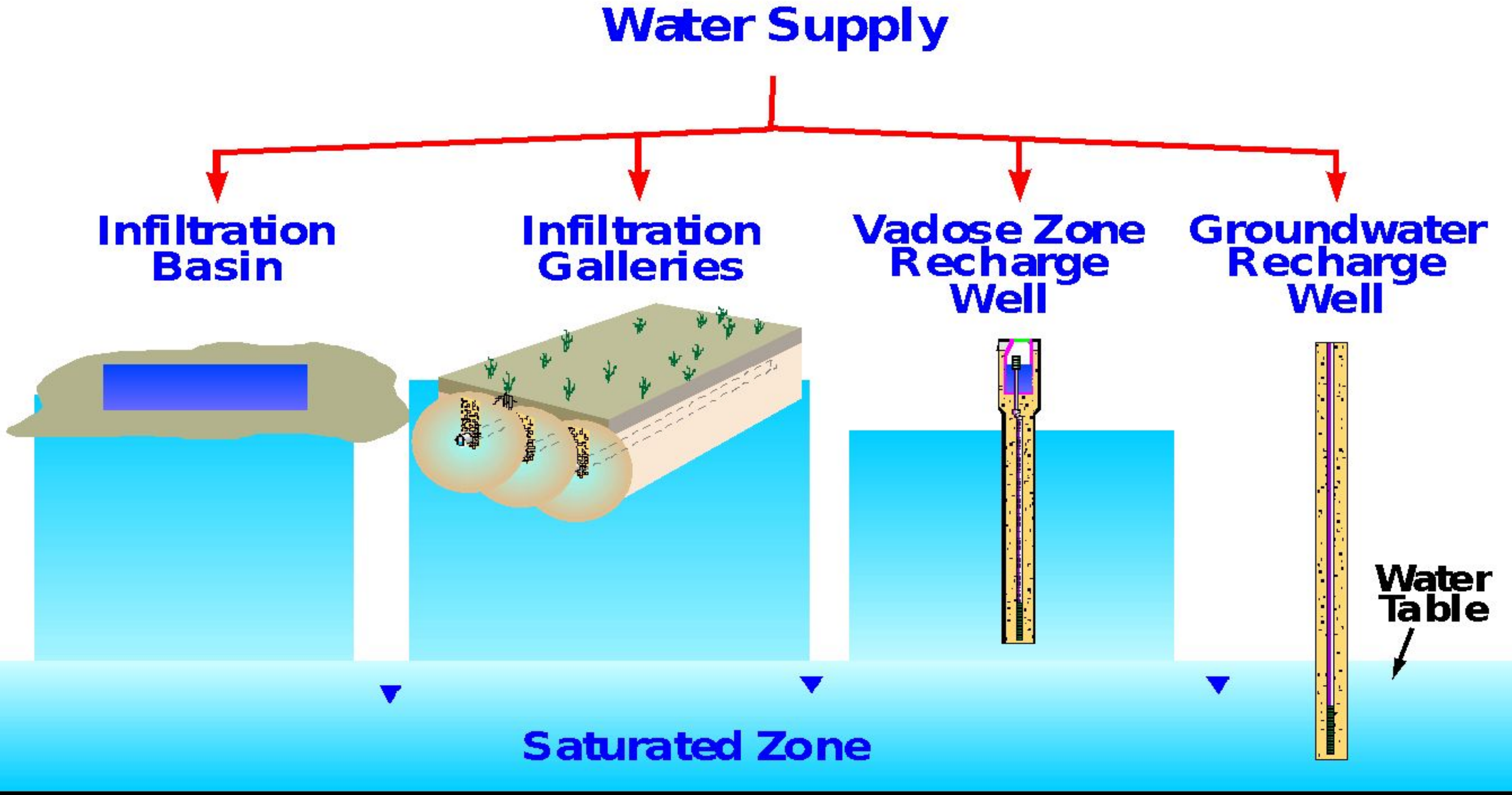
Managed Aquifer Recharge (MAR) -- Beyond the ASR Well

