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INNOVATIVE RAINWATER HARVESTING

INTEGRATING
RAINWATER HARVESTING
for
INNOVATIVE STORMWATER CONTROL:

New Directions in Site Water Management

Philip Reidy, P.E.

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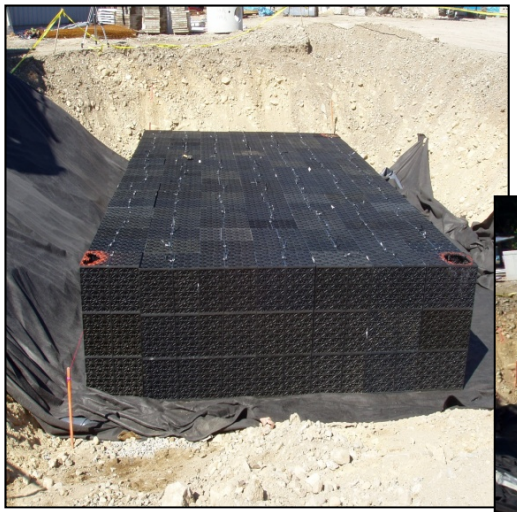
SMART SOLUTIONS FOR WATER MANAGEMENT.

Agenda

- **Harvesting Configurations:**
  - System Types
  - Traditional, In-series storage
  - Cistern Sizing Models
  - Integrated, Shared/Passive
  - Integrated, Dedicated/Active
  - Time-shifting Storm Flows
- **Potential Cost Savings**
  - Total water envelope
- **New thinking, technology**
  - Controller Technologies
  - Site-wide Solutions
  - Blue Roofs
- **Summary, Conclusions**



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Terminology

- **Reclaimed Water:**
  - **Post use – most sources included**
  - **Treatment required**
  - **Regulation: growing reference to reclaimed water**
- **Grey Water:**
  - **Post use – limited sources included**
  - **Treatment required – depending on application**
  - **Regulation fairly universal**
- ***Harvested Water:***
  - ***Not* post use – usually limited to roof water**
  - **Treatment not usually required – depends on application**
  - **Regulations typically do not address (e.g. State Plumbing Code)**

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Harvesting Overview

System Types

Smaller Systems

400 gal.

1,200 gal.

Larger Systems

15,000 gal.

30,000 gal.

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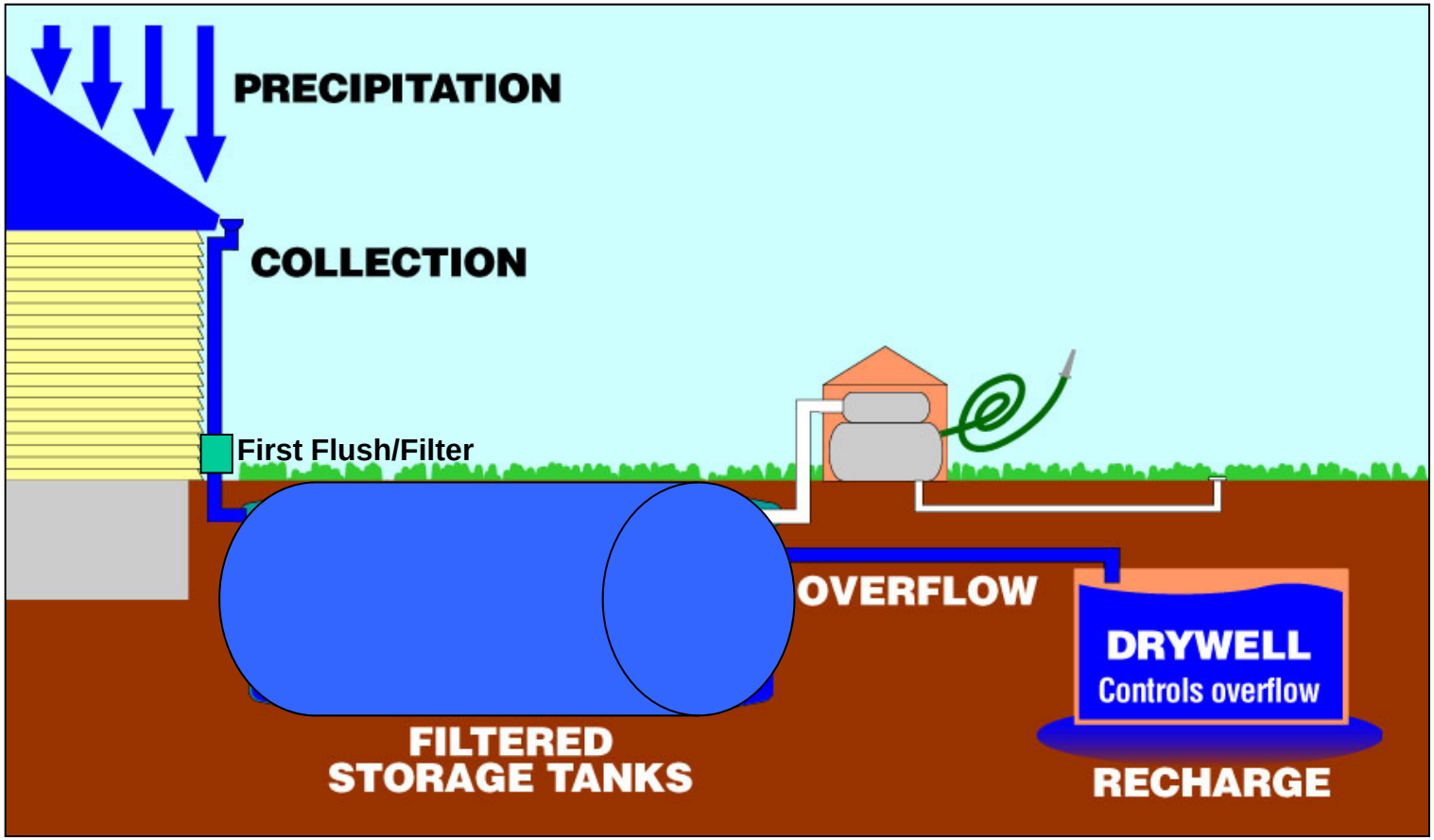
Harvesting Overview

Conceptual Model



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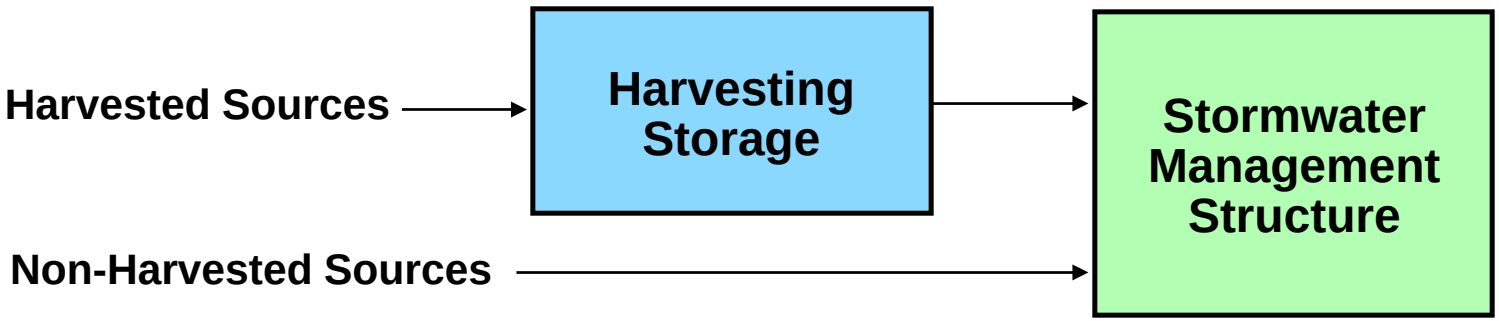
Traditional Implementation

