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Philip Reidy, P.E.

Real-time Monitoring and Active Control of Green Infrastructure:

The New Face of Performance and Compliance Monitoring

Growing Green Infrastructure in New York

2011 Central New York Green Infrastructure Symposium
Sheraton Syracuse University Conference Center
November 17, 2011

Grey vs. Green: Why Distributed?

Searching for lowest-cost, effective, sustainable Stormwater Control Measures

	Costs *	Benefits	Drawbacks
Centralized/Grey Infrastructure	$1.50 - $6.00 per gallon mitigated	• Centralized operation • Compliance monitoring • Manageable maint.	• Cost • Energy intensive • Benefit lag time • No envir. co-benefits • Often land-constrained

Distributed / Green Infrastructure	$0.20 - $1.50 per gallon mitigated	• Cost
		• More energy efficient
		• Near-term benefits
		• Envir. co-benefits
		  ○ Shade/cooling
		  ○ Cleaner air
		  ○ Property values
		  ○ Aesthetic
		• Modular, adaptive
			• Scale
			• Compliance Monitoring
			• Maintenance
			• Lacking perf. benchmarks
			• Requires private land owner participation

* Per year on 20 year amortization (NYC DEP)

- **Significant drawbacks to either**
- **Current focus on lowest cost alternatives => address GI weaknesses**

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Addressing GI Weaknesses

Leverage technology to address GI weaknesses

- Real-time sensing enables remote monitoring and control
- Higher performance achievable with active controls
- Wired/wireless network access near-ubiquitous in urban environments
- Commoditized service and component pricing delivers high functionality at low cost

Consideration	Approach	Added Value
Scale	Advanced controls provide higher unit performance (per sq. ft., gallon, etc.)	Higher performance and ROI per installation
Compliance	Remote monitoring facilitates problem detection and performance assessment	Data analytics provide automated threshold triggers, alarms, reporting
O+M	Remote access to real-time monitoring streamlines maintenance	Commoditized maintenance services likely to emerge from landscape and service trades
Lacking perf. benchmarks	Broad array of pilots underway to establish performance benchmarks	Pilots further promote system evolution and innovation
Private Land Access	3rd party implementation w/fixed price contracts	Shifts costs, risks and effort away from munis, attracts private capital

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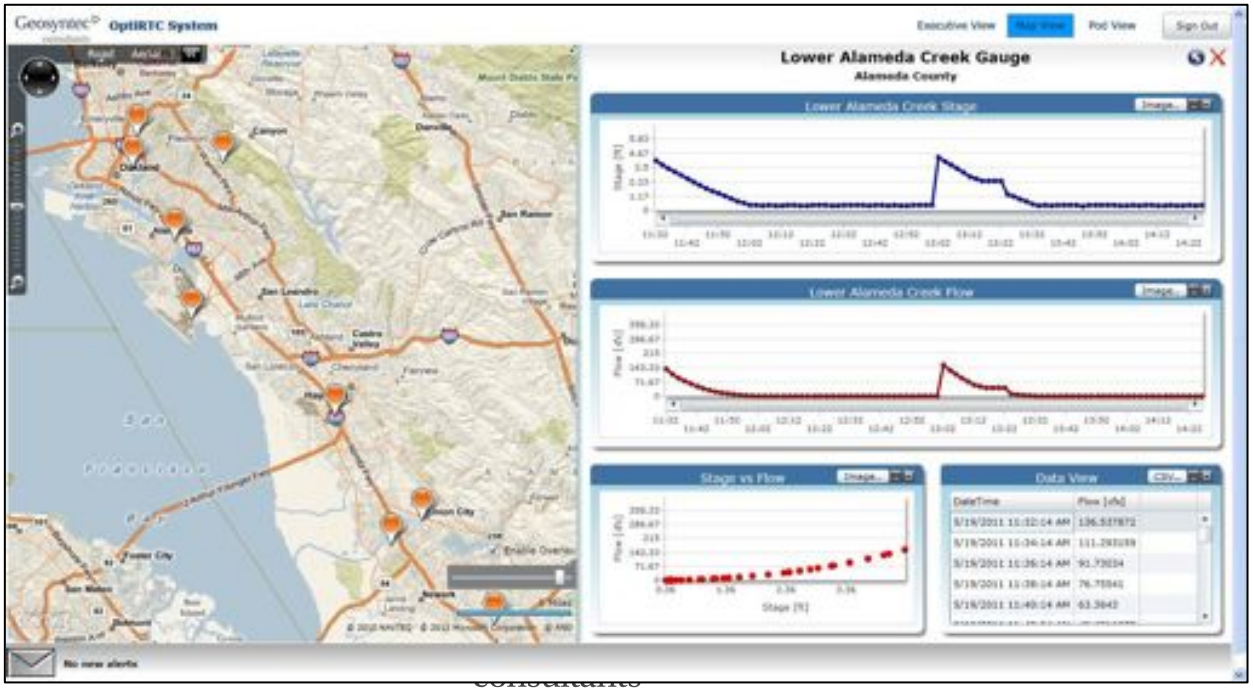
New Approaches

