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

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Utah Water Research Laboratory

Utah State University

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

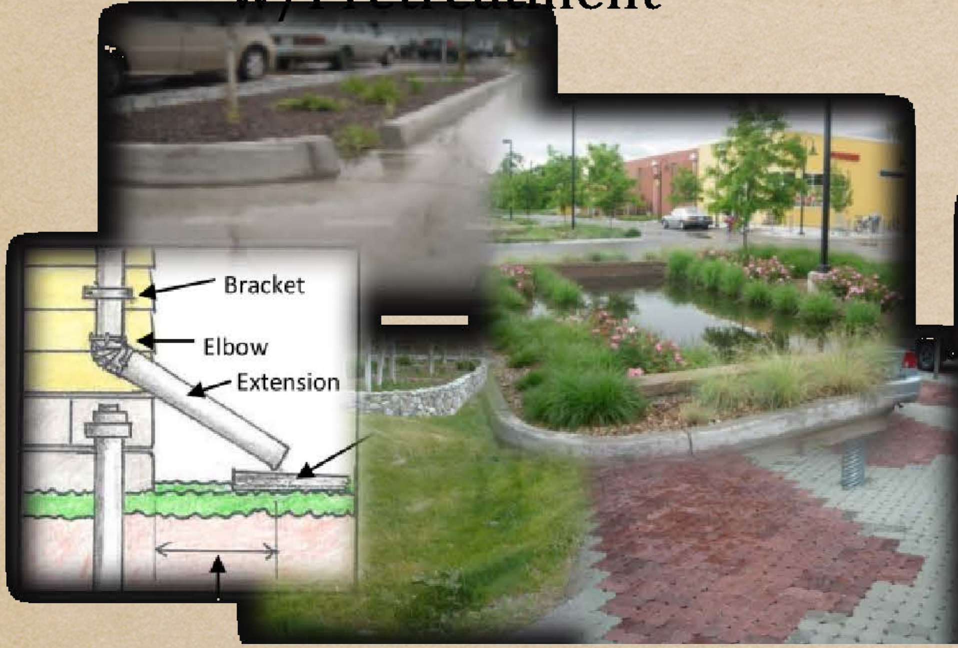
Stormwater Quality

- 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

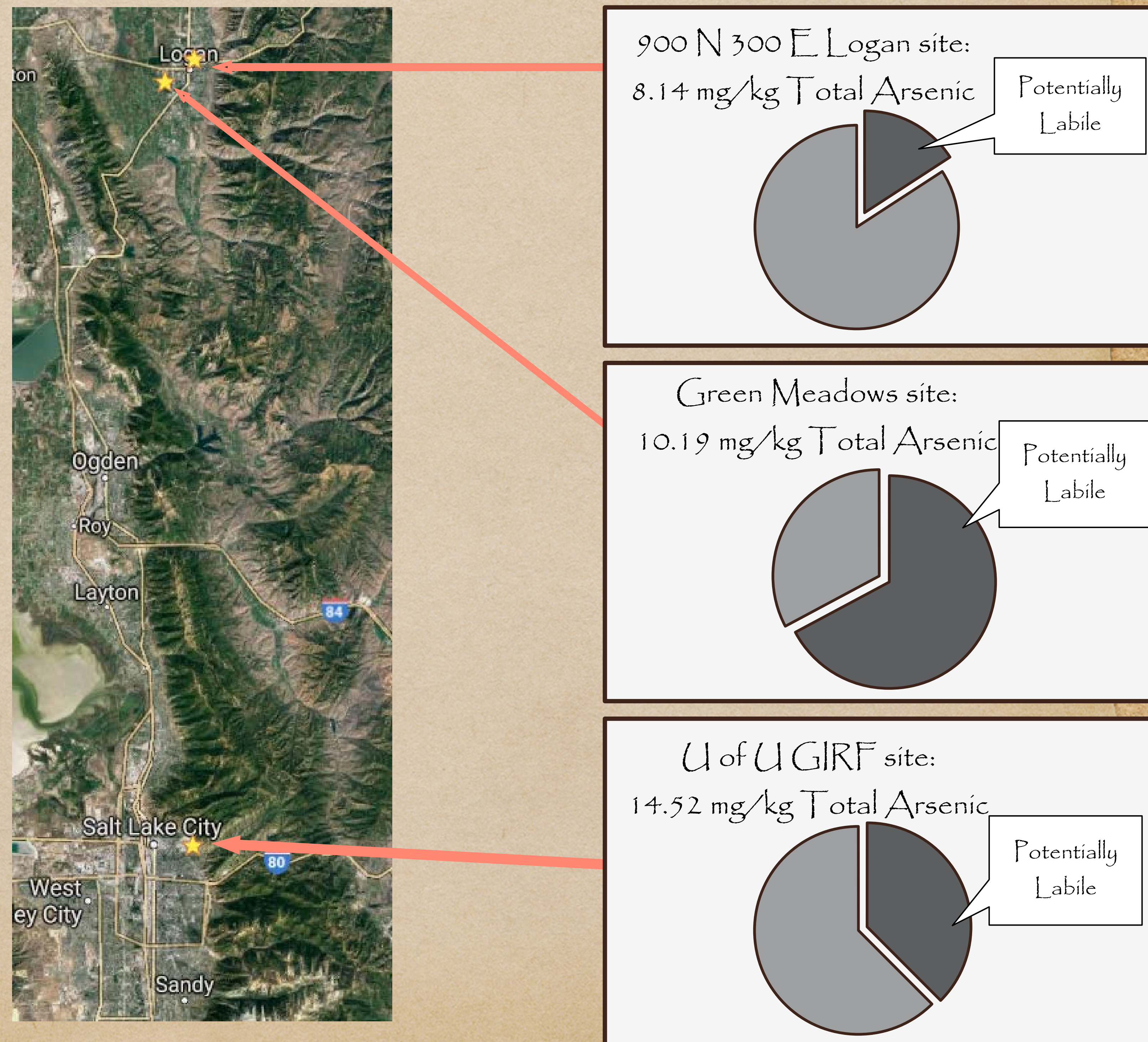
Storm Drains Red Butte Creek, UofU

Bioretention Area w/Varying Filtration Media @ SLCPU

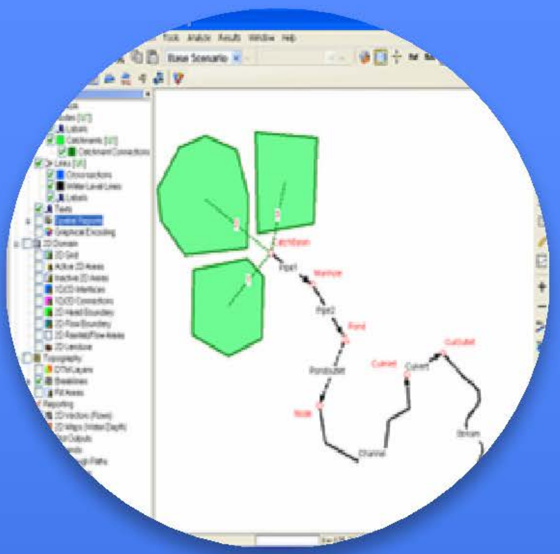
1300 S Storm Drain to Jordan

