Assessment of Stormwater Harvesting via Manage Aquifer Recharge (MAR) to Develop New Water Supplies in the Arid West: The Salt Lake Valley Example

EPA-STAR Program
Grant #83582401
Project Overview

- Interdisciplinary, Integrated Project
- Designed to Test Hypothesis
- MAR is Technically Feasible, Socially/Regulatorally/Environmentally/Economically Viable Option for Development of New Water Supplies in Arid Urban Ecosystems Under Population Growth/Climate Change Pressures
Project Approach

- Integration of Stormwater Production & Conveyance Models, Vadose Zone/Groundwater Transport & Fate Models & Ecosystem Services Models for

- Assessing Impacts & Benefits of Distributed MAR for Stormwater Harvesting in

- Collaboration w/Stakeholders (Implementers and Communities)
Project Design

- Organized Into Three Components
  
  - Component I – Monitoring of Existing Distributed MAR Harvesting (GI) Schemes
  
  - Component II – Integrated Stormwater/Vadose Zone/Groundwater/Ecosystem Services Modeling
  
  - Component III – Assessment of Stakeholder Attitudes, Collaboration on Feasible Distributed MAR Scenario Development and Outcomes
Component I: Monitoring of Existing Distributed MAR (GI) Systems

Stormwater Quality
- System Performance Monitoring
- System Performance Reporting
- Groundwater Pollutant Loading (Quantity & Configuration)
- Limitations/Constraints to Field-Scale Implementation
Key Questions Here

- How Do these Systems Perform in Arid Western Environments?
  - Shallow Infiltration w/Pretreatment
  - Shallow Infiltration w/out Pretreatment (D-blocks)
  - Deep Infiltration w/or w/out Pretreatment

- For Stakeholders - Are These the Right Options to Consider?
iUTAH GIRN APPROACH

- Neighborhood Drainages in Logan
- Dry Wells, Roofs @ USU
- Storm Drains
  - Red Butte Creek, UofU
- Bioretention Area w/Varying Filtration Media @ SLC PU
- 1300 S Storm Drain to Jordan
Preliminary Findings/Observations

Potential Issues w/ Shallow Infiltration Systems re. As Mobility

900 N 300 E Logan site: 8.14 mg/kg Total Arsenic

Potentially Labile

Green Meadows site: 10.19 mg/kg Total Arsenic

Potentially Labile

U of U GIRF site: 14.52 mg/kg Total Arsenic

Potentially Labile
Component II

Integrated Modeling

Storm/Groundwater/Ecosystem Modeling

- Loading Inputs of Stormwater
- Water Quality and Flow Changes
- Impacts on Water Availability
- Impacts on Ecosystem Services
Data and Model Flow

**Stormwater Component**
- Model: WinSLAMM
  - Runoff, Infiltration, Pollutant Loadings

**Surface Water Component**

**Groundwater & Vadose Zone Component**
- Models: MODFLOW, MT3DMS and HYDRUS
  - GW to SW, Water Quality
  - SW to GW

**Water Quality Constituents:**
- flow, stream temperature, specific conductance, turbidity, nitrogen, phosphorus, dissolved oxygen, fDOM, chlorophyll
Stormwater Modeling w/ WinSLAMM

- Provide Assessment of & WQ Changes w/ GI
- Difference w/ & w/ Out GI Related to Groundwater Inputs & Reductions to Surface Water of Both Water & Pollutants
- Calibrated w/ Three Small Subwatersheds in Logan, One Small & One Large Urban Watershed in SL Valley
Issue Critical to Stakeholder Advisory Board – Will Municipality Retain Ownership of Harvested Stormwater?

Graphical user interface (GUI) for reconnaissance
Recovery Effectiveness

- Recoverable Quantity of Recharged SW?
- Establish Recovery Scheme to Ensure No Depletion of GW Resource
- GUI Developed for One Well Injection/Extraction to be Modified to Address Distributed Recharge and Multiple Wells Scheme for Recovery
- Ecosystem Services Modeling
  - Red Butte Creek
  - Jordan River