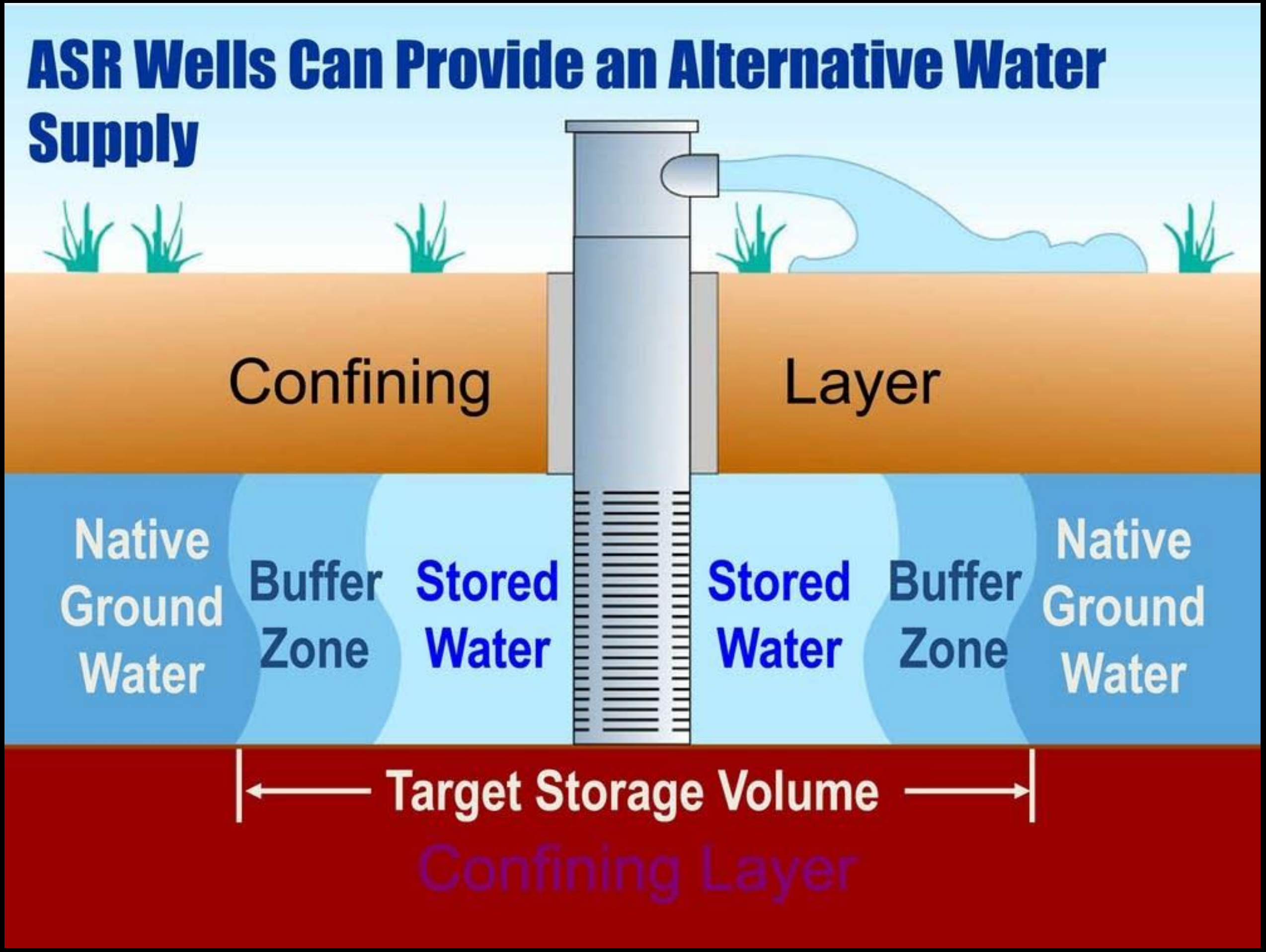
Stephanie J. Moore, P.G.
Daniel B. Stephens & Associates, Inc.
a GeoLogic Company

TAGD Groundwater Summit
Austin, Texas
August 28-30, 2018

MAR techniques range from low to high tech



Aquifer Storage and Recovery



ASR is just one part of MAR

Outline

- Overview of Managed Aquifer Recharge
  - Definitions: MAR, ASR, ASTR, VZ
  - Technical considerations
- Regulatory environments
  - Highly variable by state
- Types of MAR projects
- Intersection with LID/Stormwater Mgmnt.
- ASCE Guidelines for MAR