Preliminary Findings/Observations

Potential Issues w/Shallow Infiltration Systems re. As Mobility

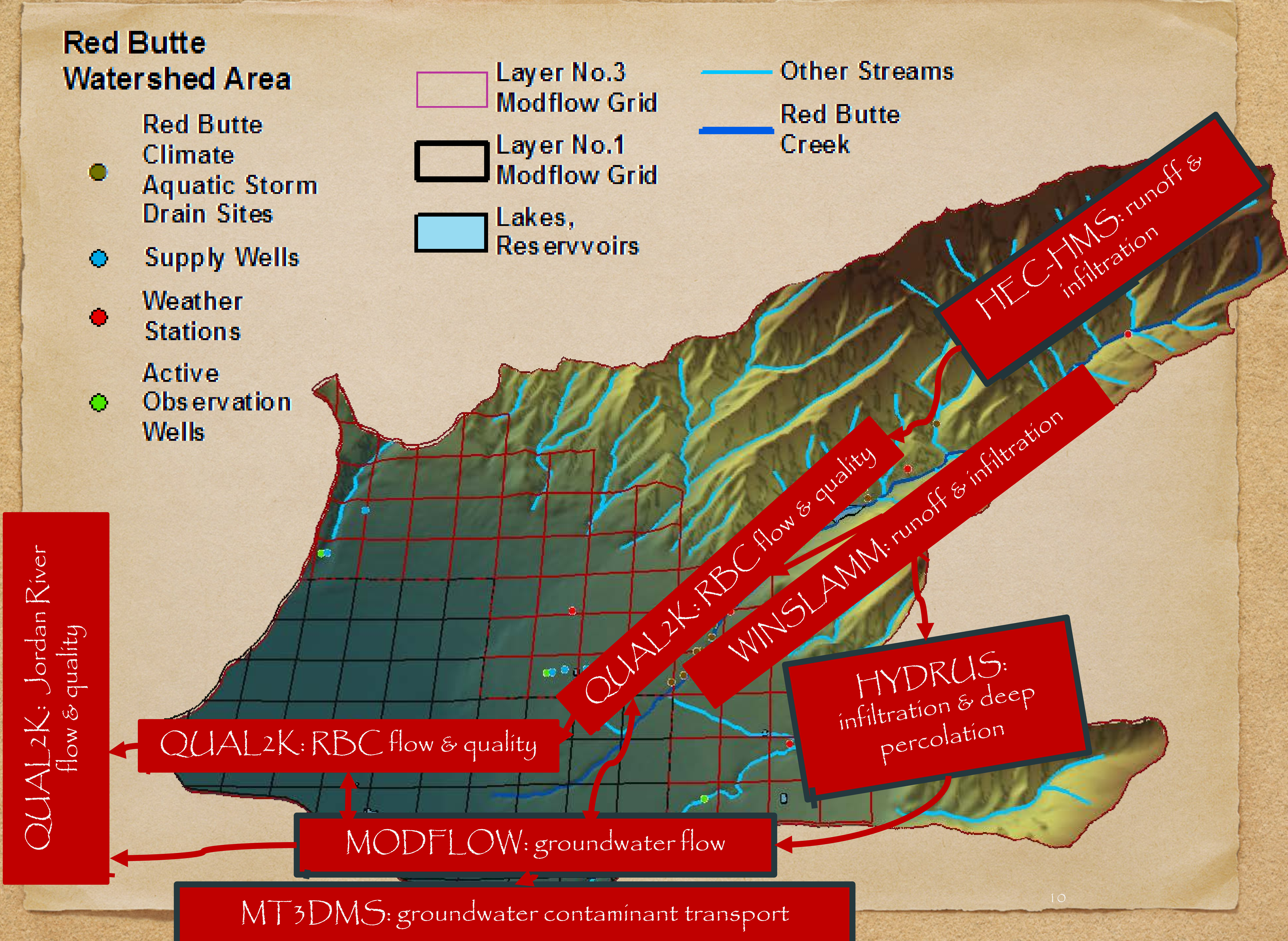


Component II - Integrated Modeling



Storm/Groundwater/Ecosystem Modeling

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



Red Butte Watershed Area
Red Butte Climate Aquatic Storm Drain Sites
Supply Wells
Weather Stations
Active Observation Wells
Layer No.3 Modflow Grid
Layer No.1 Modflow Grid
Lakes, Reservvoirs
Other Streams
Red Butte Creek
HEC-HMS: runoff & infiltration
QUAL2K: RBC flow & quality
WINSLAMM: runoff & infiltration
HYDRUS: infiltration & deep percolation
QUAL2K: Jordan River flow & quality
QUAL2K: RBC flow & quality
MODFLOW: groundwater flow
MT3DMS: groundwater contaminant transport

Data and Model Flow

Stormwater Component

Model:
WinSLAMM

Runoff, Infiltration, Pollutant Loadings

Surface Water Component

Models:
HEC-HMS: Rainfall-runoff
QUAL2K: Streamflow & water quality

Water Quality Constituents:
flow, stream temperature, specific conductance, turbidity, nitrogen, phosphorus, dissolved oxygen, fDOM, chlorophyll