Note: WINSLAMM, HEC-HMS, and MODFLOW inputs to QUAL2K
<table>
<thead>
<tr>
<th>Ecosystem Service</th>
<th>Metric (Units)</th>
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<tbody>
<tr>
<td>Increased Summer Baseflow</td>
<td>Duration of Low Flow Conditions (days)</td>
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<tr>
<td>Flood Attenuation</td>
<td>Flood Magnitude (m³/s), Duration (minutes), Rate of Change of Slope of Hydrograph</td>
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<tr>
<td>Process Water Quality Contaminants</td>
<td>Pollutant Concentration (mg/L), Conductivity (S/m)</td>
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<tr>
<td>Maintenance of Natural Thermal Regime</td>
<td>Maximum Weekly Average Temperature (°C) &amp; Maximum Daily Temperature (°C)</td>
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<tr>
<td>Aquatic Biodiversity</td>
<td>Habitat Suitability Curves for Fish Species of Interest (e.g., Bonneville cutthroat trout, Utah chub, rainbow trout)</td>
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Ecosystem Services Research Questions

- What Environmental Benefits are Lost, Altered, or Improved with Stormwater Harvesting?
  - At What Thresholds Do Changes Occur?
- How Can Methods Developed in This Project be Generalized to Other Water-Scarce Regions?
- How can Understanding Changes to Environmental Benefits from Stormwater Harvesting Aid Resource Management Decision-Making?
Component III - Stakeholder Involvement

Social Acceptability
- Stakeholder Identification
- Stakeholder Attitudes and Preferences
- Social/Regulatory Constraints
- Economic Cost/Benefits
Expected Outcomes

- Development of Methodology - Field Measurements, Modeling, Stakeholder Interaction
- Optimize Distributed MAR for Stormwater Harvesting via GI Implementation
- Development of Additional Water Supplies
- Improve Risk Management (Source Water Protection)
- In Response to Population Growth, Climate Change, Conflicting Public/Ecosystem Demands
Now to Highlights of Component III Progress
Overview of Approach

- Key Informant Interviews (2016)
- City/County/State Stormwater Program Managers
- Private Sector Consultants & Developers
- On-line Survey of All Utah MS4 Permittees
- Focus Groups of Neighborhood Residents
- Coordinate Stakeholder Advisory Committee
Key Informant Interviews

- QUESTIONS
  - Five Types of MAR/GI Practices
    - TYPE A: Extended Detention Basins
    - TYPE B: Distributed Surface Storage & Infiltration (grassy swales, rain gardens, tree boxes) (Shallow Infiltration w/Treatment)
    - TYPE C: Subsurface Storage and Infiltration (D-blocks, R-tanks, dry wells, vaults) (Shallow Infiltration w/Out Treatment)
    - TYPE D: Deep Subsurface Injection Wells (Deep Infiltration w/ & w/Out Treatment)
    - TYPE E: Rain Barrels
  - Familiarity
  - Effectiveness (flooding, SW & GW quality impacts/protection, local water supply augmentation)
  - Best/Worst Aspects
  - Barriers to Wider Adoption
Key Informant Interviews

- Sample
  - City and County staff (PU/PW Directors; Stormwater Program Managers and/or engineers)
    - 17 interviewed to date; 5-8 more planned
  - State Agency staff (DEQ/DWQ)
    - 2 interviewed to date; Water Rights & Permitting planned
  - Private Consulting Engineering Firms
    - 1 interviewed to date; 3-5 more planned to include Developer Community
Emerging Findings (very preliminary)

- TYPE A Widely Used, Works; But Perceived as No Longer Sufficient to Meet Emerging State Rules
- GVLID Options (Types B & C) Attractive
  - Limited in Some Situations
    - Biophysically
    - Socially/Politically
Emerging Findings (very preliminary)

- LID Type D (Deep Wells) Unlikely to be Widely Acceptable
- Concerns About Potential for GW Contamination
- Perceptions & Concerns Similar Across Cities
- Viability Differs Across Cities (Diff. Contexts)
Outcome of Stakeholder Advisory Committee Meeting – 10/2016

- Held in Conjunction w/ Utah APWA Meeting
- Participation by Eight City, County, State, Consulting Representatives

- Input on
  - Labeling of MAR/GI Practices
  - Emphasized Need for MAR/GI System Performance Data
  - Identified Participants Willing & Able to Add Systems to Monitoring Network (Spanish Fork & South Jordan)
  - Highlighted Concerns about Water Rights & Reuse of Stored, Recharged GW
  - Recommended Inclusion of Developer Community in Stakeholder Profile

- Scheduled Next SAC Meeting in Conjunction w/ Spring Public Works & Stormwater Coalition Meetings
Upcoming work

- On-Line Survey – Winter 2016/17
  - Sample All MS4 Permittees
    - Update Mailing List w/SAC Input
  - Seeking Co-sponsorship from USWAC, Others

- Focus Groups
  - Looking for SAC Help in Identifying a Few Instances of BMP Field-implementations where Neighbors can be Approached to Participate in Focus Group Interactions
Thank You & Questions?