So what are we talking about?

- Internet-based controls and computing platform for monitoring and control of new and existing distributed infrastructure
- Remote decision-making, display and communications (browser-based dashboards)
- Active vs. Passive PMPs: A method of making existing and future perform better through autonomous adaptive response to changing environmental conditions
- Compliance: Addresses a key need in monitoring compliance of distributed systems
- Cost: Advanced performance and capabilities at a reasonable cost – fraction of typical SCADA systems

Functional Overview

- Control platform interfaces with field measurement devices and internet data feeds
- Logs data to secure cloud-based solution; runs models on logged data – producing "Decision Space" data
- With measured data, decision-space data, and conditional logic, actuate devices in the field; send internet-based communications to stakeholders and dependent devices
- Client-specific data visualization/control dashboards and mobile applications



Enabling Technologies

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Applications

Active controls / real-time monitoring

- Advanced Rainwater Harvesting Systems

  Conventional Rainwater Harvesting is not a viable stormwater control measure

- Active Blue and Green Roofs

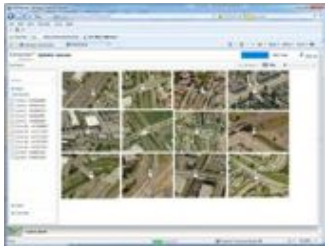
  Significantly increased performance and reduced cost for same level of control

- Active outlet control for swales, lakes/ponds and water features

  Drawdown in advance of precipitation

- Intelligent Distributed Detention

  Actively controlled detention coupled with in-sewer and weather monitoring/modeling

