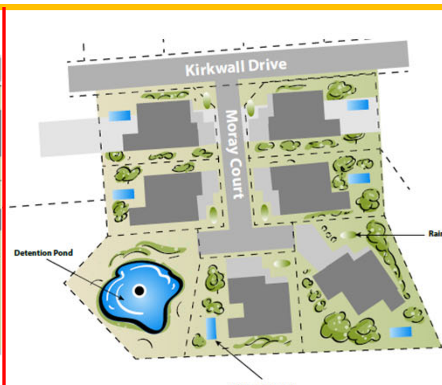
CONCEPT PLAN 1: HIGH DENSITY RESIDENTIAL HSG-C



CD1.2 No Controls High Density Residential

NO CONTROL

- ✗ STD 2 - PEAK FLOW CONTROL
- ✗ STD 3 - GROUNDWATER RECHARGE VOLUME
- ✗ STD 4 - TSS 80% REMOVAL (90% MS4)
  - TP 60% REMOVAL
- ✗ NO INCREASE IN NUTRIENT LOAD
- ✗ PREDEVELOPMENT HYDROLOGY
- ✗ RESILIENT HYDROLOGY



CD1.3 LID MADEP High Density Residential

LID MADEP

- ✓ STD 2 - PEAK FLOW CONTROL
- ✓ STD 3 - GROUNDWATER RECHARGE VOLUME
- ✓ STD 4 - TSS 80% REMOVAL (90% MS4)
  - TP 60% REMOVAL
- ✗ NO INCREASE IN NUTRIENT LOAD
- ✗ PREDEVELOPMENT HYDROLOGY
- ✗ RESILIENT HYDROLOGY

CD1.4 LID Peak High Density Residential

LID VOLUME

- ✓ STD 2 - PEAK FLOW CONTROL
- ✓ STD 3 - GROUNDWATER RECHARGE VOLUME
- ✓ STD 4 - TSS 80% REMOVAL (90% MS4)
  - TP 60% REMOVAL
- ✓ NO INCREASE IN NUTRIENT LOAD
- ✓ PREDEVELOPMENT HYDROLOGY
- ✓ RESILIENT HYDROLOGY

42

CONCEPT PLAN 1: HIGH DENSITY RESIDENTIAL HSG-C

CD1.2 No Controls High Density Residential

NO CONTROL

- ✗ STD 2 - PEAK FLOW CONTROL
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- ✗ STD 4 - TSS 80% REMOVAL (90% MS4)
  - TP 60% REMOVAL
- ✗ NO INCREASE IN NUTRIENT LOAD
- ✗ PREDEVELOPMENT HYDROLOGY
- ✗ RESILIENT HYDROLOGY

- NO BMPS
- COMMON FOR PROJECTS THAT DON'T TRIGGER STATE OR FEDERAL REQUIREMENTS
- AND MUNICIPALITIES WITH WEAK SWM REGULATIONS

CD1.3 LID MADEP High Density Residential

LID MADEP

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- ✓ STD 4 - TSS 80% REMOVAL (90% MS4)
  - TP 60% REMOVAL
- ✗ NO INCREASE IN NUTRIENT LOAD
- ✗ PREDEVELOPMENT HYDROLOGY
- ✗ RESILIENT HYDROLOGY

- 3 BMP TYPES:
  - RAIN GARDEN (DRIVEWAYS), 0.5" WQV
  - SUBSURFACE INFILTRATION TRENCH (ROOFTOP), 0.5" WQV
  - DETENTION POND (ROADWAYS)
- RAINGARDEN AND ROOFTOP INFILTRATION TO SATISFY STDS 3 (GRV) AND STD 4 (NITROGEN AND PHOSPHOROUS)
- DETENTION POND TO SATISFY STD 2 (Q-PEAK)

CD1.4 LID Peak High Density Residential

LID VOLUME

- ✓ STD 2 - PEAK FLOW CONTROL
- ✓ STD 3 - GROUNDWATER RECHARGE VOLUME
- ✓ STD 4 - TSS 80% REMOVAL (90% MS4)
  - TP 60% REMOVAL
- ✓ NO INCREASE IN NUTRIENT LOAD
- ✓ PREDEVELOPMENT HYDROLOGY
- ✓ RESILIENT HYDROLOGY