Harvesting Storage Inserted into Drainage Profile

- "Bolt-On" Approach
- Harvesting Cost Fully Incremental
- Footprint and Profile Considerations



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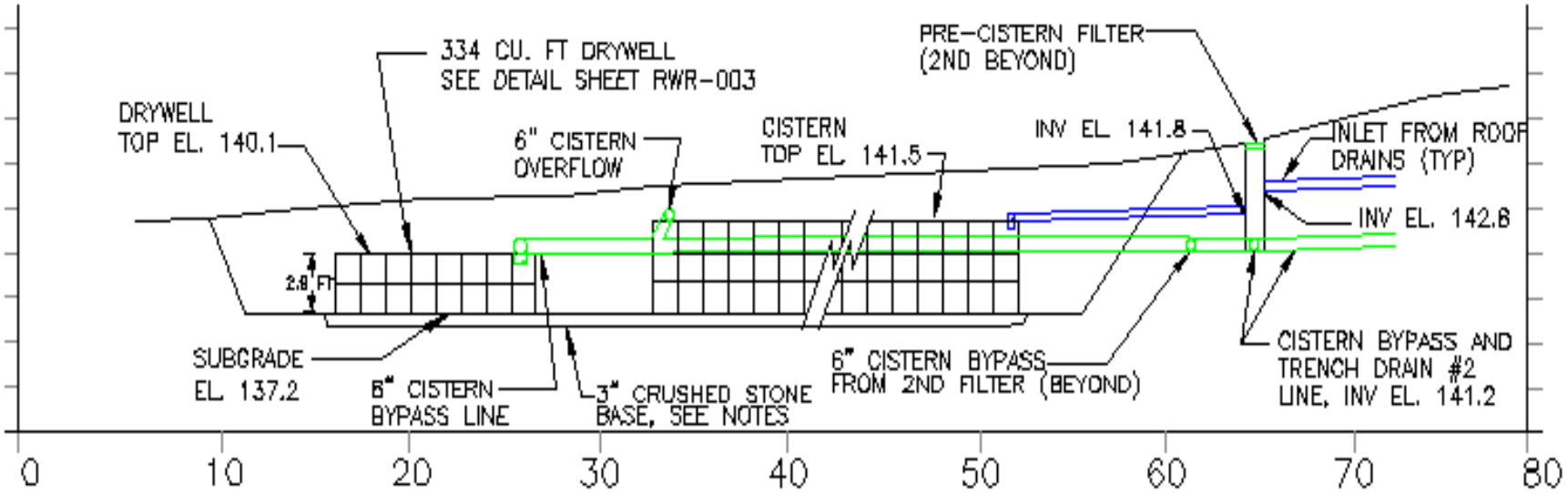
Traditional Implementation

Harvesting Storage Inserted into Drainage Profile



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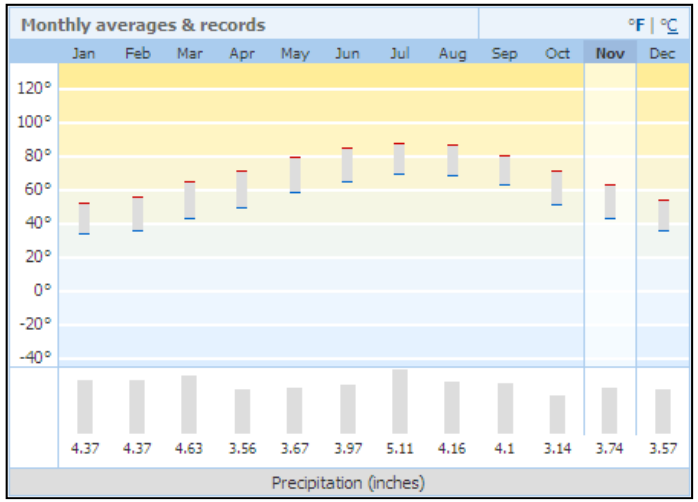
Cistern Sizing

Two primary methods for cistern sizing (Water Budget Analysis):

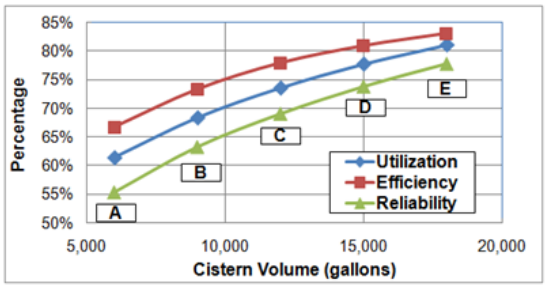
Avg. Historic Supply vs. Demand



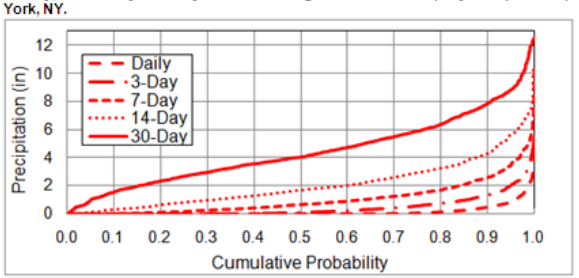
Discrete Probabilistic Modeling

Attachment 1: Cistern Sizing and System Performance Summary

Option	Cistern Volume (gal)	Capture Area: Std Roof	Capture Area: Green Roof	Daily Demand (gal)	Utilization: Ut.	Utilization: Water Saved (gal)	Efficiency: Eff.	Efficiency: Runoff Red'n (gal)	Reliab.
A	6,000	9,752	1,598	1,000	61%	93,967	67%	89,768	55%
B	9,000	9,752	1,598	1,000	68%	104,580	73%	98,721	63%
C	12,000	9,752	1,598	1,000	74%	112,513	78%	104,947	69%
D	15,000	9,752	1,598	1,000	78%	118,855	81%	109,016	74%
E	18,000	9,752	1,598	1,000	81%	123,939	83%	111,934	78%



Attachment 2: Cumulative rainfall probability distributions for daily, 3-day, weekly, bi-weekly, and 30-day/monthly intervals during summer months (May to September) in New York, NY.