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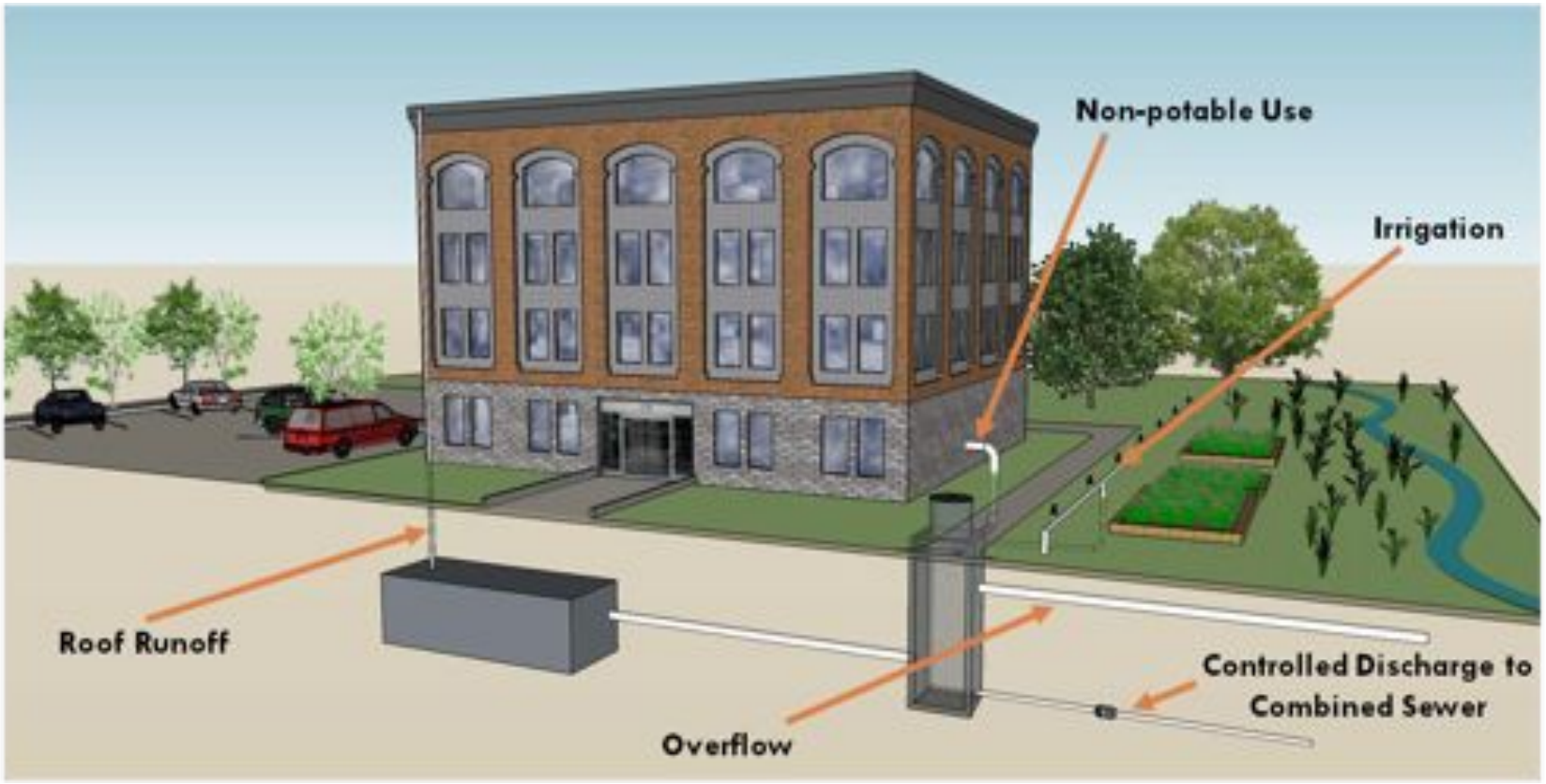
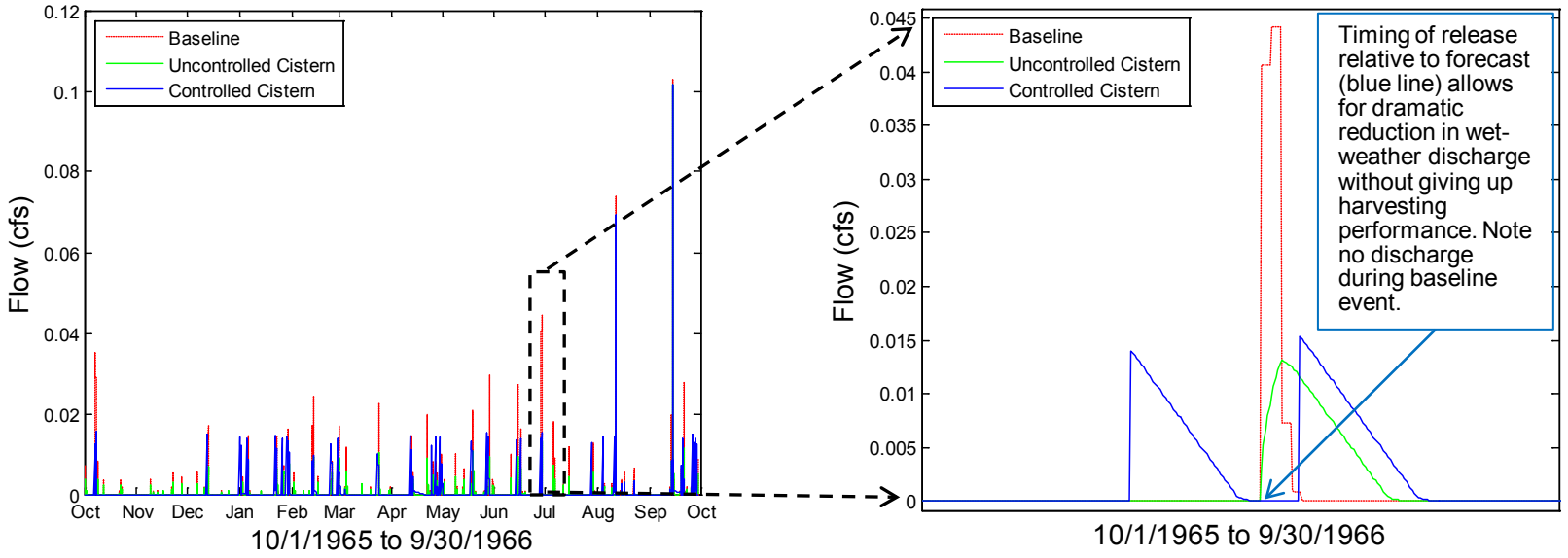
Advanced Harvesting for CSO Control