- 2 BMP TYPES:
- SUBSURFACE INFILTRATION FOR ROADWAYS AND DRIVEWAYS
- ROOFTOP INFILTRATION TO SATISFY STDS 3 (GRV) AND STD 4 (NITROGEN AND PHOSPHOROUS) , 1" WQV
- ROADWAY INFILTRATION TO SATISFY STD 2 (Q-PEAK), STRUCTURAL DESIGN

43

43

CD1.3 LID MADEP High Density Residential

LID MADEP

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- ✓ STD 3 - GROUNDWATER RECHARGE VOLUME
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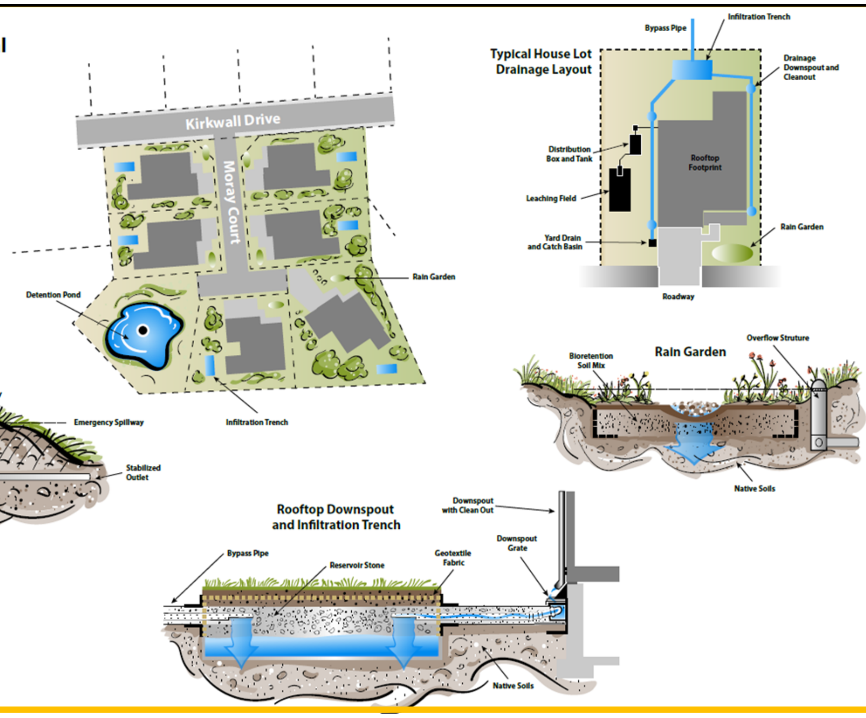

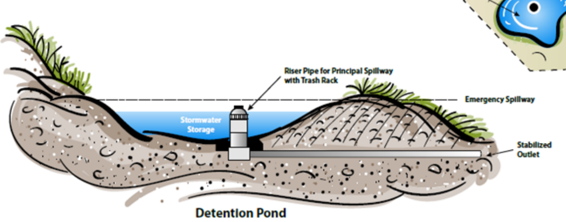

44

CD1.4 LID Peak High Density Residential

LID VOLUME

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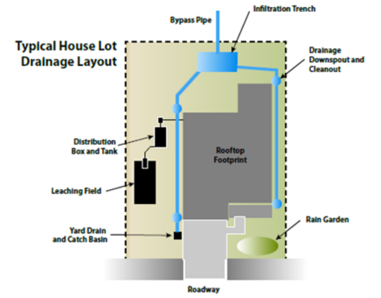

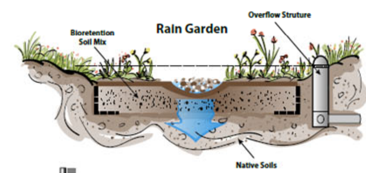

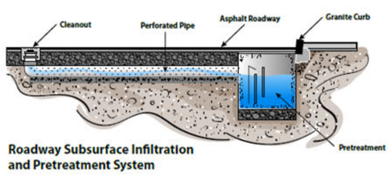

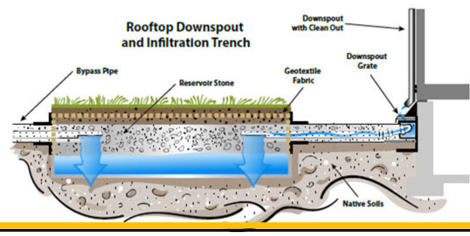

45

CONCEPT PLAN 1: HIGH DENSITY RESIDENTIAL HSG-C

CD1.2 No Controls High Density Residential

NO CONTROL

- ✗ STD 2 - PEAK FLOW CONTROL
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- ✗ RESILIENT HYDROLOGY

CD1.3 LID MADEP High Density Residential

LID MADEP

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- ✓ STD 3 - GROUNDWATER RECHARGE VOLUME
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CD1.4 LID Peak High Density Residential

