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7th Annual TRIECA Conference
Toronto, March 21 & 22, 2018

What is Green Really Worth? Quantifying the Benefits of Green Infrastructure in Washington, DC

Daniel Medina, PhD, PE

Senior Environmental Engineer, LimnoTech

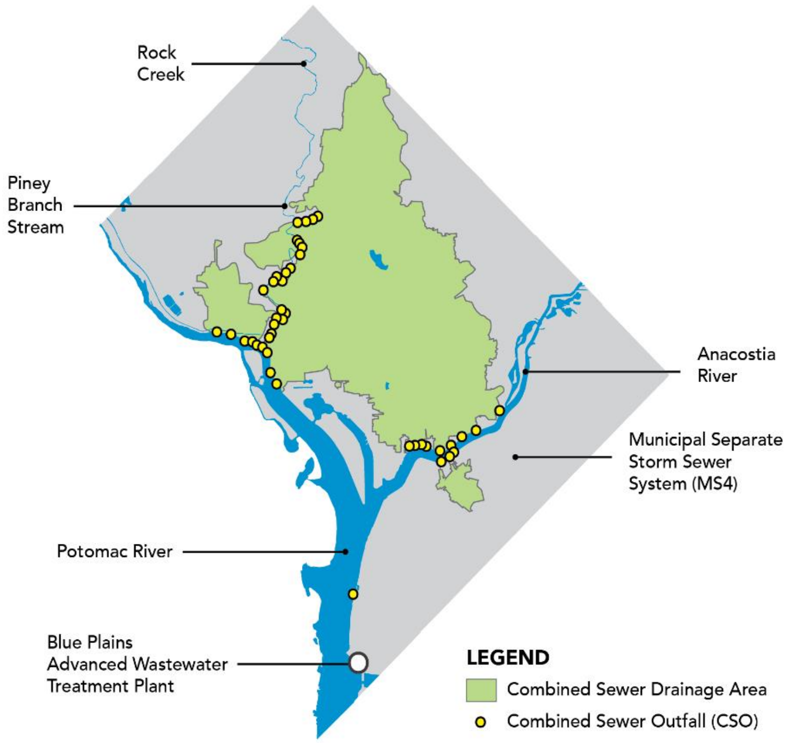
Carlton Ray, P.E. and
Bethany Bezak, P.E. - DC Water

Outline

- Overview of DC Clean Rivers
- Role of Green Infrastructure
- Quantification of Benefits
- Next Steps

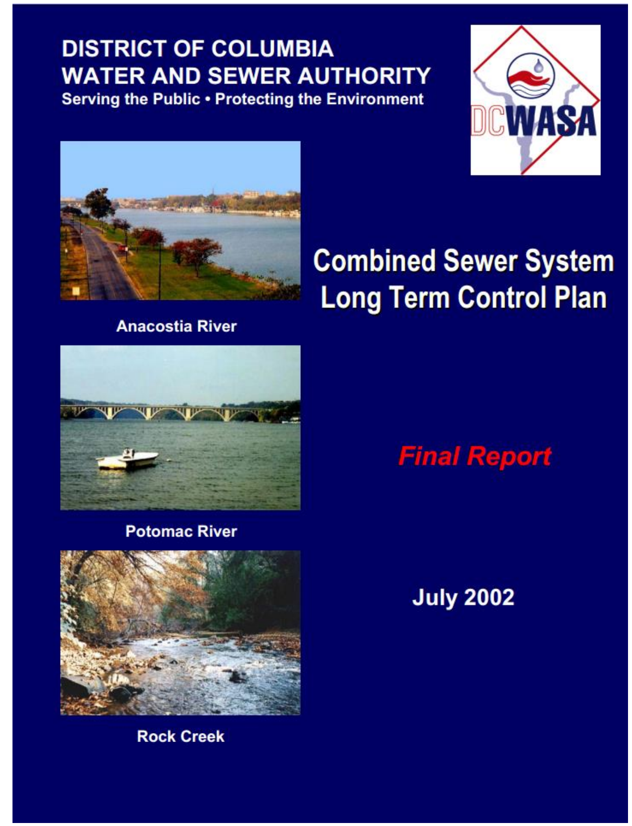
DC Clean Rivers Project Overview

- Combined Sewer System Covers 1/3 of the District (12,478 acres)
- 47 Active CSO outfalls
  - 13 to Anacostia
  - 10 to Potomac
  - 24 to Rock Creek
- Three receiving waters
  - Anacostia River
  - Potomac River
  - Rock Creek



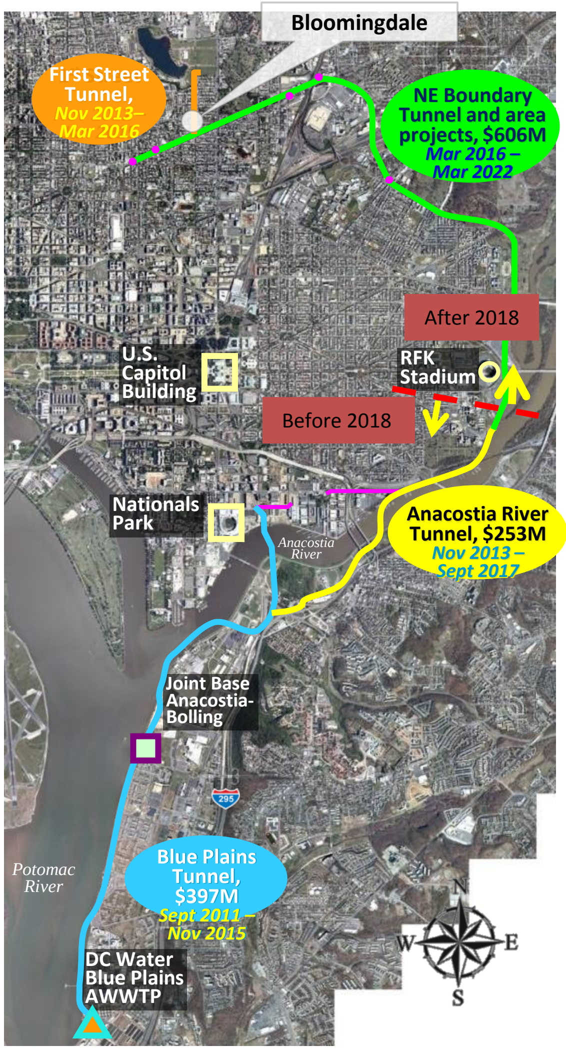
DC Clean Rivers – Long Term Control Plan

- Original LTCP (2002)
  - Reduce CSO overflows from 75 per year to 1-4 per year
  - Rely heavily on grey improvements:
    - Tunnels
    - Pump station upgrades
    - Sewer separation



Tunnels

- 4 large storage/conveyance tunnels
- Dewatering pumping station at Blue Plains
- Pumping station replacement at Poplar Point
- Schedule
  - LTCP = 20 years (2005-2025)
  - Nitrogen Removal = 2007-2015
- Cost
  - LTCP = $2.6 billion
  - Nitrogen Removal = $950 M
  - Total > $3.5 billion