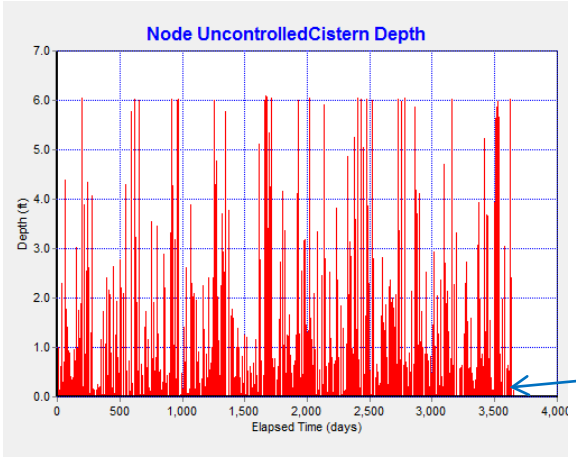
Simplest Definition of Advanced Rainwater Harvesting:

Drain storage in advance of predicted rainfall or other trigger



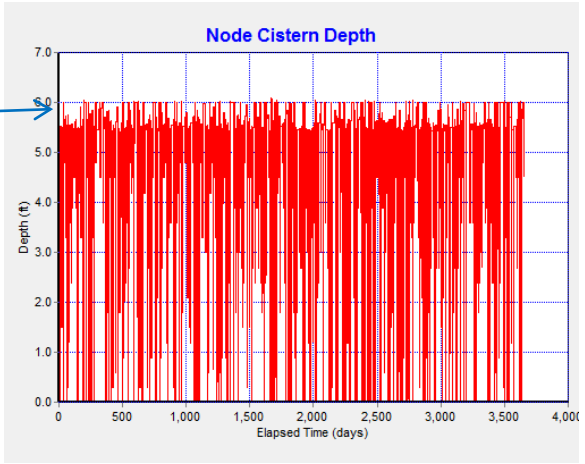
Advanced Harvesting/Controlled Detention Flow Comparison Modeling– DDOE





Water remains in system for potential onsite use while providing improved CSO flow control. Drains only right before events.

Detention tank empty except during rainfall.