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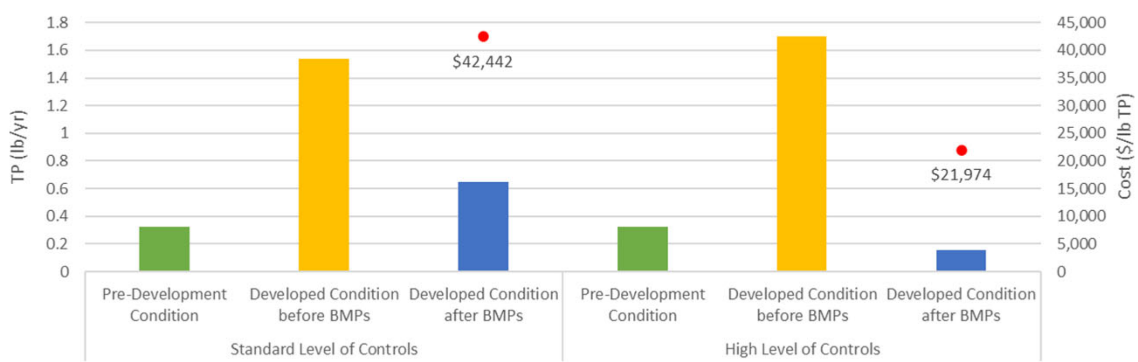

46

46

CONCEPT PLAN 1: HIGH DENSITY RESIDENTIAL HSG-C

CD1.3 LID MADEP High Density Residential

LID MADEP
- ✓ STD 2 - PEAK FLOW CONTROL
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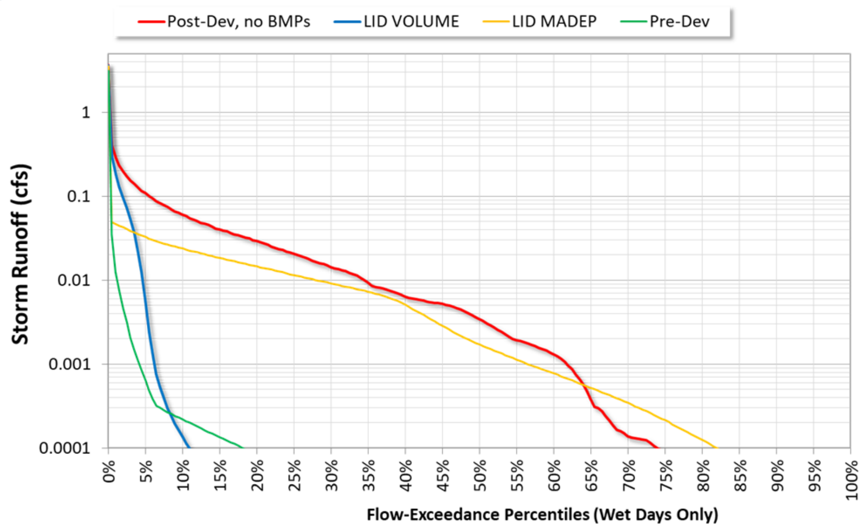

47

47

CONCEPT PLAN 2: HIGH DENSITY COMMERCIAL HSG-A

CD2.2 No Controls Commercial Redevelopment

NO CONTROL
- ✗ STD 2 - PEAK FLOW CONTROL
- ✗ STD 3 - GROUNDWATER RECHARGE VOLUME
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- ✗ RESILIENT HYDROLOGY

CD2.3 LID Basic Commercial Redevelopment

LID MADEP
- ✓ STD 2 - PEAK FLOW CONTROL
- ✓ STD 3 - GROUNDWATER RECHARGE VOLUME
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CD2.4 LID Volume Commercial Redevelopment