Probabilistic Modeling

- **Input: 20 years local hourly Precip/ET data; current and projected demand profile**
  - Local weather station
  - Continuous simulation
- **Output: Projected performance metrics across range of cistern sizes**
  - Utilization, Reliability and Effectiveness

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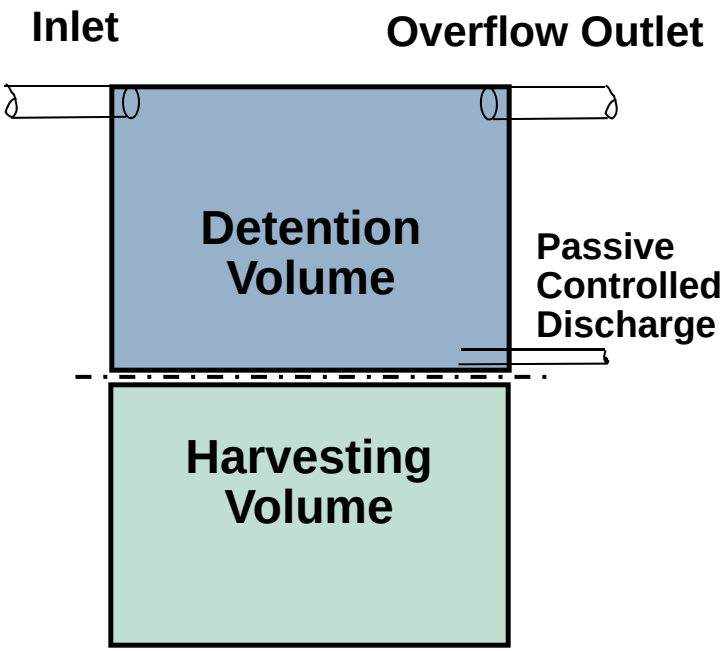
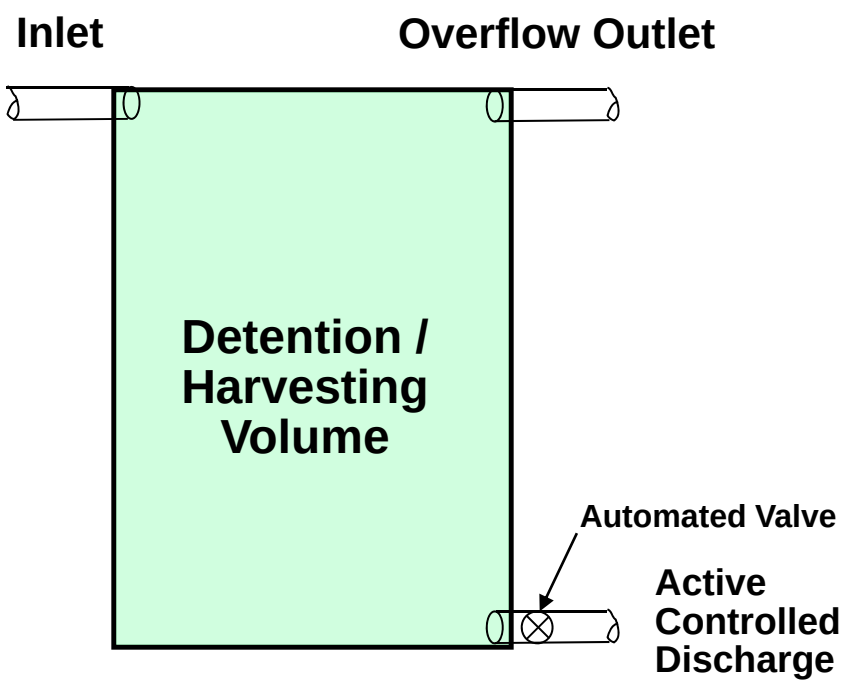
Integrated Solutions

Integrating Detention Volume with Harvesting Volume

Shared/Passive



Dedicated/Active



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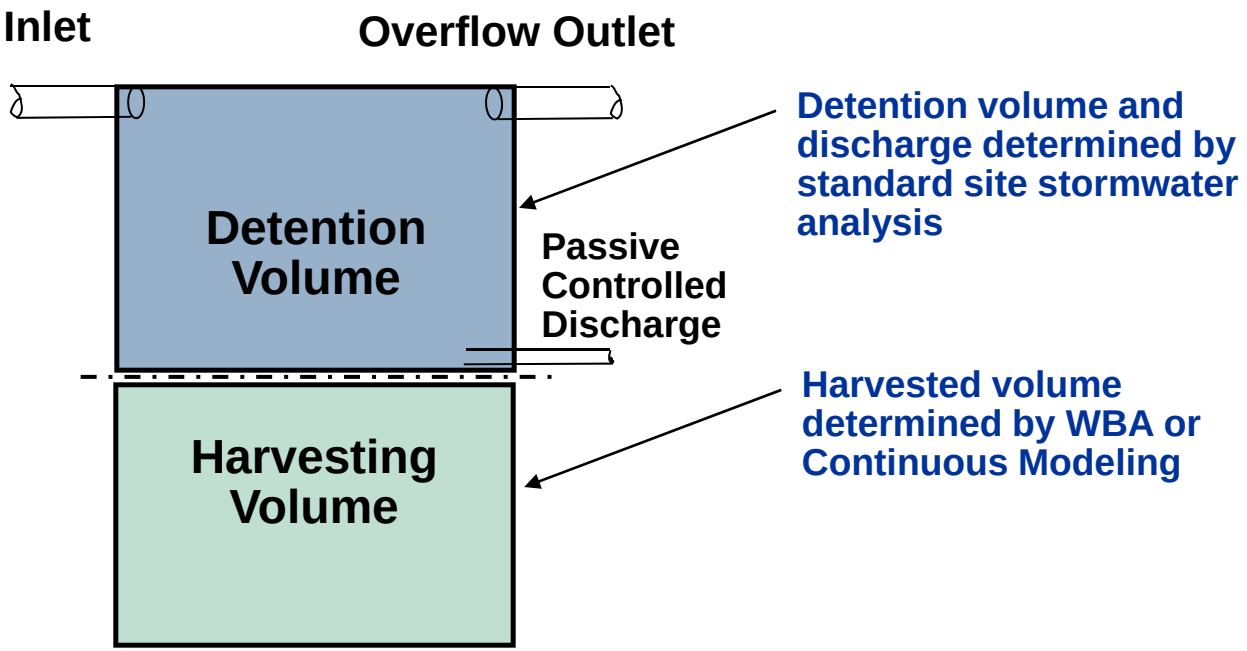
Integrated Solutions

Integrating Detention Volume with Harvesting Volume – Cont.

Shared/Passive Storage Configuration



- Pros: Passive; Simple implementation
- Cons: No volume savings; unlikely foot-print reduction