Advanced Harvesting/Controlled Detention Flow Comparison Modeling– DDOE

DDOE Modeling Summary

- Baseline runoff volume:
  - 12,680 cf/yr
- Passive detention wet-weather runoff volume:
  - 11,326 cf/yr
  - 11% reduction
- Controlled wet-weather runoff volume:
  - 3,899 cf/yr
  - 69% reduction in wet-weather flow volume
  - Note no harvesting factored in, assumes accurate forecasts

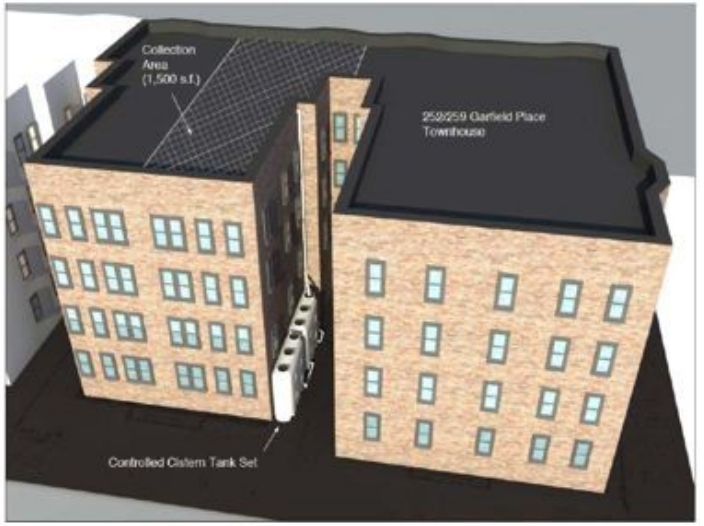
Intelligent Detention Retrofit

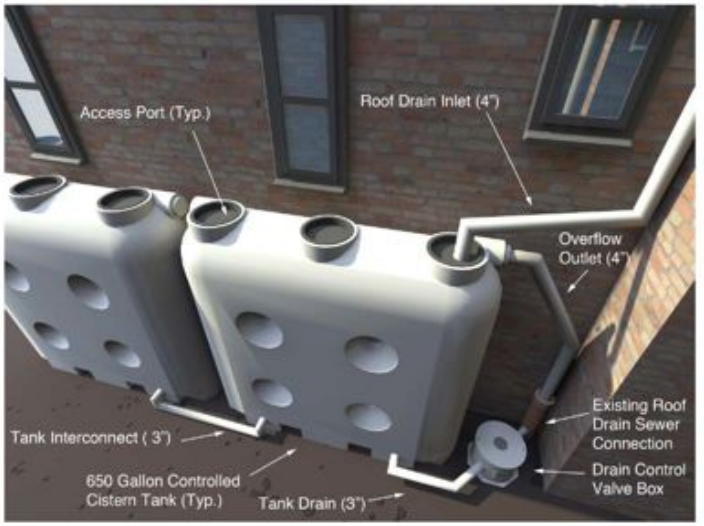
348 4TH AVENUE SYSTEM CONFIGURATION SCHEMATIC

>85% reduction in wet weather volume with 950 gallon smart detention system

>90% reduction in wet weather volume with 1200 gallon smart detention system

253/259 GARFIELD PLACE SYSTEM CONFIGURATION SCHEMATIC





Intelligent Detention Retrofit

Continuous simulation modeling of CSO reduction

Rooftop Tributary Area (Sq. Ft.)	Assumed Volumetric Runoff Coefficient	Total Runoff Volume (Gal.)	Runoff Volume Associated with CSO (Gal.)	Cistern Size (Gal.)	Total Runoff Capture Volume (Gal.)	% Runoff Capture	Runoff Capture Volume Associated with CSOs (Gal.)	% Reduction in Runoff Contributing to CSOs
1,500	0.9	34,215	31,068	250	14,512	42.4%	11,961	38.50%
				500	22,574	66.0%	19,701	63.41%
			Site 2 ->	950	29,586	86.5%	26,439	85.10%
				1000	30,095	88.0%	26,948	86.74%
			Site 1 ->	1200	31,609	92.4%	28,461	91.61%
				1500	33,094	96.7%	29,947	96.39%