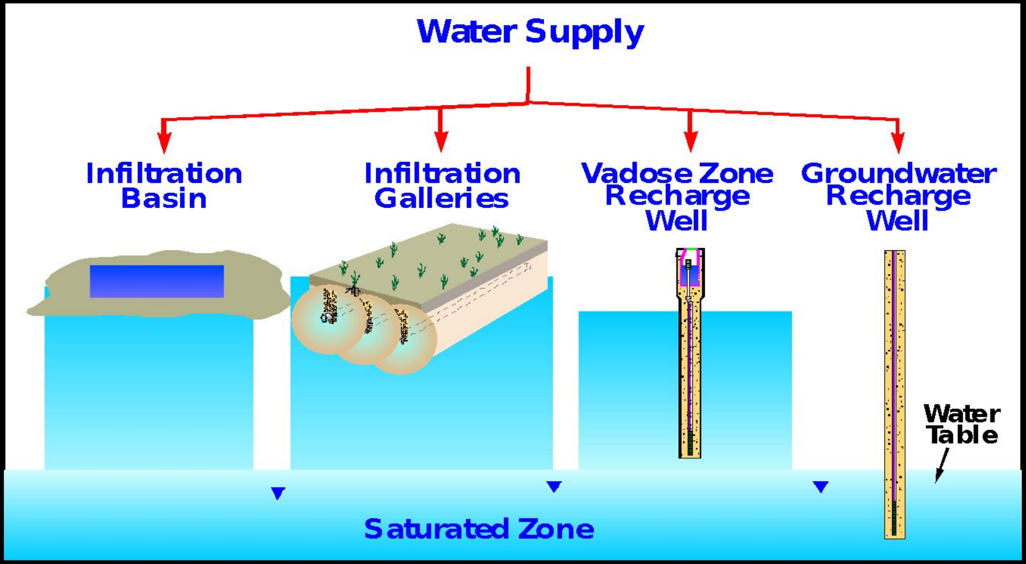
Managed Aquifer Recharge

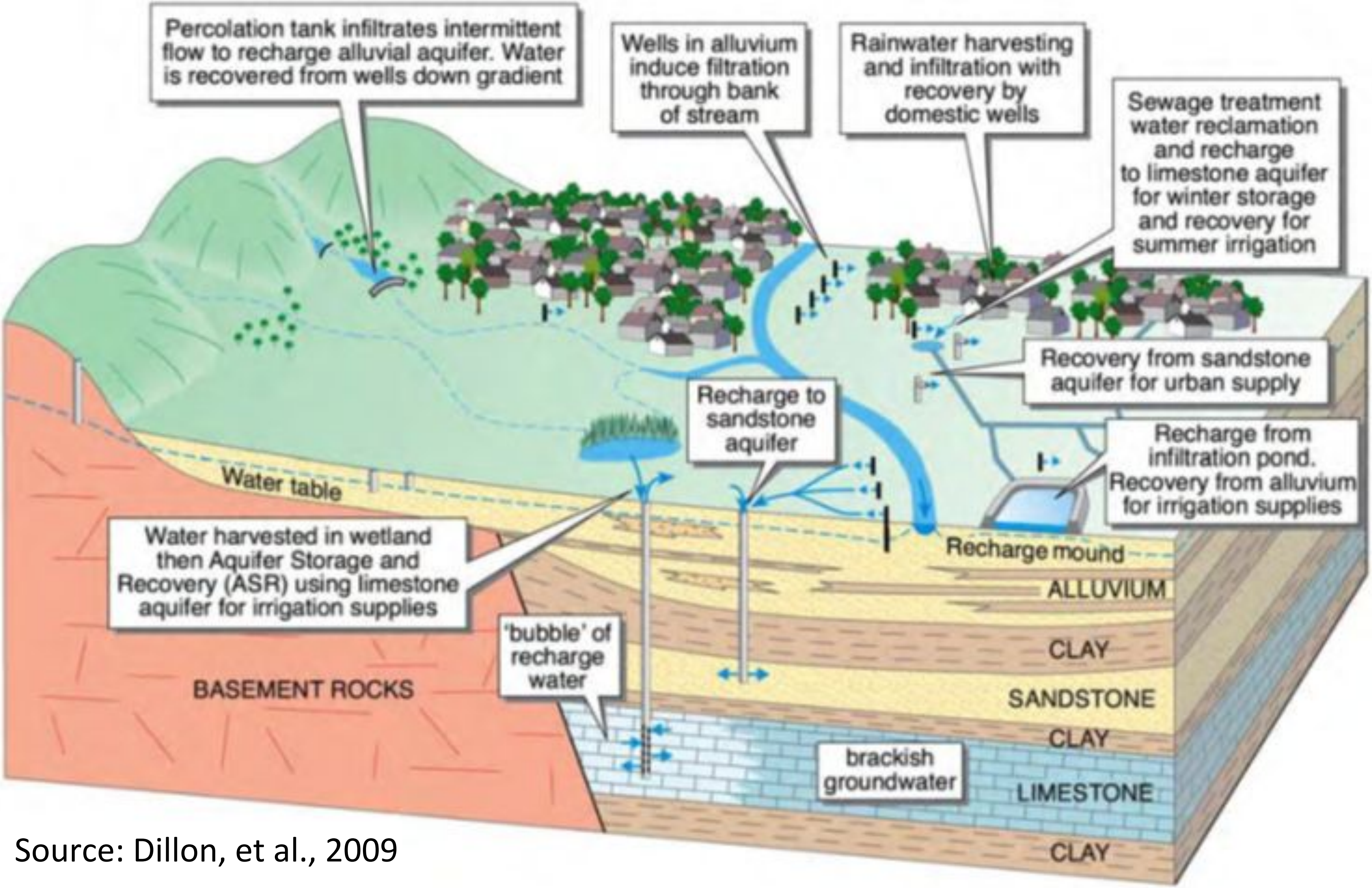
- The practice of increasing, by artificial means, the amount of water that enters a groundwater reservoir.