LID VOLUME
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  - TP 60% REMOVAL
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48

CONCEPT PLAN 2: HIGH DENSITY COMMERCIAL HSG-A

CD2.2 No Controls Commercial Redevelopment

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CD2.3 LID Basic Commercial Redevelopment

LID MADEP

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CD2.4 LID Volume Commercial Redevelopment

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49

CD2.3 LID Basic Commercial Redevelopment

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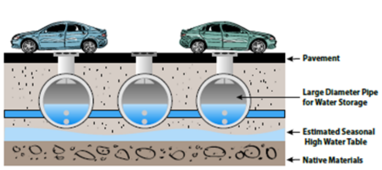
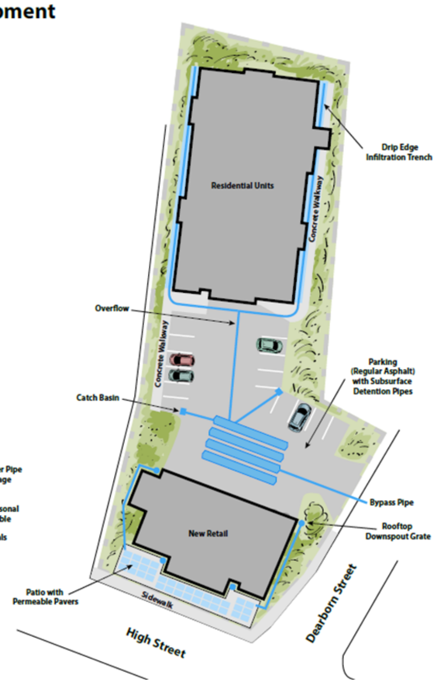
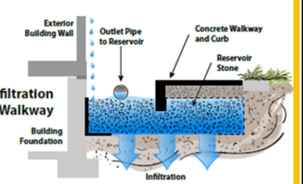
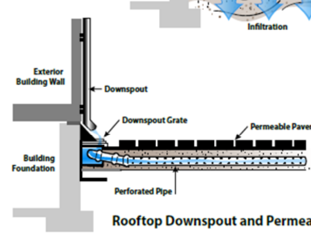


Subsurface Detention





Drip Edge Infiltration Trench and Walkway



Rooftop Downspout and Permeable Pavers

50

CD2.4 LID Volume Commercial Redevelopment

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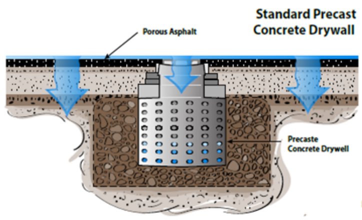

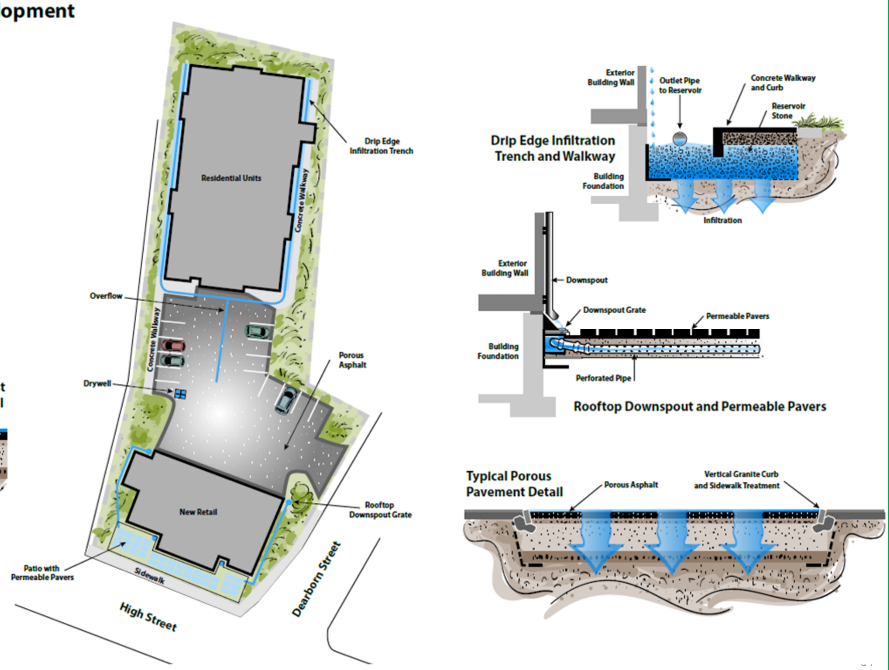

51

CONCEPT PLAN 2: HIGH DENSITY COMMERCIAL HSG-A

CD2.2 No Controls Commercial Redevelopment

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CD2.3 LID Basic Commercial Redevelopment