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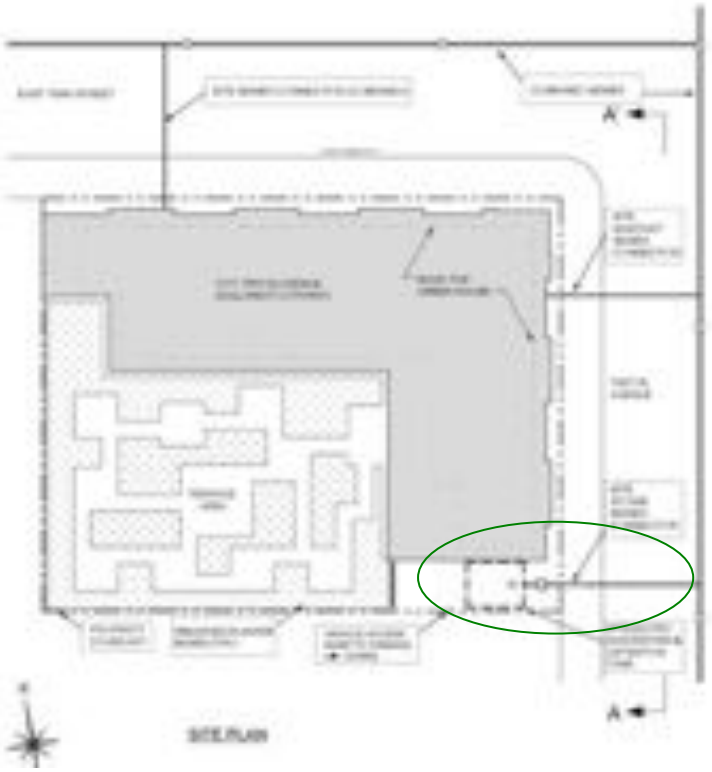
Harvesting and Smart Detention

Stormwater control volume ‘retrofit’



- 0.67 ac site, 100% impervious, 100% serviced by CSOs
- 15,500 gallon SW control structure per NYC Street Connection rule
- Roof-top hydroponic greenhouse with 700 – 2,800 gpd demands, plus terrace irrigation

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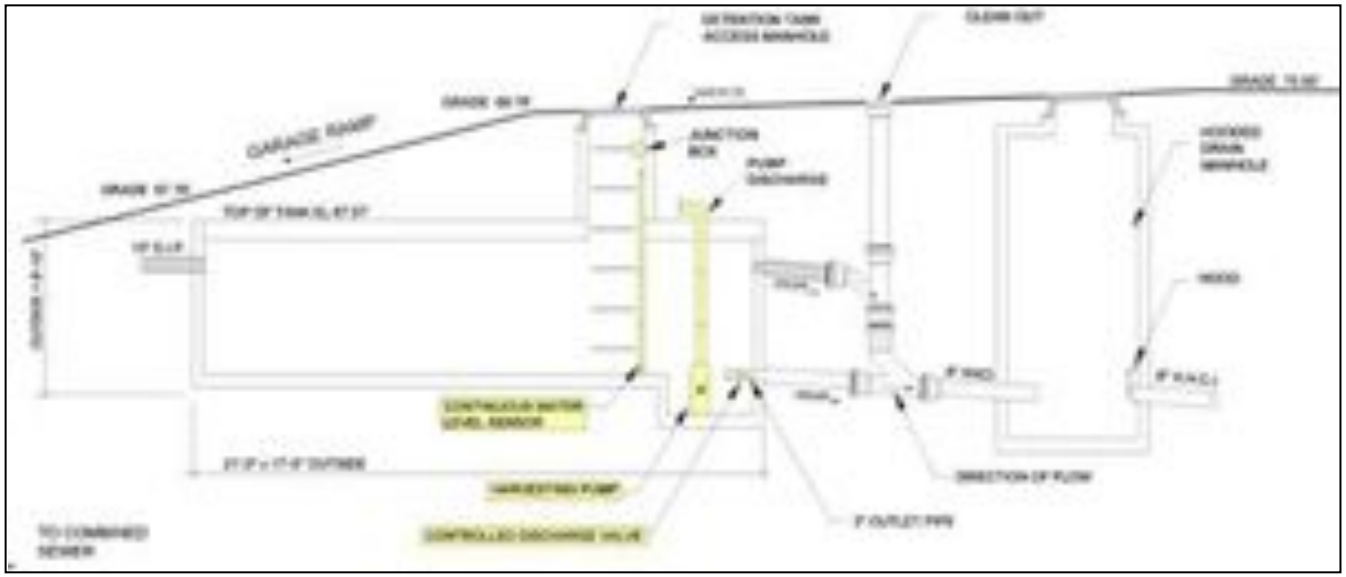
Harvesting and Smart Detention