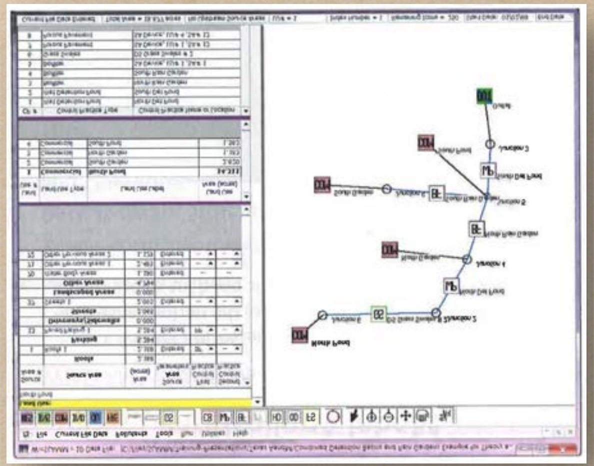
Groundwater & Vadose Zone Component

Models:
MODFLOW, MT3DMS and HYDRUS

GW to SW, Water Quality

SW to GW

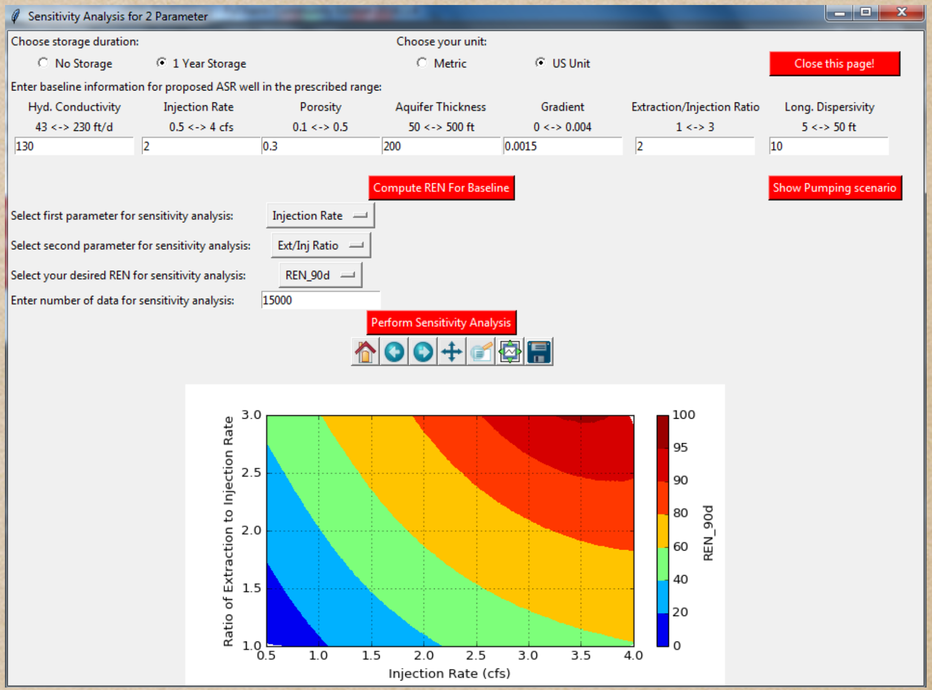
Stormwater Modeling w/WinSLAMM



- 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

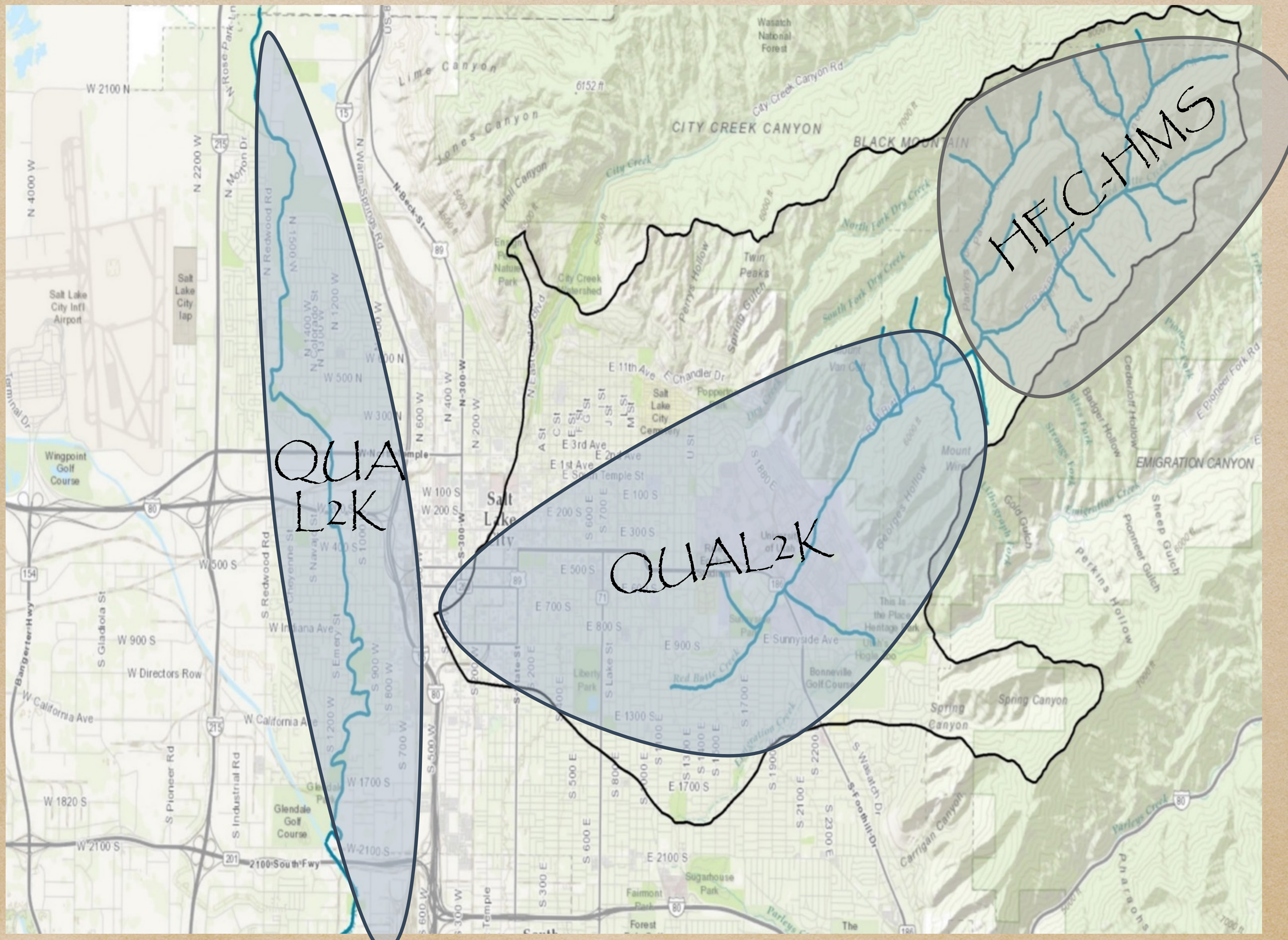
Issue Critical to Stakeholder Advisory Board – Will Municipality Retain Ownership of Harvested Stormwater?

Graphical user interface (GUI) for reconnaissance Recovery Effectiveness



- Recoverable Quantity of Rechaged 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



<u>Note</u>: WINSLAMM, HEC-HMS, and MODFLOW inputs to QUAL2K

Ecosystem Services Metrics to be Used

Ecosystem Service	Metric (Units)
Increased Summer Baseflow	Duration of Low Flow Conditions (days)