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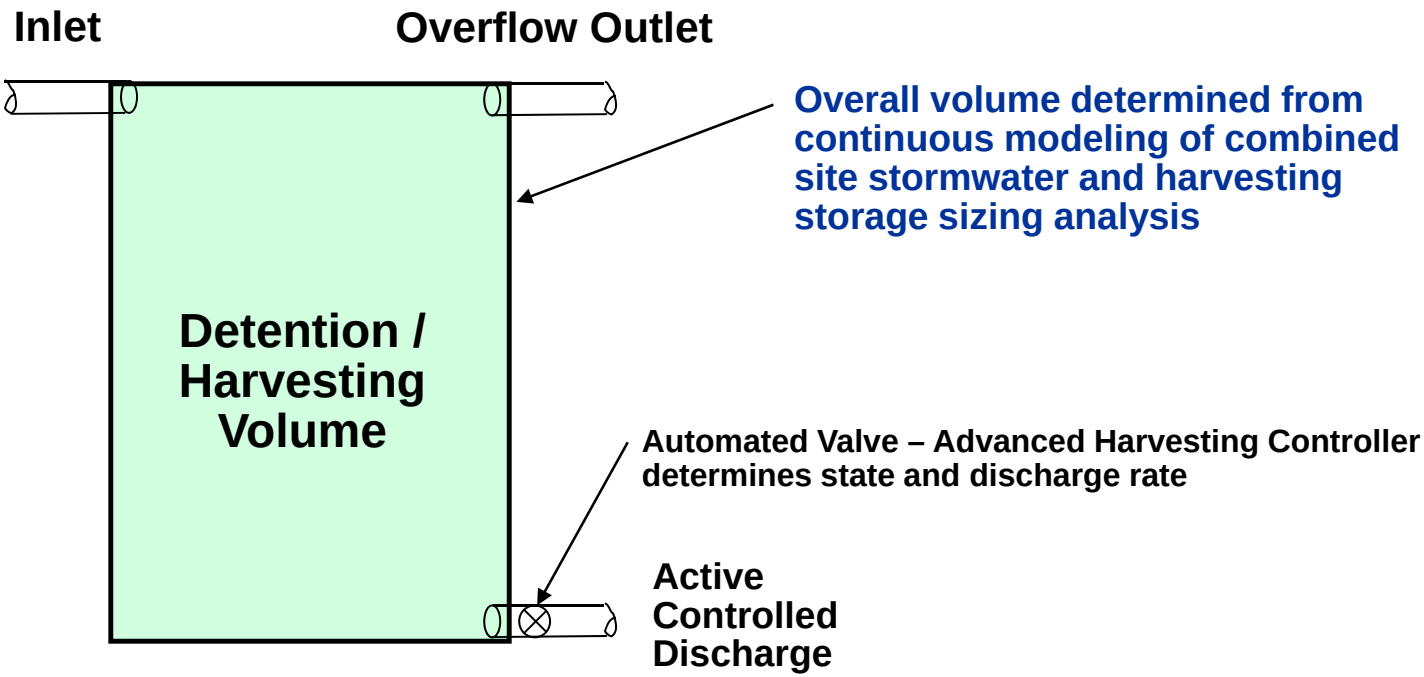
Integrating Detention Volume with Harvesting Volume – Cont.

Dedicated/Active Storage Configuration



- Pros: Volume, footprint, cost savings
- Cons: Active controls, back-up power

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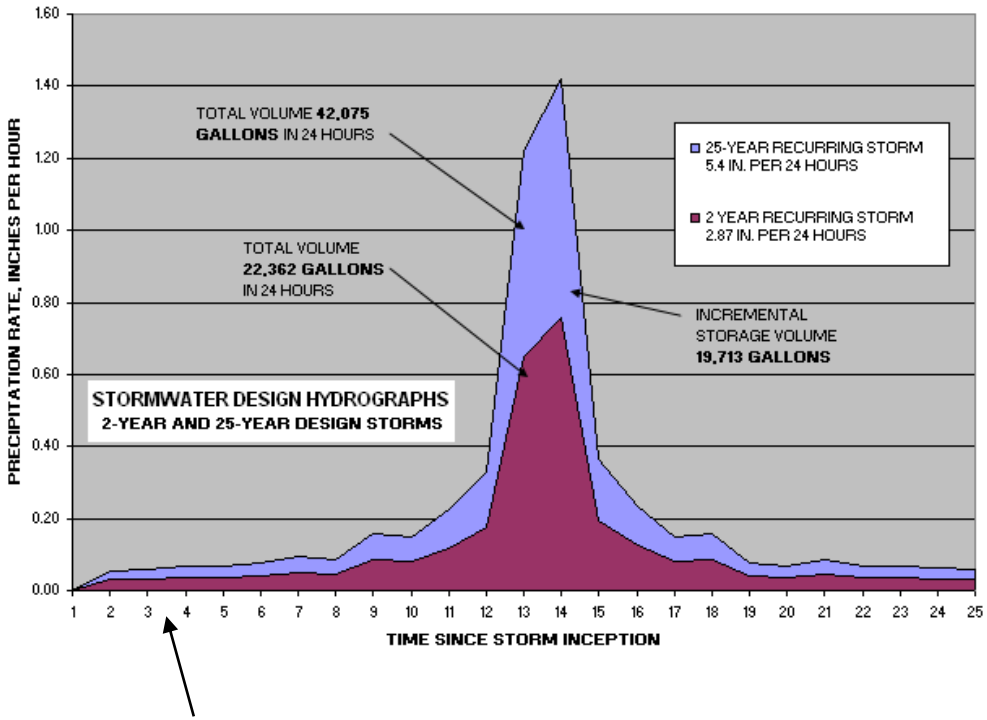
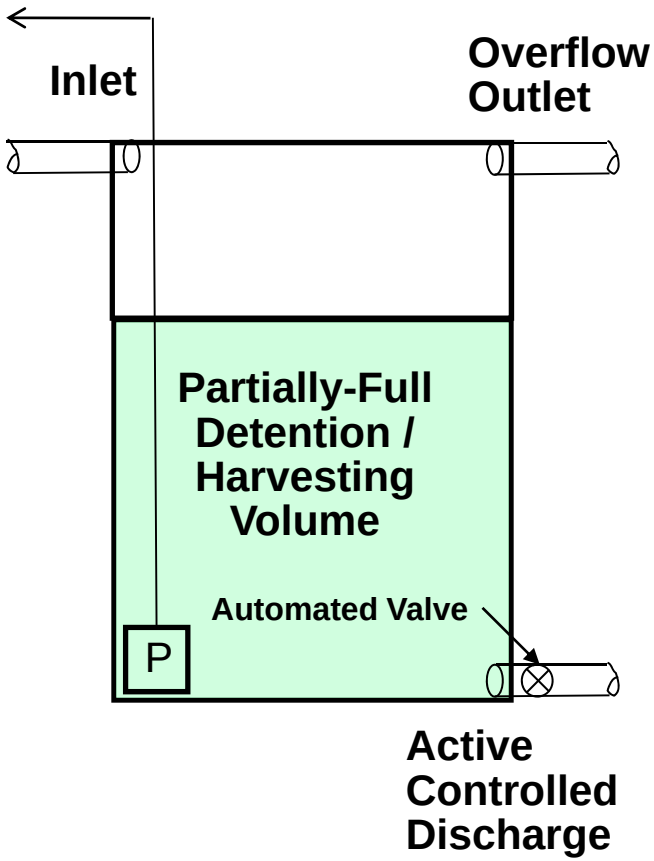
Integrated Solutions

Integrating Detention Volume with Harvesting Volume – Cont.