Stormwater control volume 'retrofit'



SUMMARY OF SYSTEM PERFORMANCE	OFF-SITE STORMWATER FLOW REDUCTION (Gal./Yr.)	CSO MITIGATION (Gal./Yr.)	WATER USE (Gal./Yr.)
PASSIVE/CURRENT DESIGN	0	153,759	643,665
ACTIVELY CONTROLLED SYSTEM	309,440	455,278	314,290
CHANGE (GAL./YR)	**309,440**	**301,519**	**329,375**
% CHANGE	**N/A**	**196%**	**51%**

SWMM modeling of CSO reduction *with integrated onsite use demand*

Retrofit < $0.20/gal.

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Actively-controlled outlet retrofit: CSO and Water Quality Control

Actively-controlled outlets:

- Wetlands
- Ponds and lakes
- Swales and biocells
- Other impoundments

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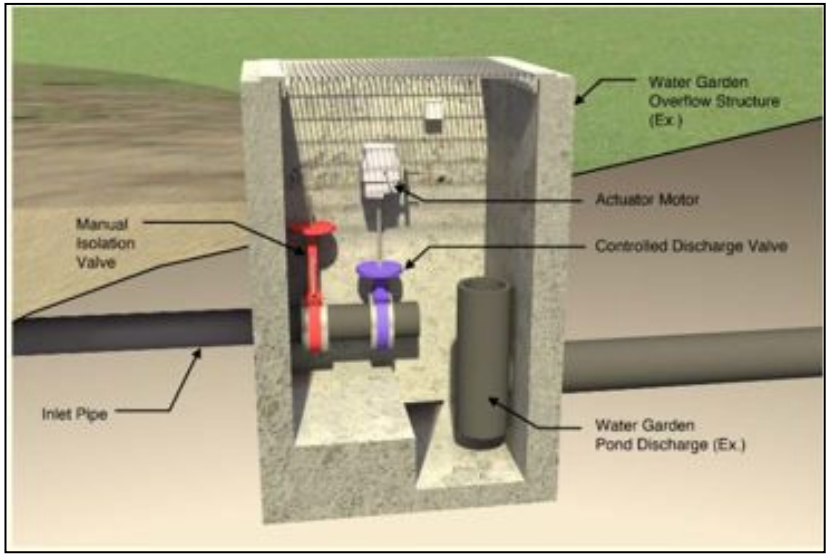

- Design or retrofit outlet to drawdown slightly prior to rain events that might cause CSOs or other downstream impacts
- Minimal investment with high ROI