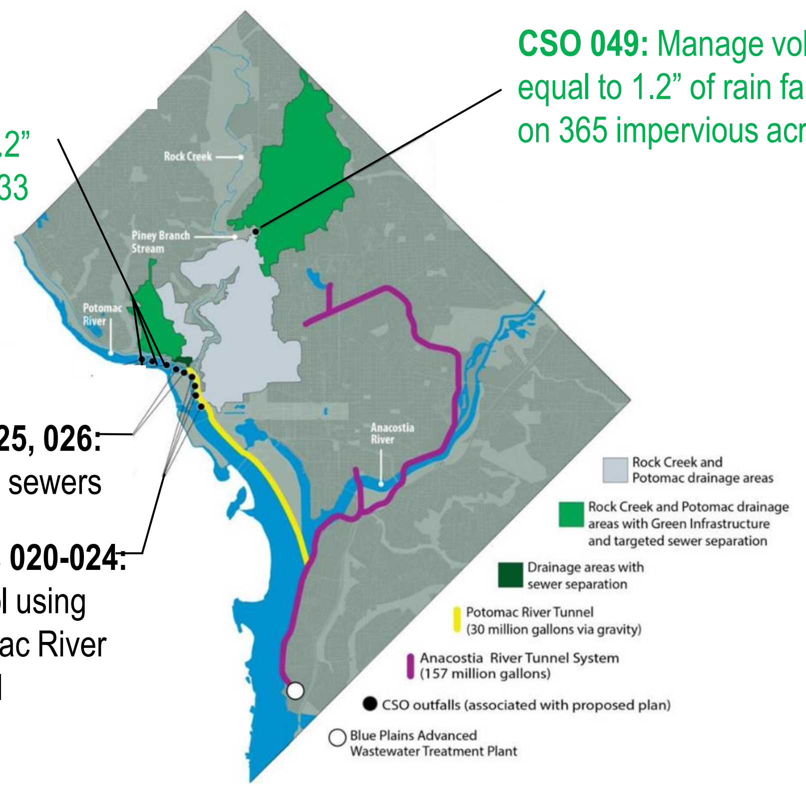
The Task

- Quantify reduction in volume and frequency of CSO overflows caused by:
  - Increased Green Infrastructure
  - Changes in pumping
  - Variations in tunnel volume
  - Grey infrastructure improvements

DC Clean Rivers Project Overview: Amended Consent Decree

CSO's 027, 028, 029: Manage volume equal to 1.2" of rain falling on 133 impervious acres

CSO 049: Manage volume equal to 1.2" of rain falling on 365 impervious acres



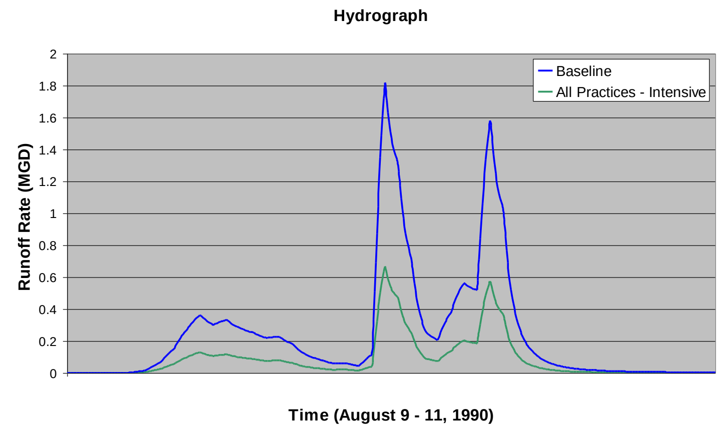
CSO's 025, 026: Separate sewers

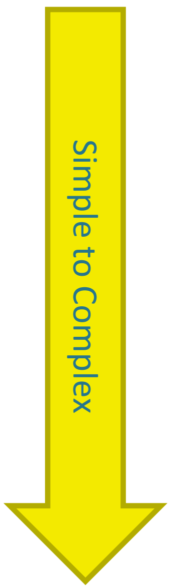
CSO's 020-024: Control using Potomac River Tunnel

Green Infrastructure Model Basics

- Why do we need a computer model?
  - Models are used as tools to help predict CSO overflows caused by different management scenarios.
  - Ties scenarios to normalized climate conditions
- Building trust
  - Models are tools
  - Models are calibrated to actual sewer flow measurements specifically selected to quantify CSO overflow volume and frequency.
- Is X volume of tunnel = X volume of green infrastructure?

GI Modeling Methods



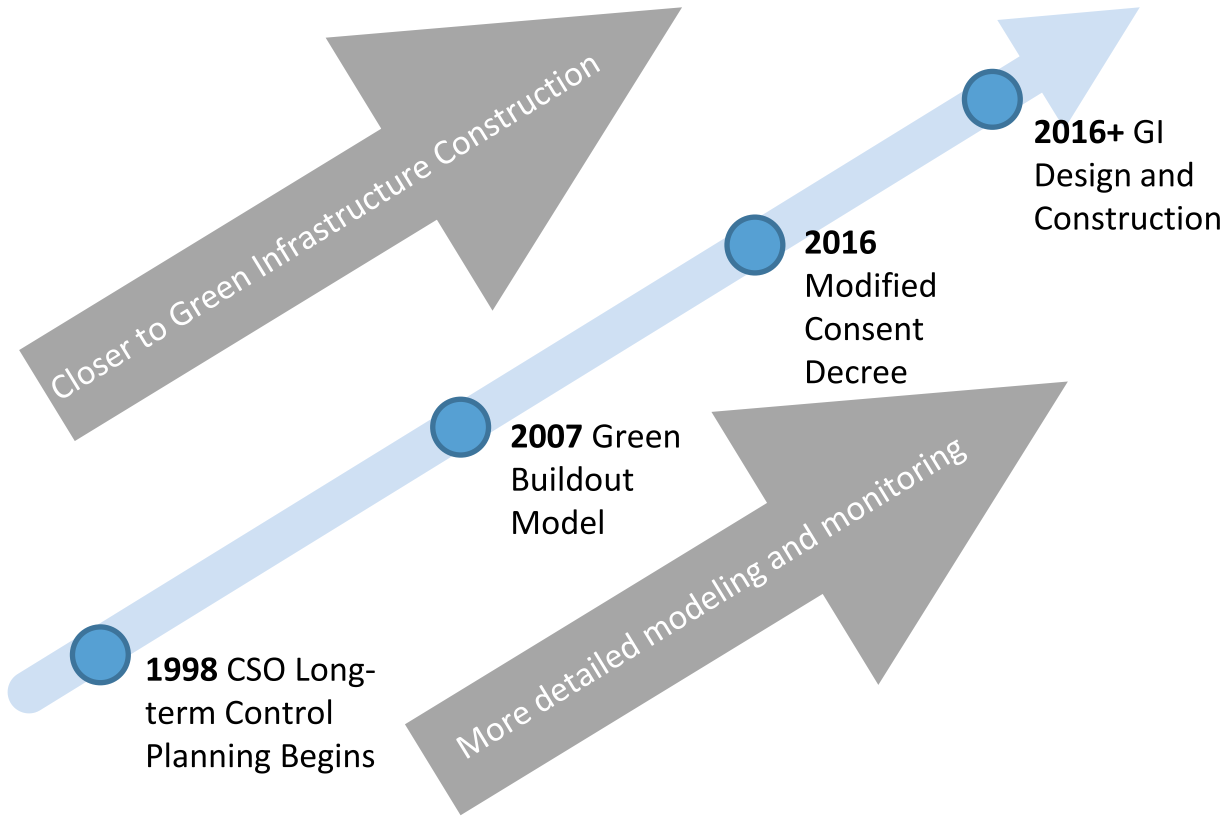


- Runoff reduction
  - Volume reduction percentage
  - Treatment percentage
  - Peak flow reduction/shaving
  - Rainfall shaving
- Drain time/volume simulation
  - Assume treatment volume and drain time
  - Link with runoff model, or use as separate model
- Complex GI representation
  - Model internal processes of GI practice: soil permeability, infiltration, underdrain, vertical conductivity

Clean Rivers Modeling Tools

- MIKE URBAN by DHI Software
  - Fully dynamic hydraulic and hydrologic model
  - Developed for urban runoff and collection systems
- EPA SWMM5
  - Fully dynamic hydraulic and hydrologic model
  - Recent built-in support for LID Controls
- Other tools
  - EPA Stormwater Calculator, GIS, Excel, R, Python, Rational Method, TR-55…
- Receiving Water Quality Modeling
  - Tools developed by LimnoTech and other region-wide groups
- 2D surface models
  - MIKE FLOOD