Controls-Based Discharge Trigger Point

- **Inflow Monitored in Control Structure**

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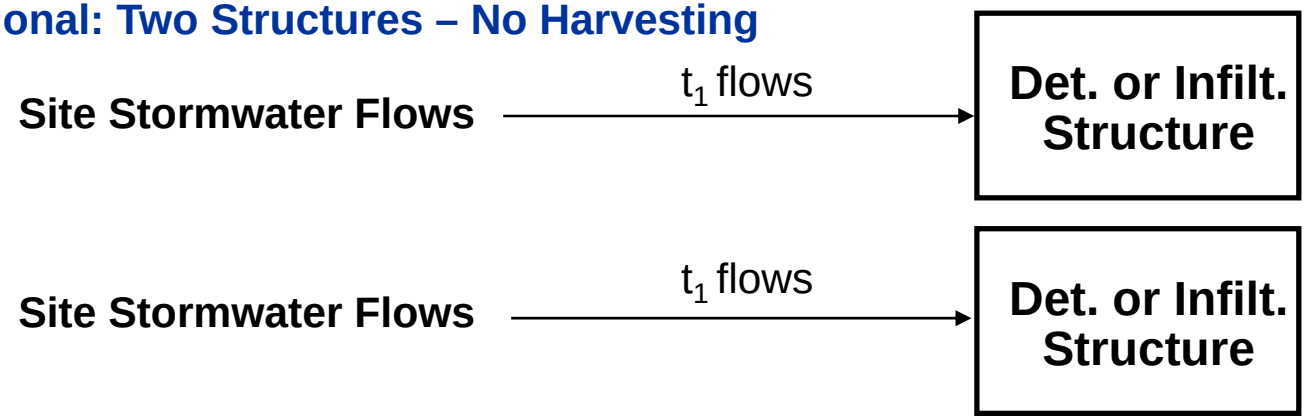
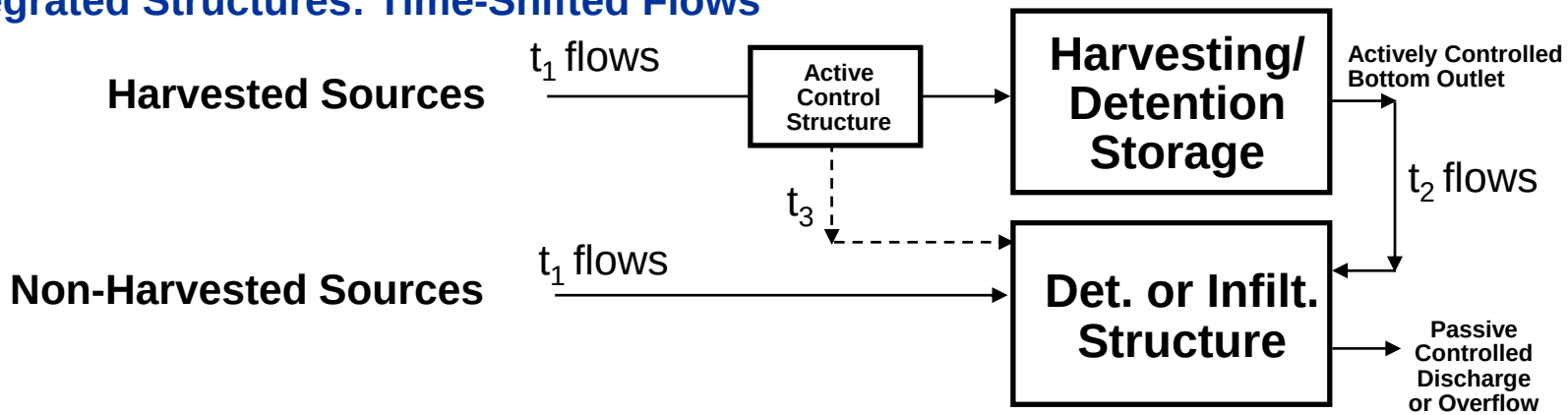
Time-Shifted Configuration

Integrating Detention/Infiltration Volume with Harvesting Volume

Traditional: Two Structures – No Harvesting



Integrated Structures: Time-Shifted Flows



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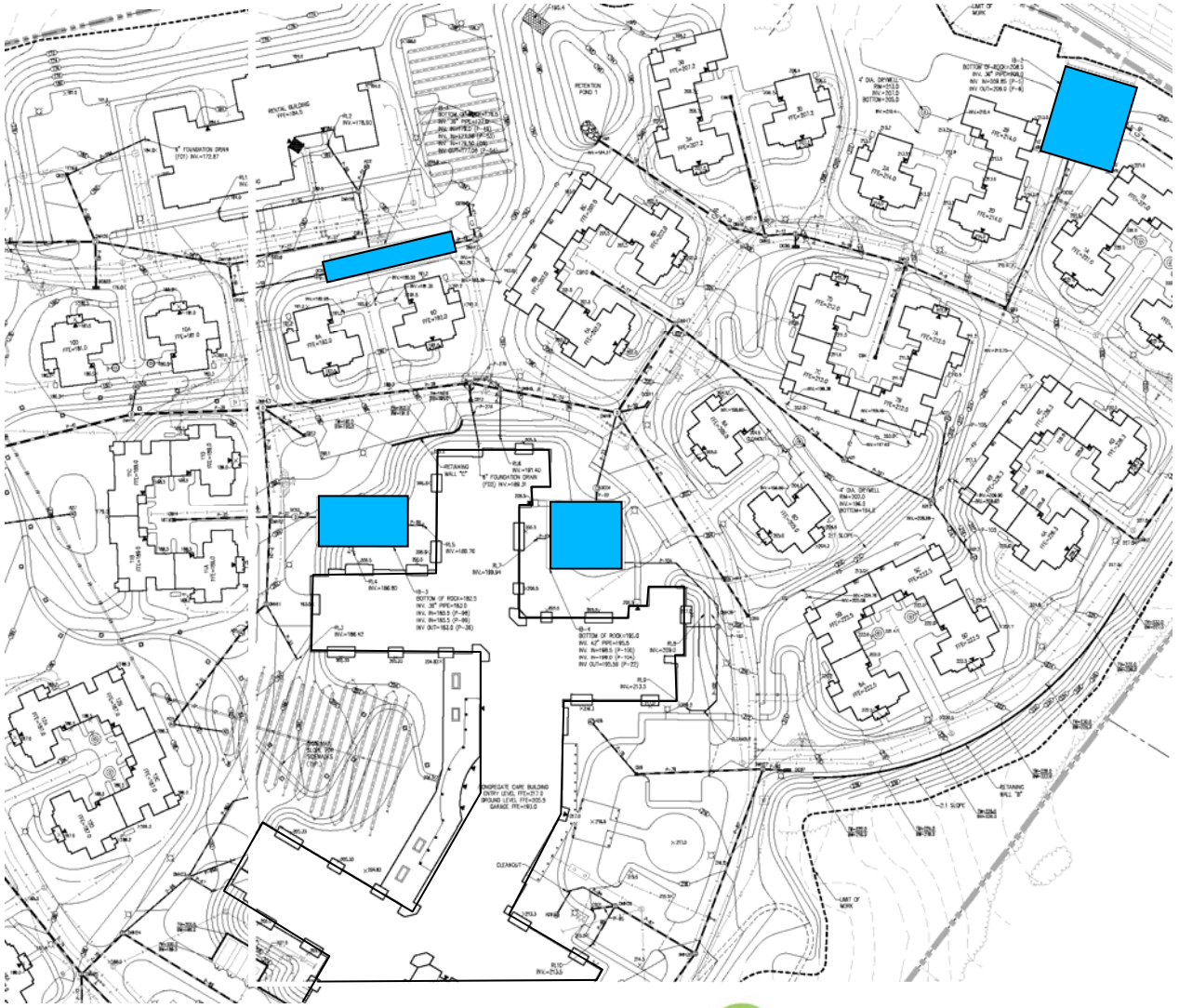
Time-Shifted Storm Flows

Original Configuration:

- All Detention and Infiltration
- Central structures receive only roof water
- Traditional harvesting configuration proposed, fully incremental to project
- Use time shifting to avoid duplicate structure costs