LID MADEP

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CD2.4 LID Volume Commercial Redevelopment

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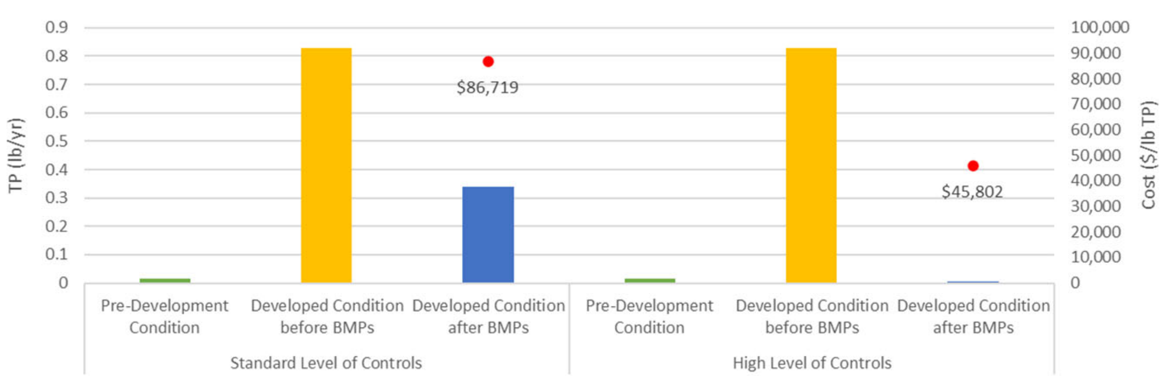

52

52

CONCEPT PLAN 2: HIGH DENSITY COMMERCIAL – RUNOFF VOLUME

CD2.3 LID Basic Commercial Redevelopment

LID MADEP

- ✓ STD 2 - PEAK FLOW CONTROL
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CD2.4 LID Volume Commercial Redevelopment