Project and Model Progression



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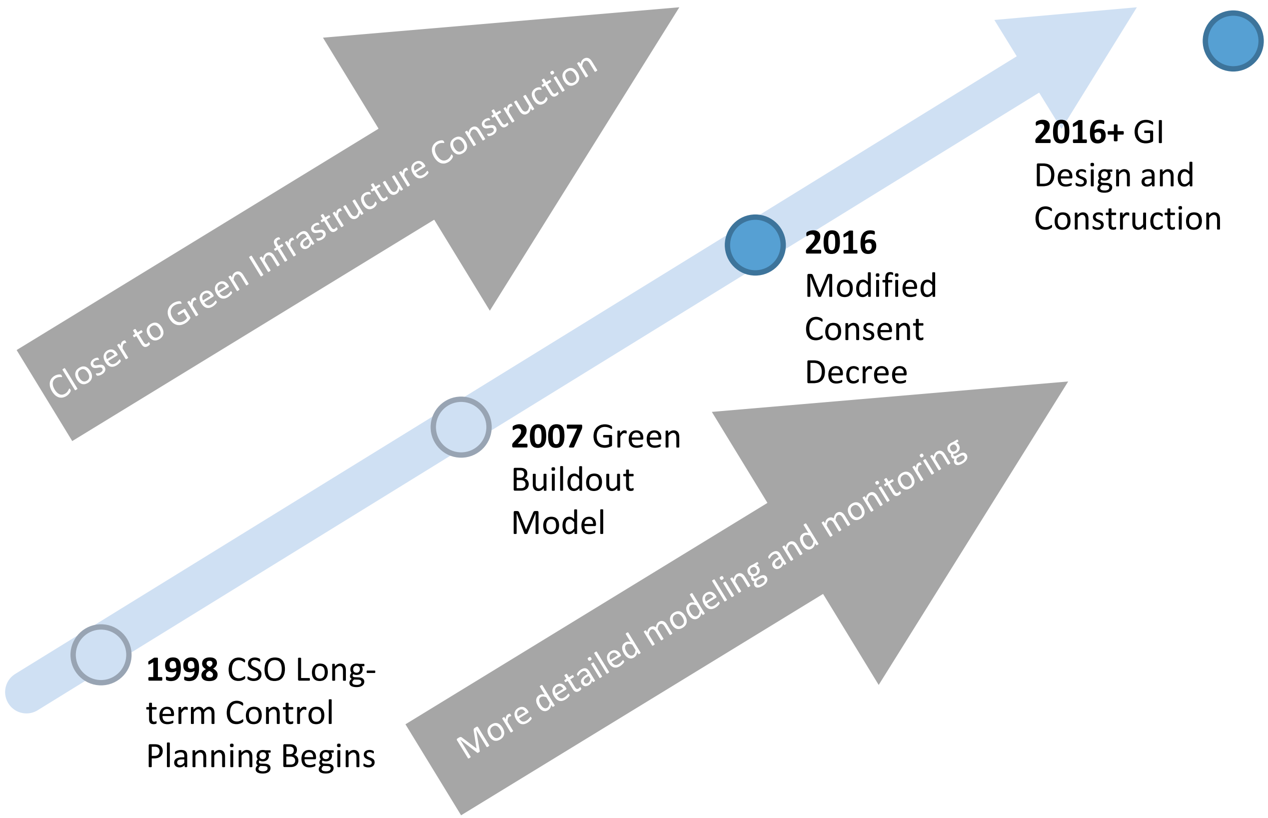
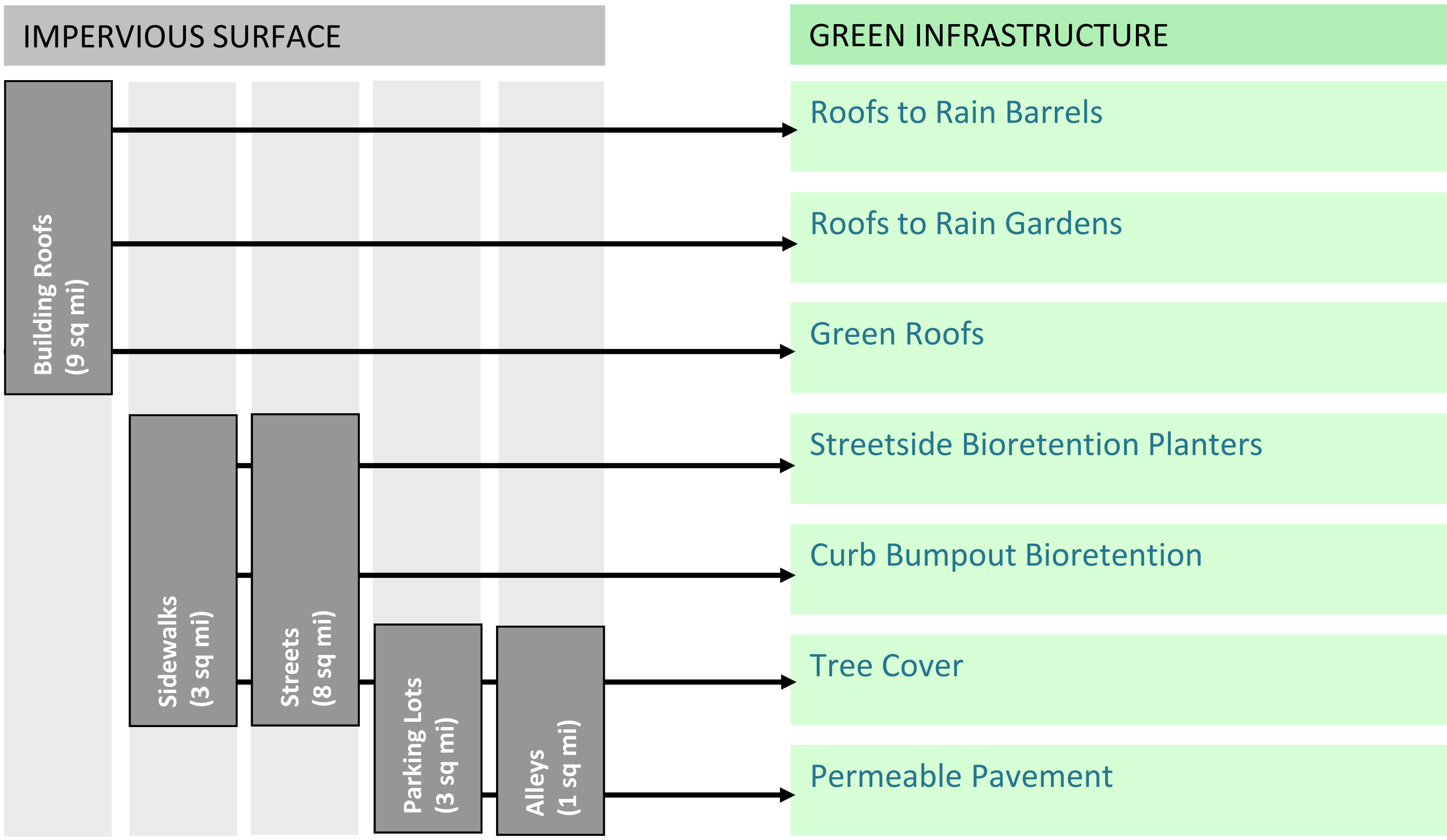