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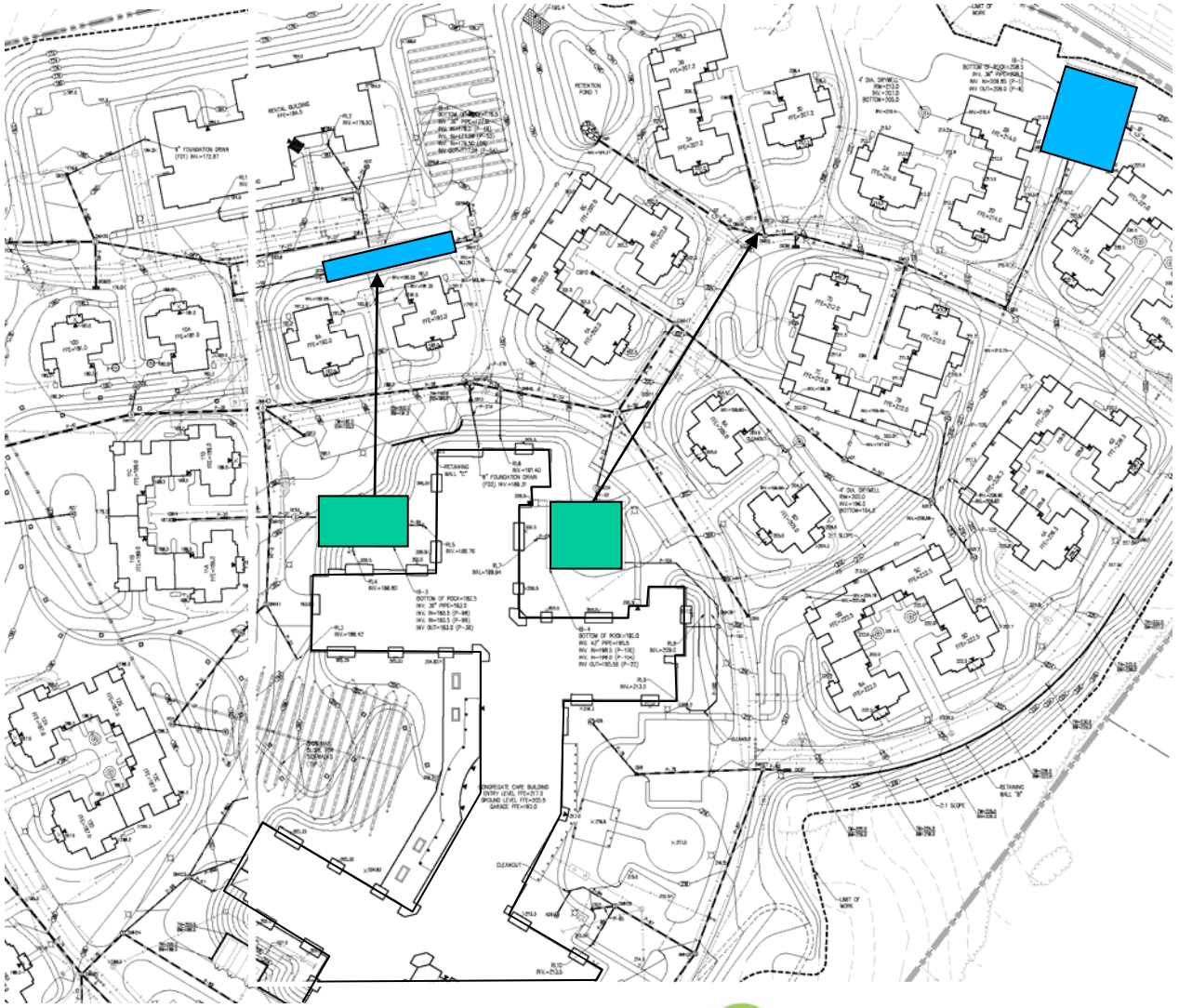
Time-Shifted Storm Flows

Proposed Configuration:

- Convert central roof water collection structures to cisterns
- Use pre-cistern control structure to manage water level in cistern
- If cisterns are partially full at onset of storm event, control structure releases water to downstream infiltration structures at pre-set trigger points
- If cisterns are empty at onset of storm event, water is maintained for re-use
- Incremental cost of two large cisterns avoided



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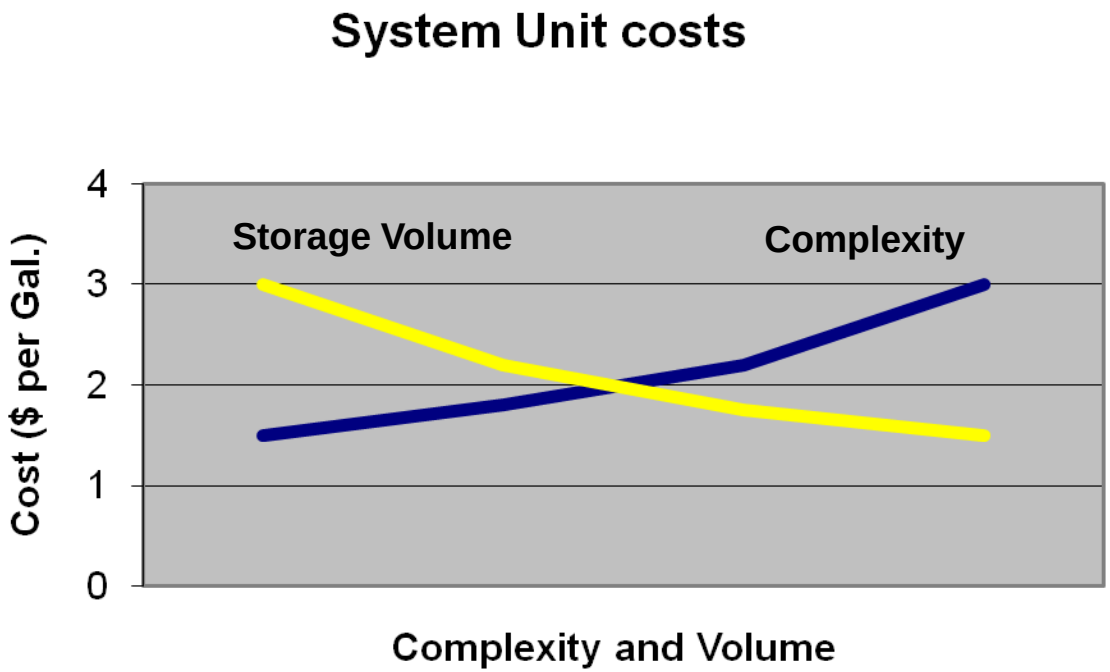
Harvesting System Cost – Stand-Alone

Harvesting system costs can vary widely based on:

- Storage Volume
- System Interfaces
- Control electronics

- **What's typically <u>excluded:</u>**
  - Collection System
  - Landscaping
  - Design Services