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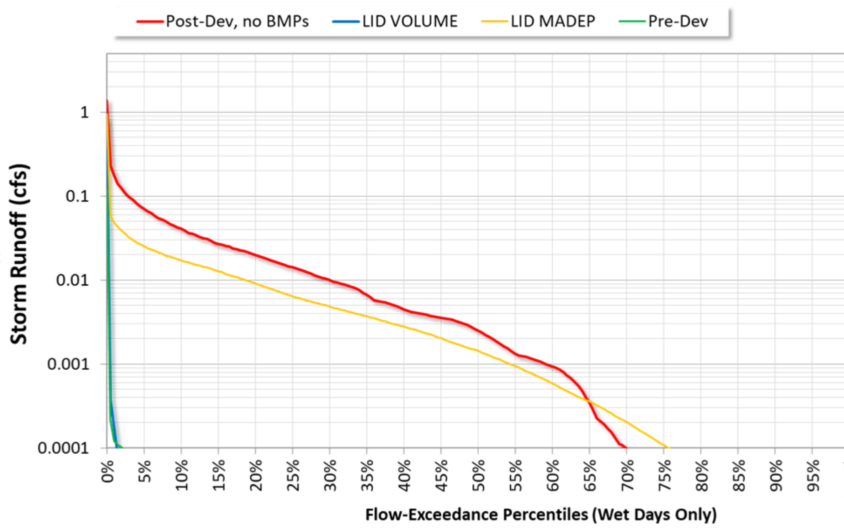
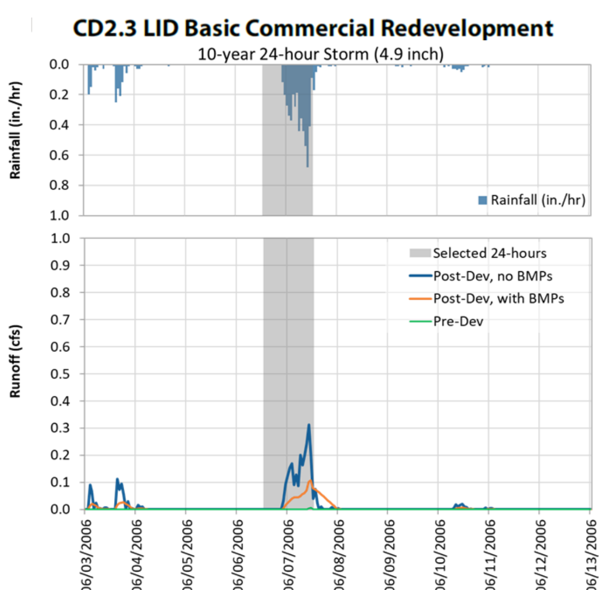
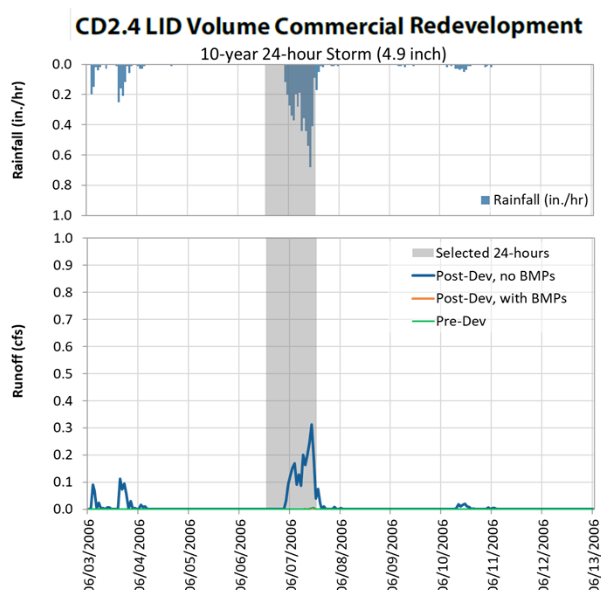


53

53

CONCEPT PLAN 2: HIGH DENSITY COMMERCIAL - RESILIENCY



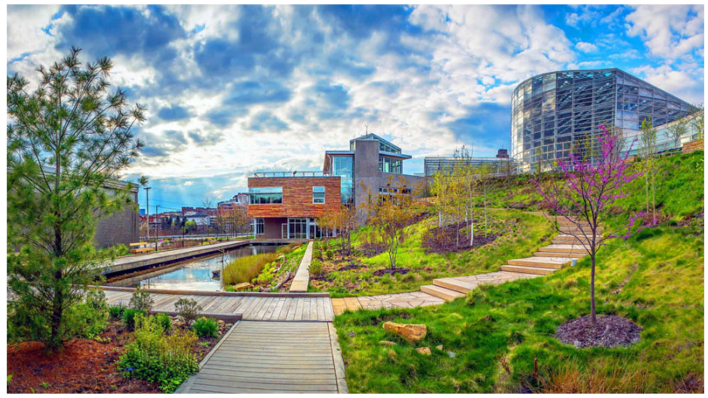


54

54

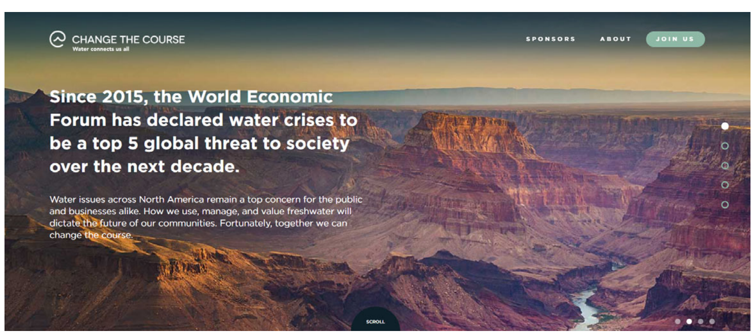
NEXT STEPS

- Meeting/Webinar in September
- Information sheets
- Compendium
- Recharge Calculations
- Discussion (10 min)



55

THANK YOU FOR YOUR TIME



Envisioning A Different Future Of Watershed Management

56

56