Model Development

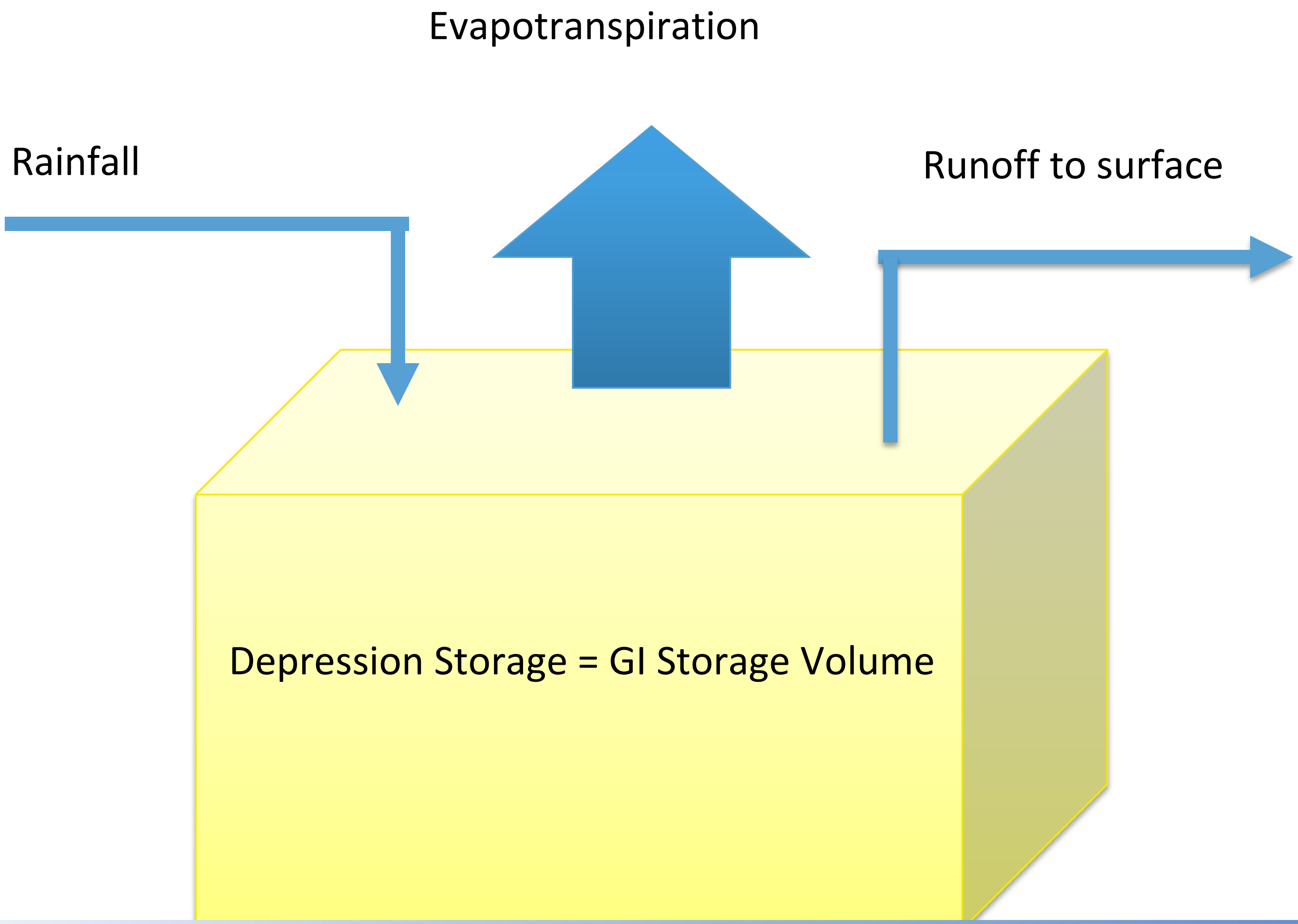
- 1998-2006 MIKE MOUSE/MIKE URBAN collection system model
  - Calibrated model of combined sewer area
  - Pumps and inflatable dams operated with real-time controls
  - Quantify volume and frequency of CSO overflows
  - Tunnels (and other grey improvements) to reach LTCP goals

- 2007-2009 Green Build-out Model (GBOM) – MIKE URBAN
  - What runoff volume can we capture with GI in DC?
  - Green Infrastructure as **depression storage** with **evaporation**

Green Buildout Model (GBOM)

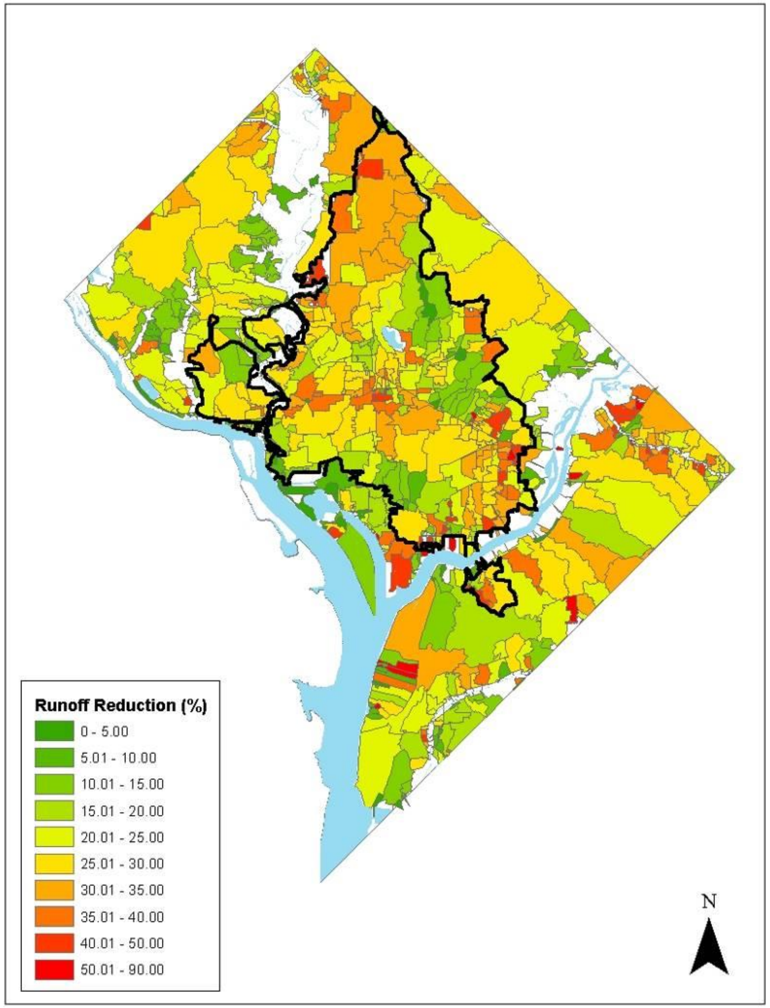


GBOM Green Infrastructure Representation



GBOM Results

- Identified the potential benefits of GI implementation
- Quantified District-wide runoff reductions
- Formed basis for moving forward with Green Infrastructure