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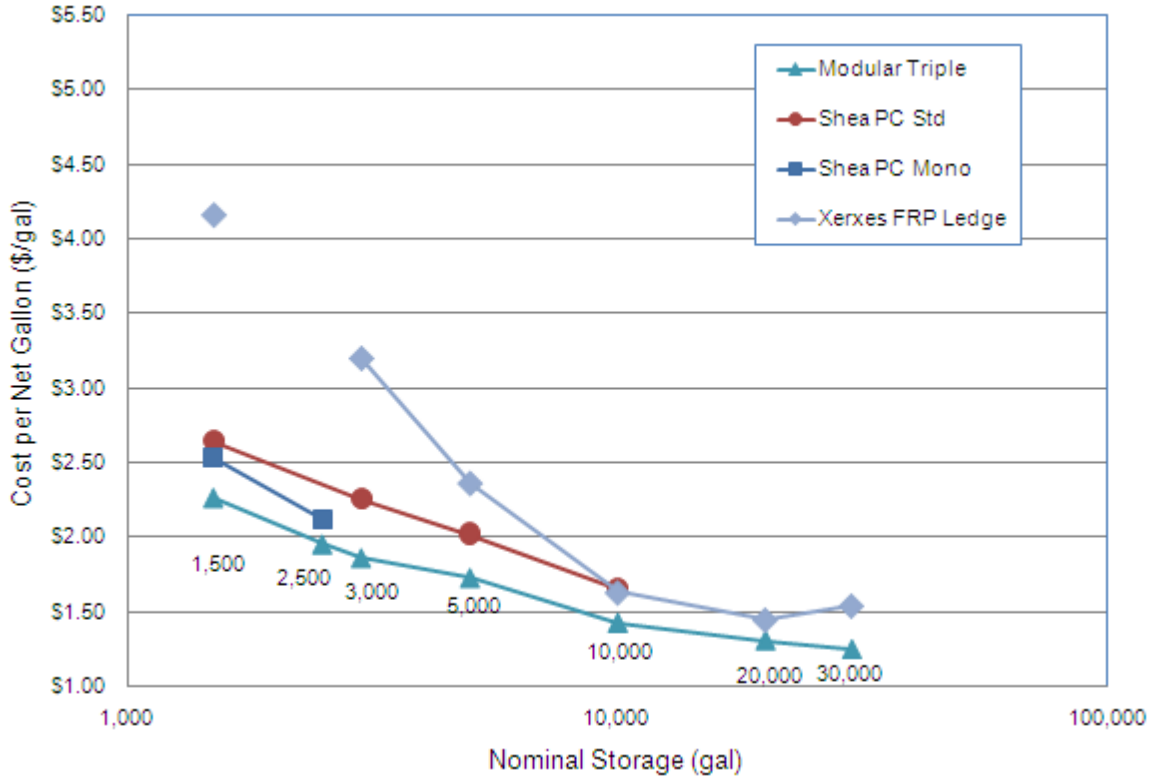
Potential Cost Benefits

Infrastructure Construction Cost Savings – no energy/carbon



- **Storage: US$1.25 – $2.50 per gallon installed (for >10,000 gal. storage)**
- **Controls: US$10,000 - $50,000+ (controller, control valves, pumps, etc.)**

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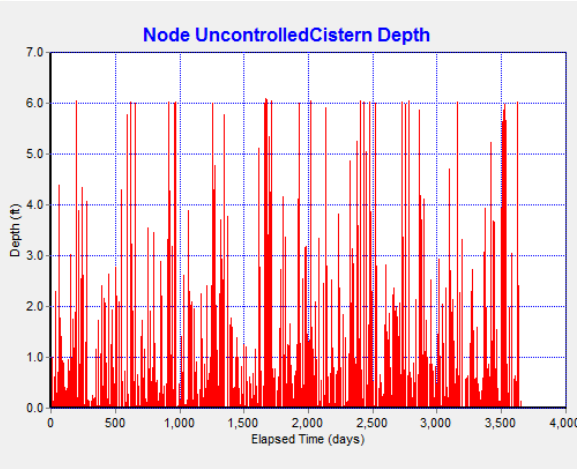
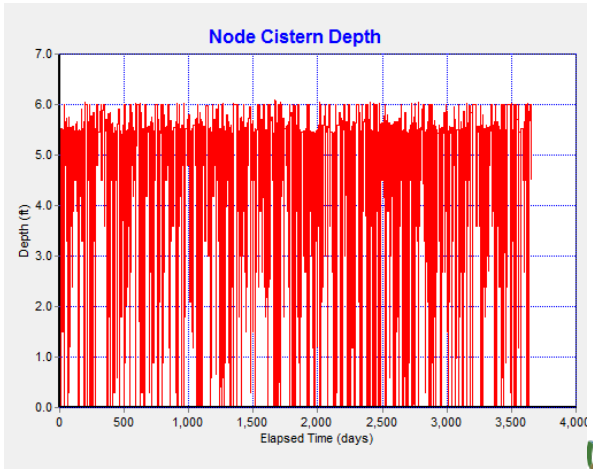
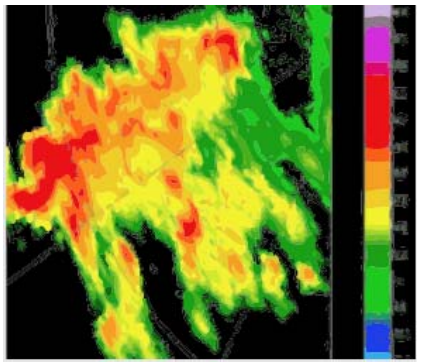
Innovative Stormwater Control

Predictive/RTC Controls

- Uses NWS QPF (Quantitative Precipitation Forecast) feeds and real-time sensors to control detention function of water storage
- Inexpensive, open source platform for maximum implementation potential
- Operate autonomously or as integrated system via server-side software







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Site-wide Solutions

- **Consider all water sources and demands to develop a**

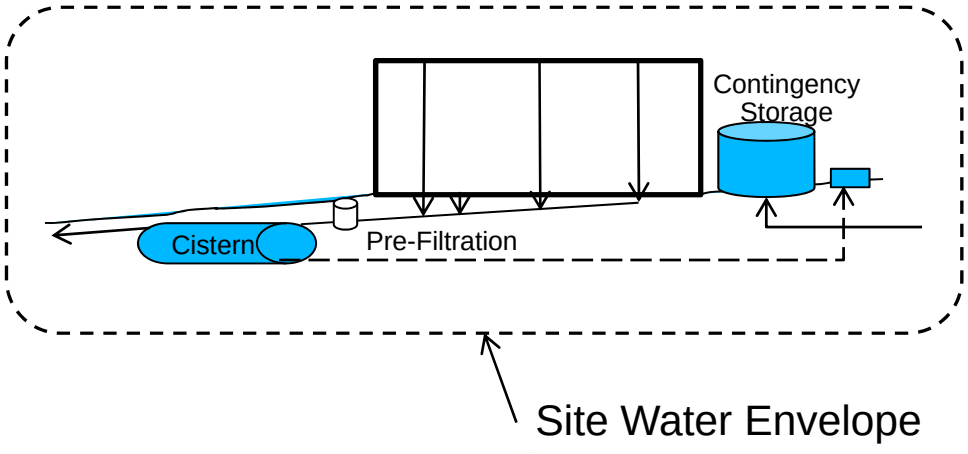
  "Total water strategy" or "Water Continuum" outlook for facility or facilities

  Supply:

  - Roof and surface water run-off
  - Chiller loop condensate, cooling tower blowdown (if not chemical)
  - Foundation drain and sump discharges
  - Process discharges (water quality dependent)

  Demand:

  - Irrigation
  - Toilet water
  - Cooling tower make-up
  - Fire protection
  - Other process or non-potable use