Flood Attenuation	Flood Magnitude (m^3/s), Duration (minutes), Rate of Change of Slope of Hydrograph
Process Water Quality Contaminants (nutrients, salts, metals…)	Pollutant Concentration (mg/L), Conductivity (S/m)
Maintenance of Natural Thermal Regime	Maximum Weekly Average Temperature (°C) & Maximum Daily Temperature (°C)
Aquatic Biodiversity	Habitat Suitability Curves for Fish Species of Interest (e.g., Bonneville cutthroat trout, Utah chub, rainbow trout)

Ecosystem Services Research Questions

- What Environmental Benefits are Lost, Altered, or Improved w/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

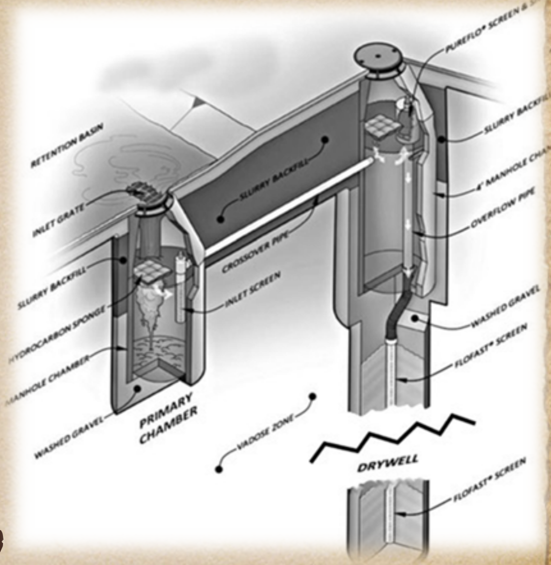
Key Informant Interviews

- 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
- GI/LID 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?