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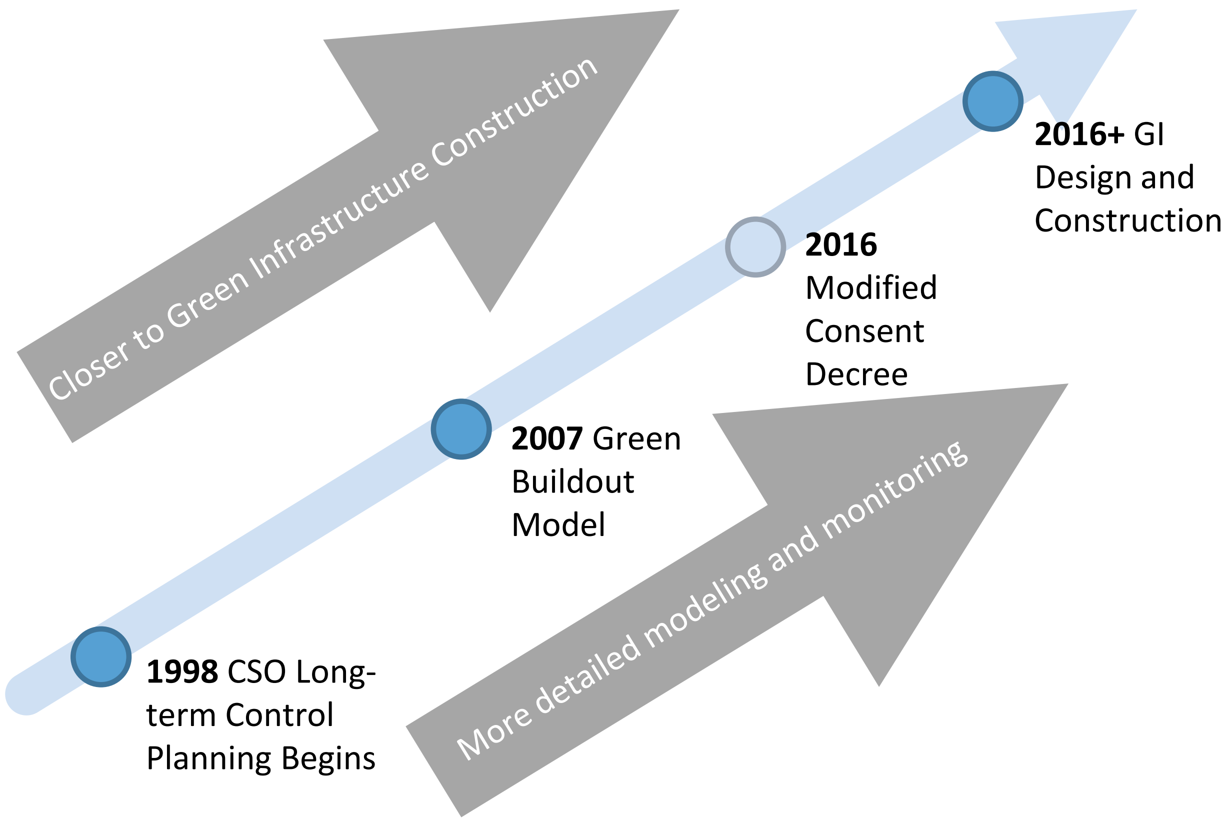
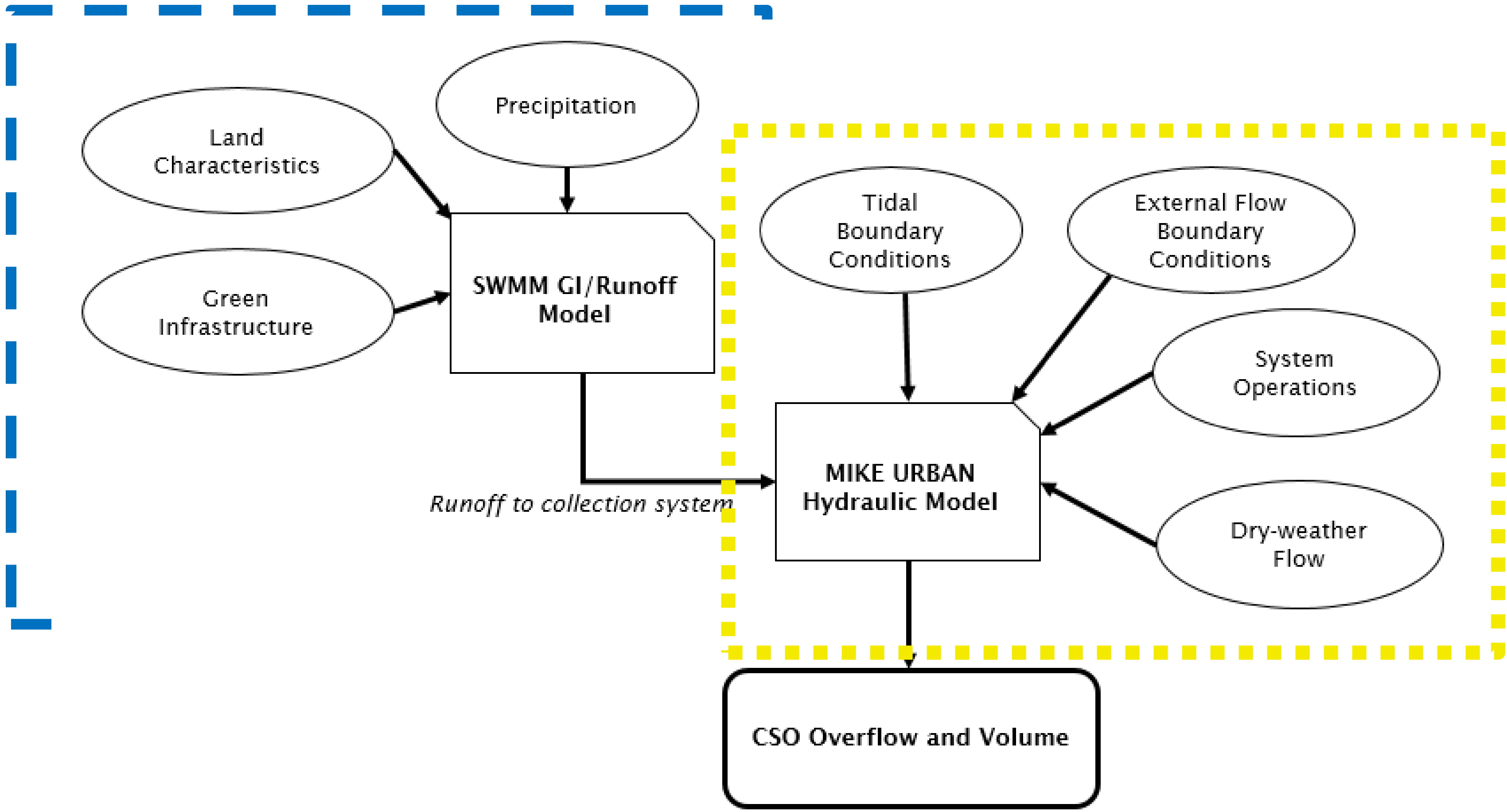