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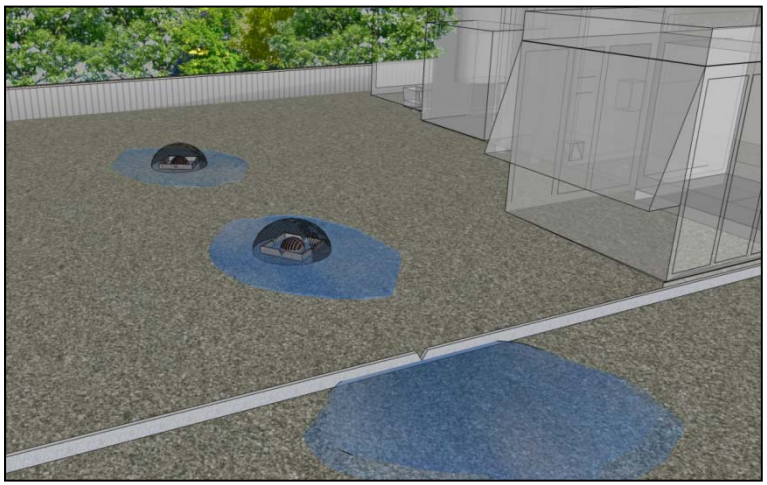
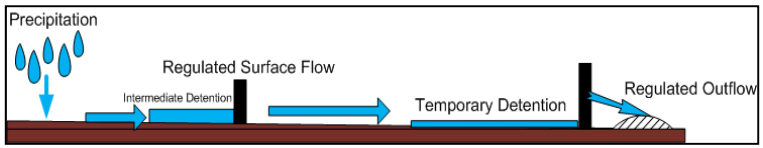
Innovative Stormwater Control

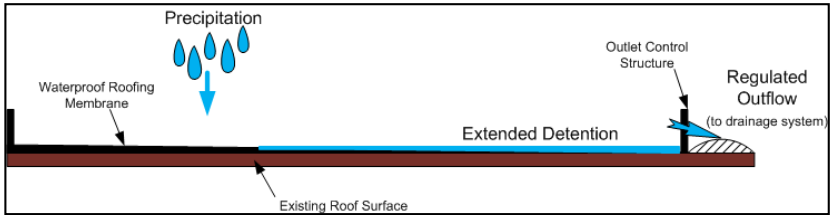
Roof-top Detention - Blue Roofs

- **Roof-top Hydraulic Retrofits – Water depth a function of structural capacity, storm control objective**
  - **Weirs at roof drain inlets**
  - **Porous overlays/perimeter dams**





Retrofit Hydraulic Structure Design with Intermediate Controls



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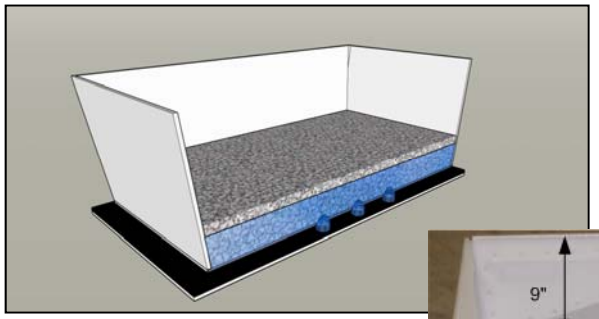
Innovative Stormwater Control

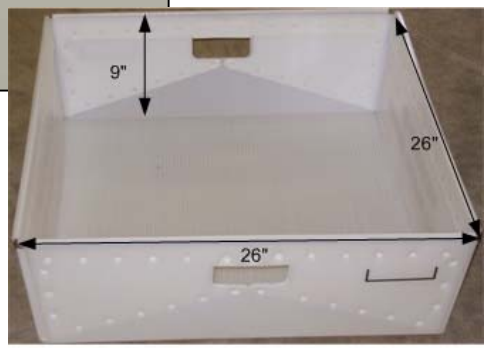
Roof-top Detention – Blue and Blue/Green Roofs

- **Modular Tray Systems**

System Characteristics:

- **Flexibility**
  - Size of system
  - Placement configuration
- **Ease of installation**
  - Coarse stone ballast
  - Retrofit designs
  - Use existing drains
- **Specialized outlet designs**
  - Detention time and Flow rate
  - Minimize clogging





Typical Tray with Dimensions

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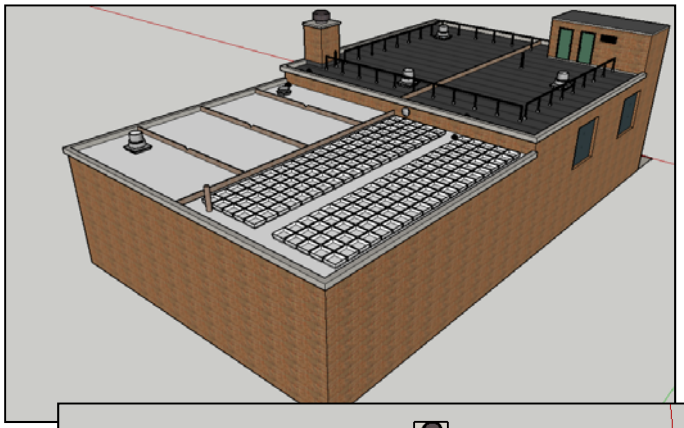
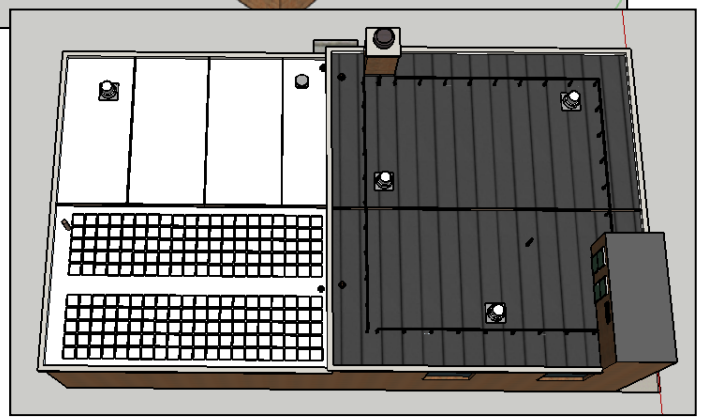
Innovative Stormwater Control

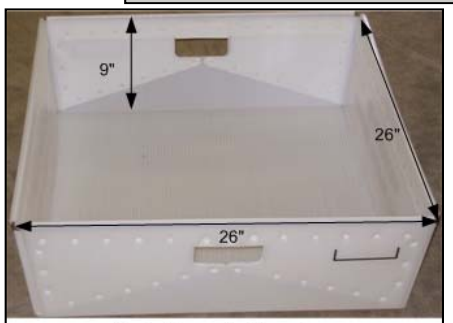
Roof-top Detention - Blue Roofs

- **Modular Tray Systems**

- **Pilot project in NYC**
- **High albedo value**
  - Use white underlayment and ballast
- **High water capture capacity**
- **Manages peak flow and timing**
- **Limited by structural capacity**
  - 3” profile typical
  - 5” to 6” profile for flood control







Typical Tray with Dimensions

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Summary & Conclusions

- **Three modes of integrating harvesting in stormwater management:**
  - Mid-height passive controlled discharge
  - Active Controlled discharge
  - Time-shifted storm flows
- **Provides water for beneficial use at small or no incremental cost**
- **Advances in controllers offer wide range of creative opportunities**
- **Limitations on applicability**
  - Not fully beneficial for seasonal applications
  - Prioritize surface water runoff
  - Back-up power for non-passive controls
  - High-intensity storms
  - Variable regulatory acceptance

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Thank you!

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