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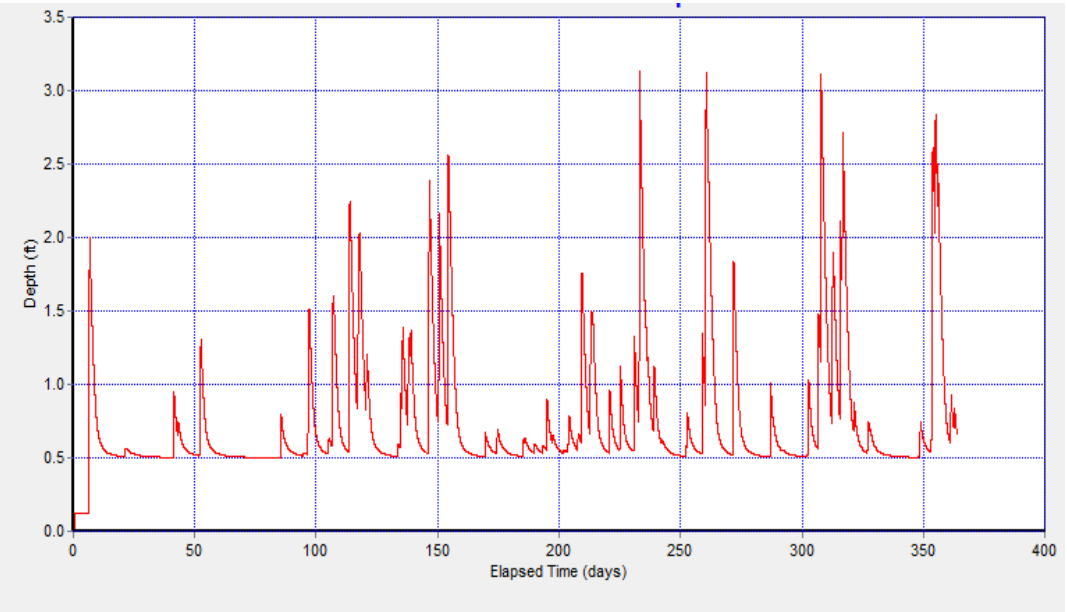
Wetland Retrofit

Applicable to CSO-connected ponds, lakes, etc.

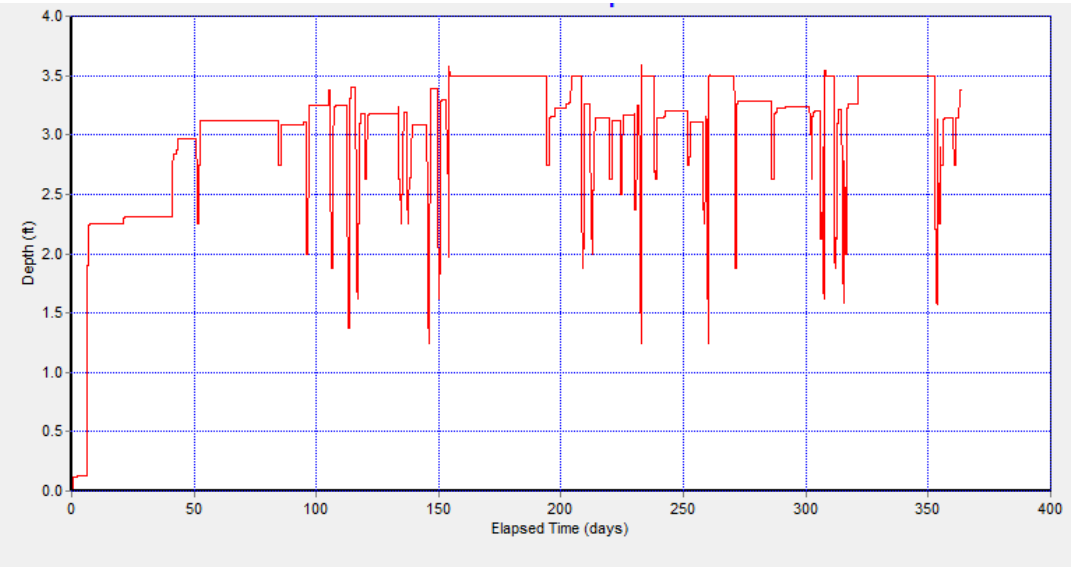
Depth Time Series and Average Hydraulic Residence Time for <u>Uncontrolled</u> Outlet

Average Hydraulic Residence Time (hrs)
13 days



Depth Time Series and Average Hydraulic Residence Time for Actively <u>Controlled</u> Outlet

Average Hydraulic Residence Time (hrs)
24 days



Green Roof Irrigation Control

Direct Measurement Capillary Irrigation

- Make real-time forecast based decisions on when and how much to irrigate the roof.
- Make storage volume available for stormwater volume control.
- Reduce irrigation waste.

Summary

- Light, flexible and inexpensive platform
- Leverages ubiquitous networking, bandwidth and mobile computing power
- Enables performance and compliance assessment of BMPs
- Enables remote problem detection and maintenance requirement
- Key facet of distributed systems

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Thank you!

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