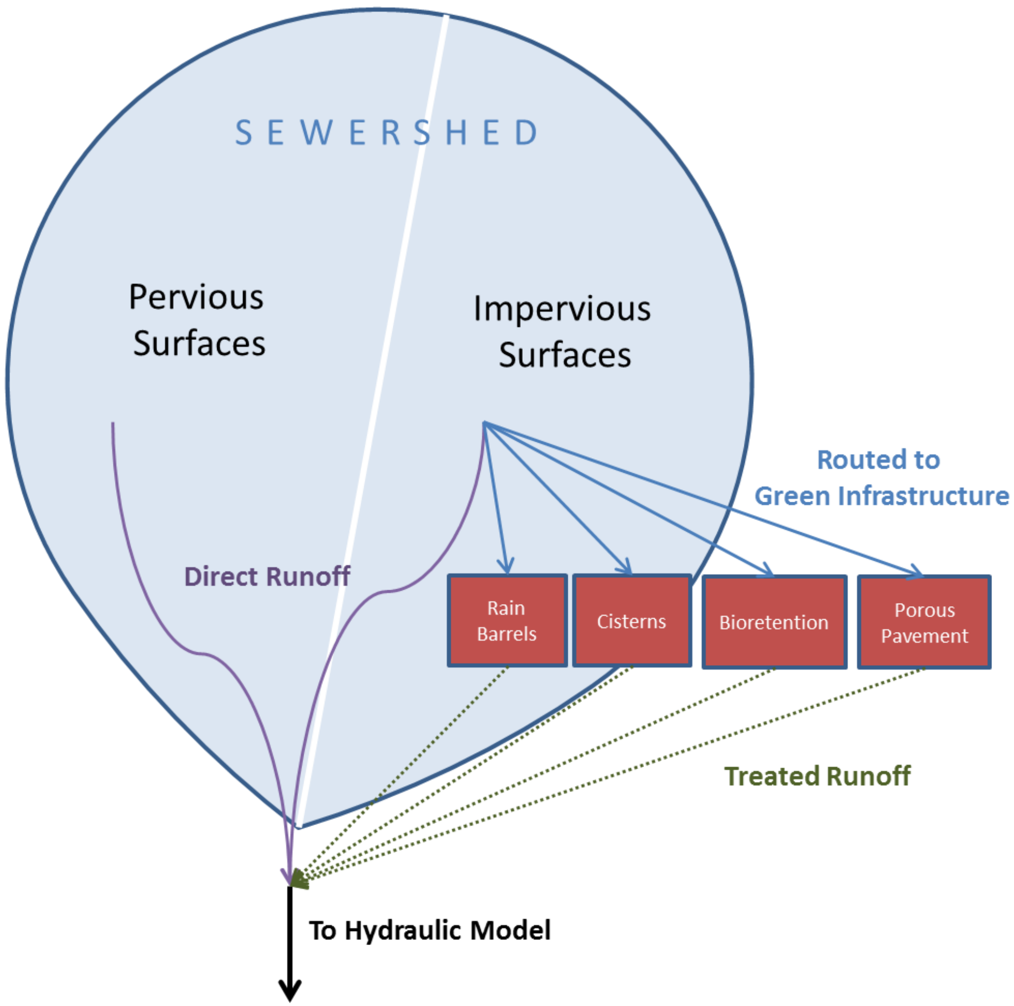
Model Development

- 2010-2016 SWMM5/MIKE URBAN coupled model
  - We know that GI is feasible in certain areas. How much do we need?
  - Shift to SWMM5 to leverage LID Controls
  - GI represented as mix of LID Controls in SWMM
  - Higher resolution drainage areas
  - Link **runoff reduction** to **combined sewer overflow reduction**

SWMM5 and MIKE URBAN Linkage



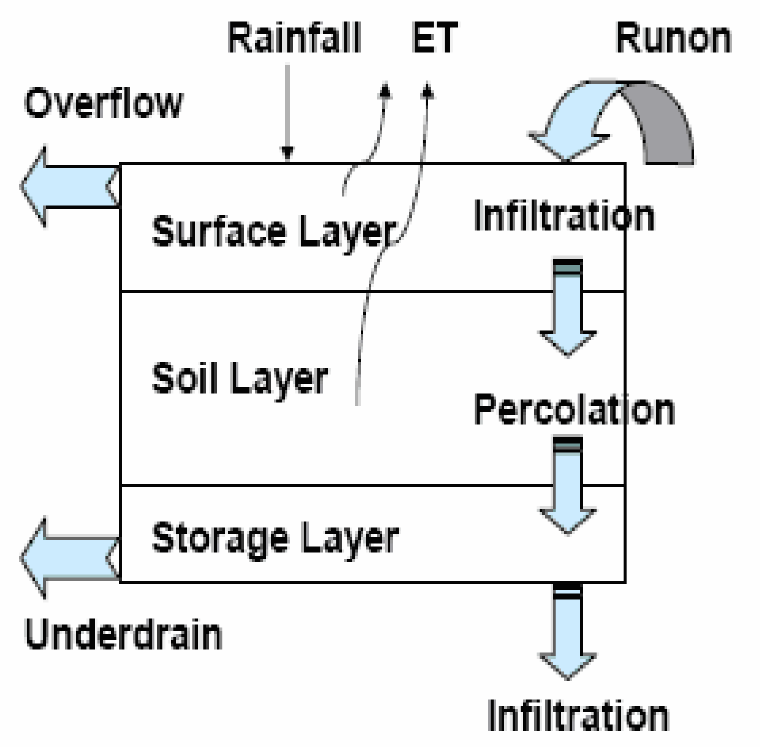
SWMM5 Runoff Framework



SWMM5 LID Controls

- Environmental Variables
  - Infiltration
  - Evapotranspiration (ET)

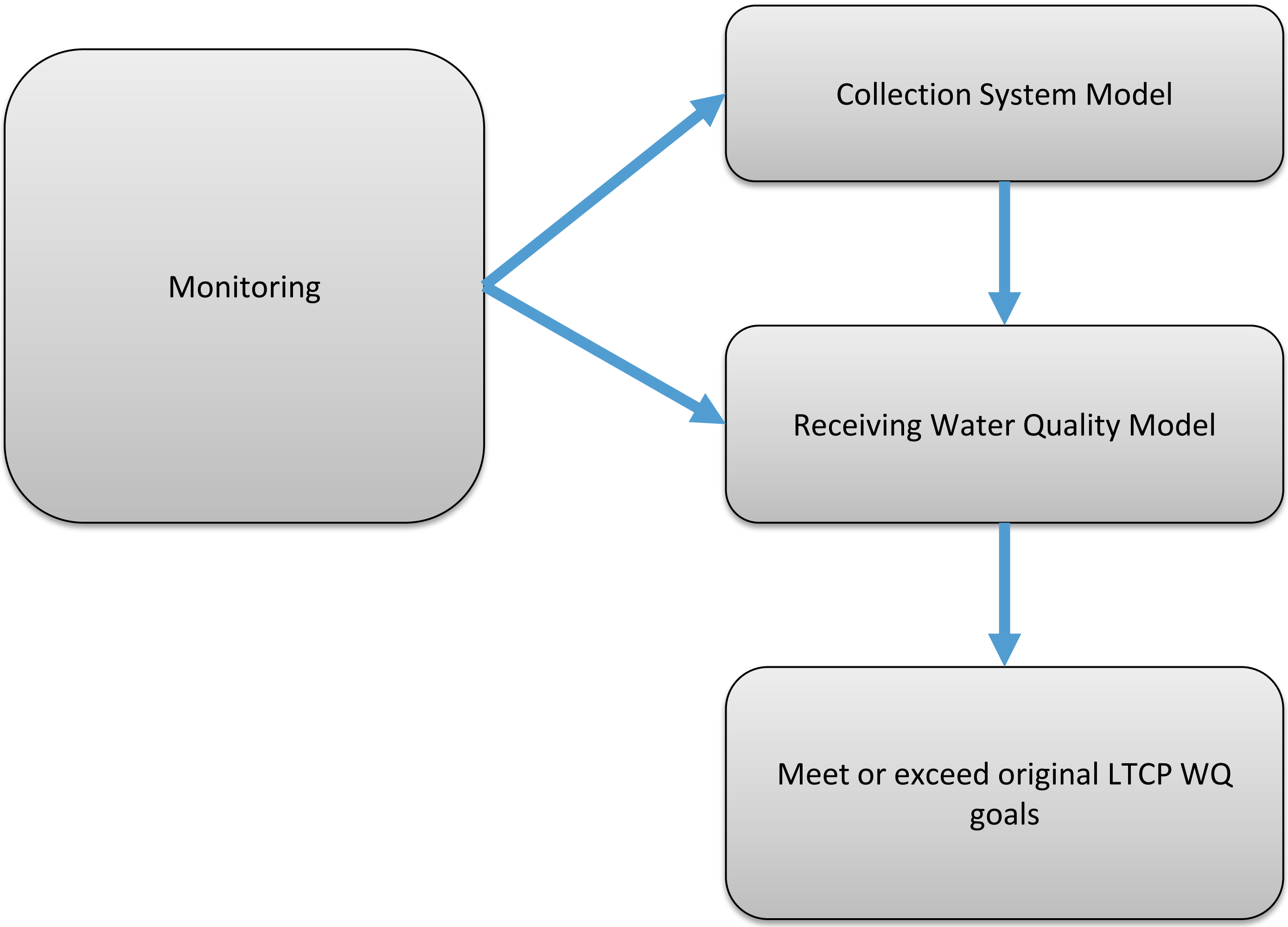
- Design Variables
  - Volume capture
  - Time to empty



Model Scenario Progression

- General approach:
  - Increase GI within reasonable limits
  - Is increase in GI enough to offset tunnel?
  - Make small but detailed changes in grey infrastructure controls necessary to meet reduction goal
- Over 60 scenarios evaluated and modeled for CSO overflow frequency and volume

Amended Consent Decree



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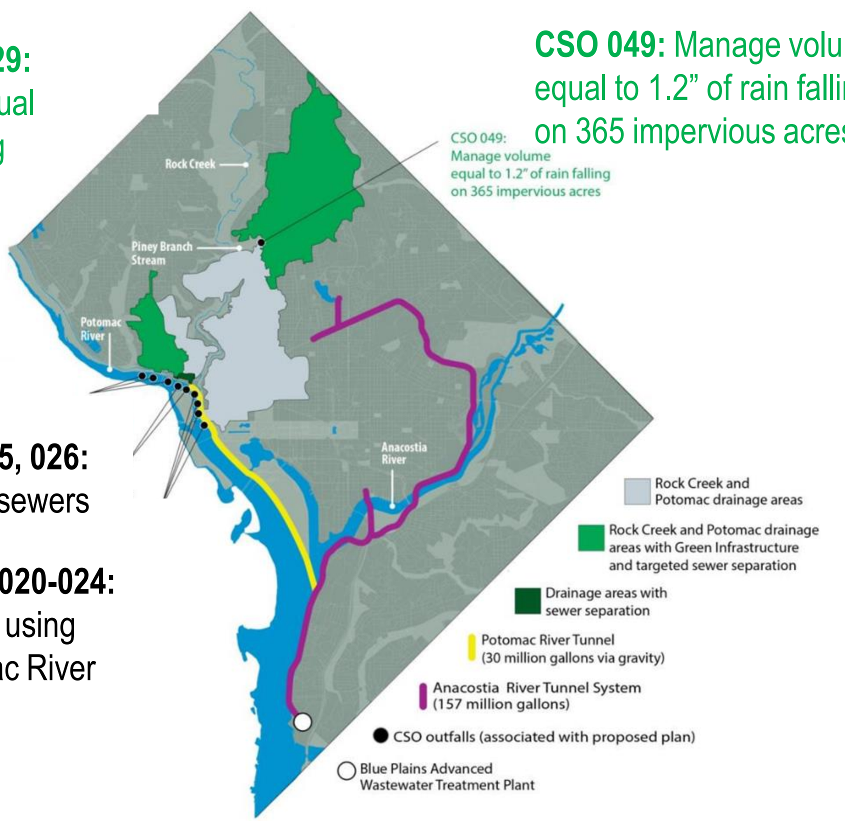

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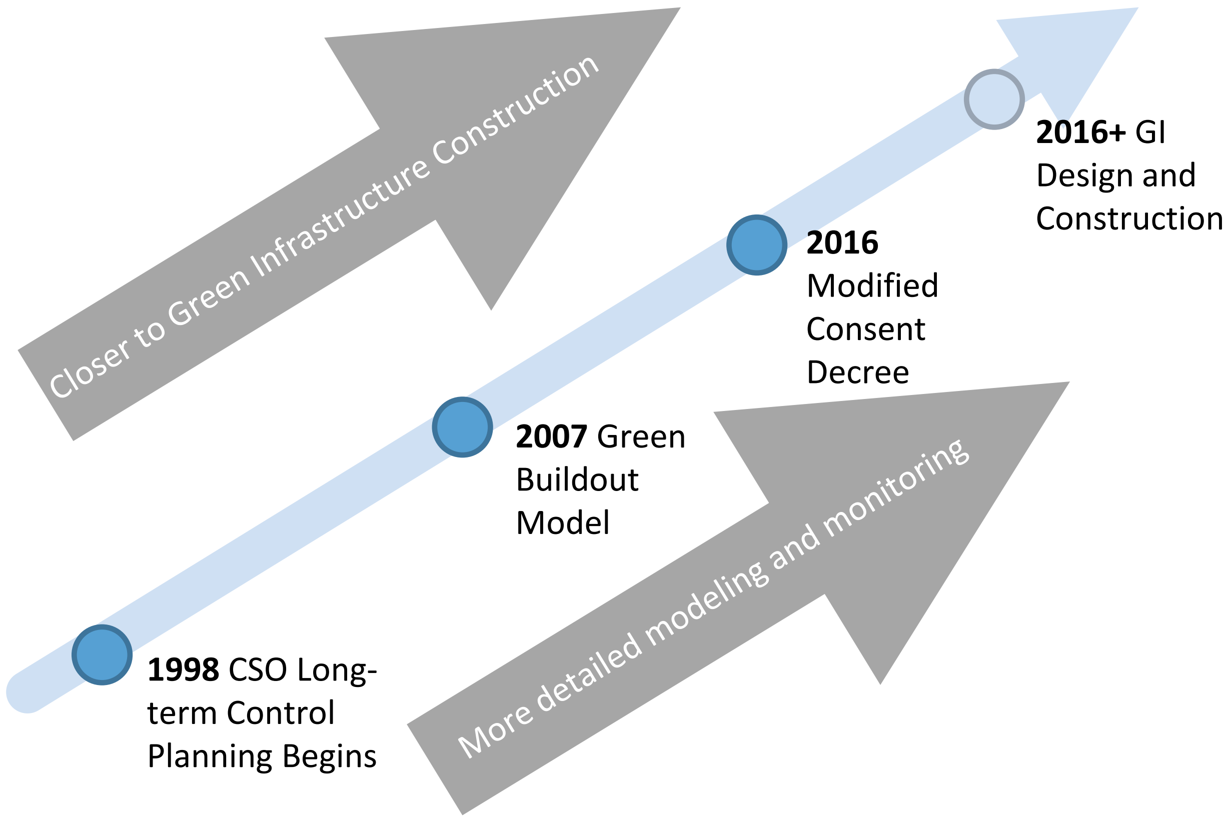
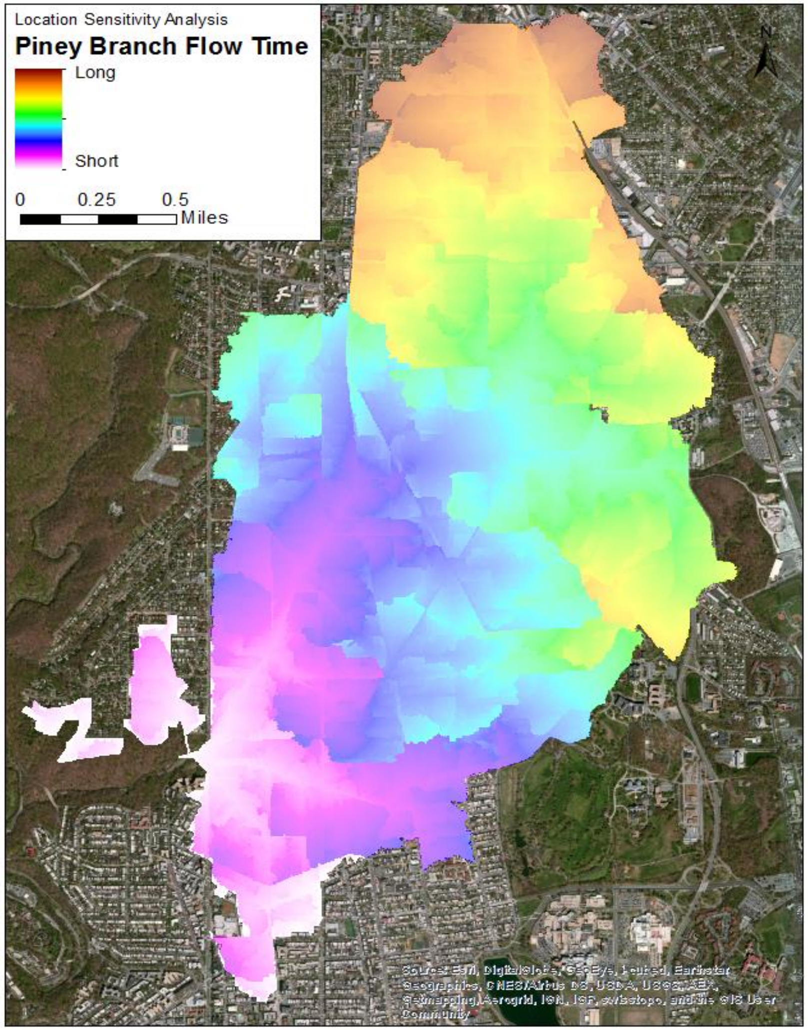


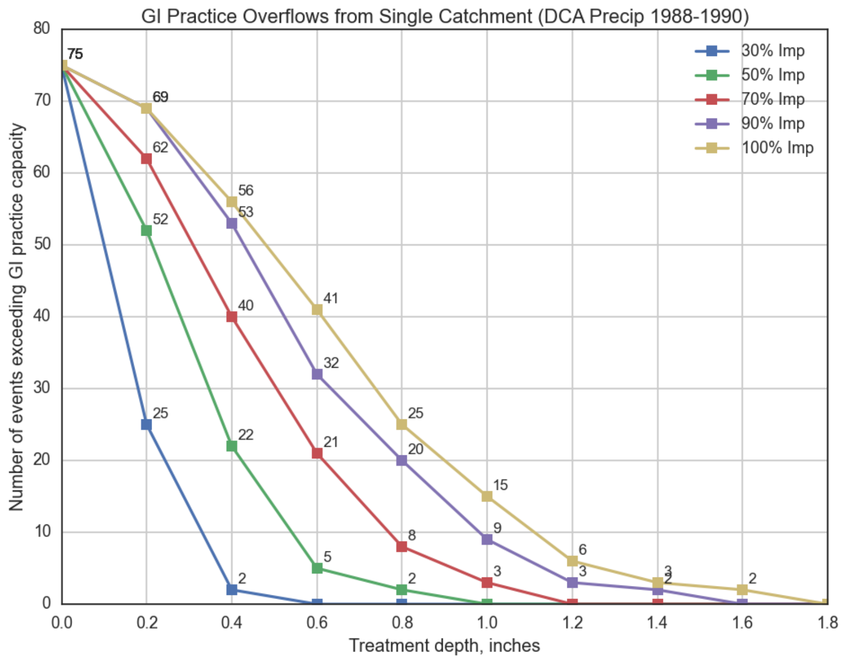
Develop GI Design Standards

- Should the first flush be diverted to WWTP?
- What if we let low flows bypass GI?
- What if GI is not uniformly distributed?
- What if we make GI larger?

Location of Facilities



Optimum Facility Size



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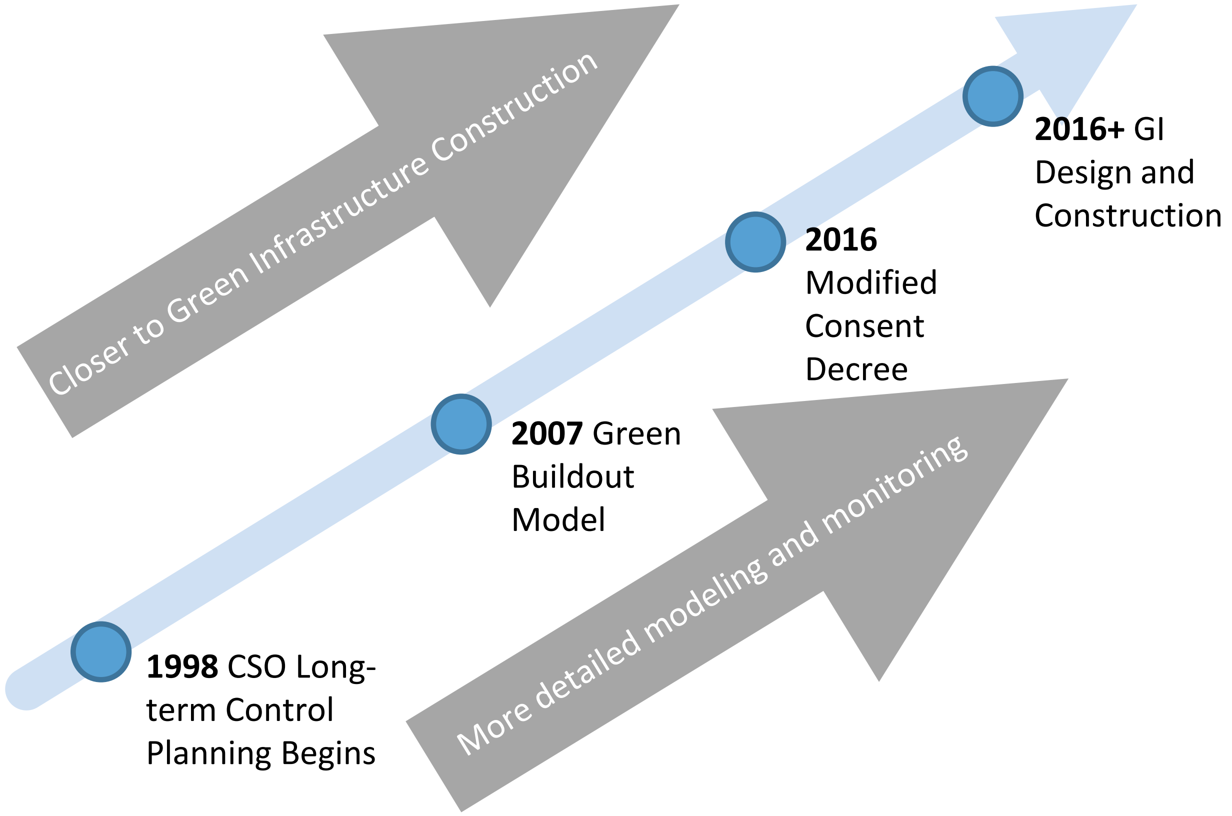
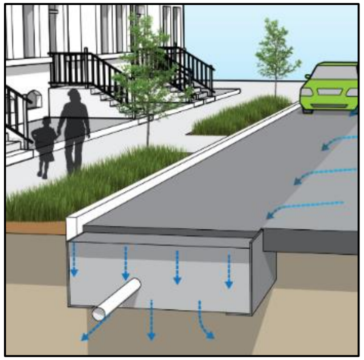
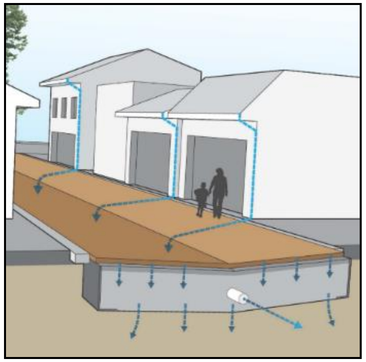
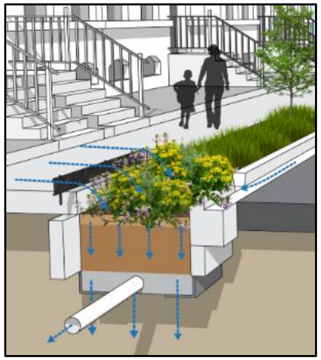
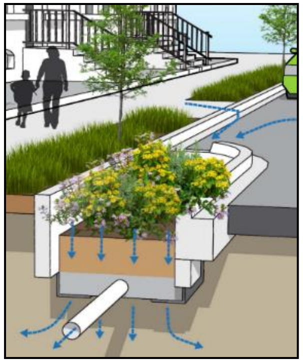


Current Work and Next Steps

- Recalibrate models when GI monitoring is available
- Conduct post-construction monitoring
- Evaluate success of first GI contract
- Use modeling to inform the GI implementation process as the DC Clean Rivers Project moves forward

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Acknowledgements to:

The DC Clean Rivers Team

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