- A water resources management tool that allows for the efficient and conjunctive management of surface water, groundwater, and reclaimed water sources.

Common MAR Goals

- Water supply management
  - Seasonal storage
  - Long-term storage
  - Emergency supply
  - Conjunctive use
- Aquifer restoration
  - Restore water levels
  - Support baseflow
  - Reduce subsidence
  - Mitigate saltwater intrusion

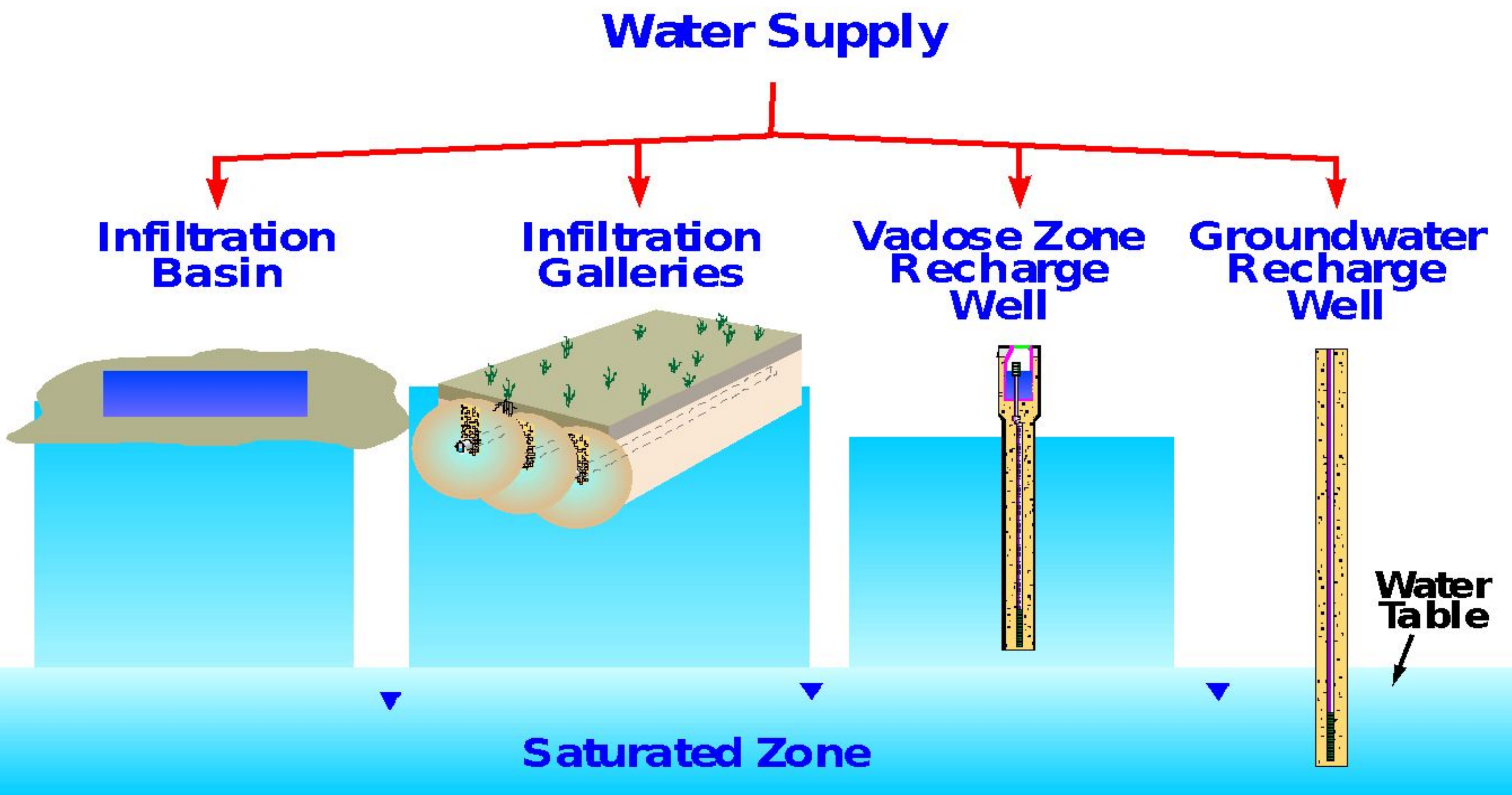




Source: Dillon, et al., 2009

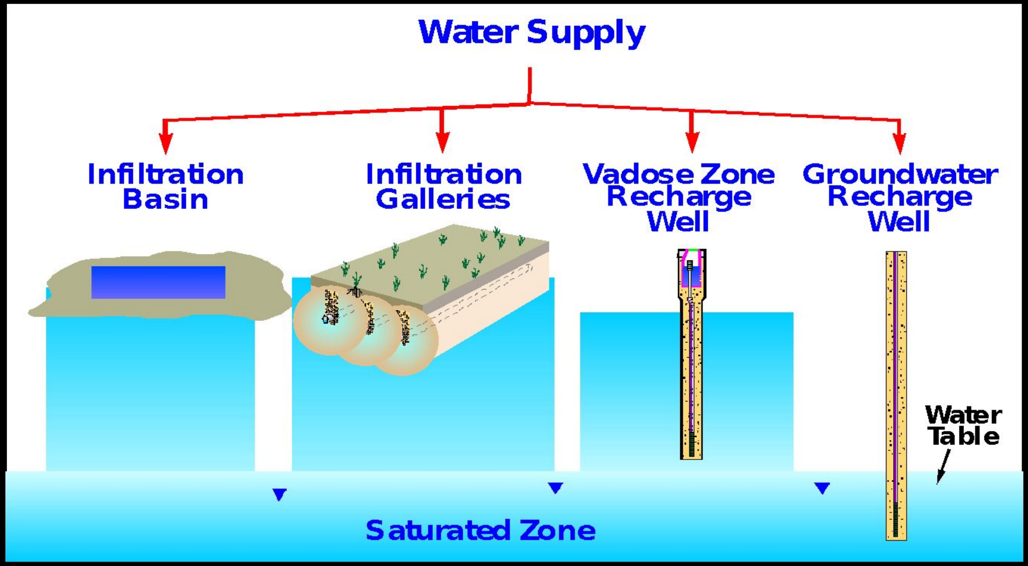
Many forms of MAR

MAR -- Not a silver bullet but depends on site specific conditions



Three Basic Pieces of MAR

- Water source
- Delivery mechanism
- Recovery mechanism



Regulatory Environment in SW

- Highly variable between and within States
- At least two regulatory agencies:
  - Water quality
  - Water rights
- Balancing act
  - Water supply and management
  - Environmental protection
- Drivers
  - Public perception, science, regs, past experience

Regulatory Environment by State

- Early adopters
  - Florida (ASR only)
  - California (Infiltration and ASR)
- Quick to catch on
  - Arizona
  - Colorado
  - Nevada
  - El Paso, some West Texas
- Warming up to the idea
  - New Mexico
  - Texas

MAR in other States

- Florida
  - Early implementation of MAR
  - Primarily ASR dual-purpose wells
- California
  - More than 65 water agencies in the state operate groundwater recharge programs and MAR is an integral component of the State Water Plan
  - Flood MAR Program

MAR in other States

- Arizona
  - 1980s: Demonstration projects in Tucson, Scottsdale, and Phoenix
  - As of March 30, 2017, the Department of Water Resources reports 189 long-term storage accounts in the state
  - 28 of the accounts have total recoverable balances of   > 100,000 acre-feet
  - Maximum total recoverable balance ~ 1,700,000 acre-feet (AWBA Main, Phoenix AMA)

MAR in other States

- Colorado
  - In 2004, there were more than 150 active aquifer storage and recovery projects in the state
- New Mexico
  - Recent evolution of regs, permitting, projects
- Texas
  - Early application, mid 1950s in West Texas
  - Current interest in (primarily) ASR

Traditional MAR Methods

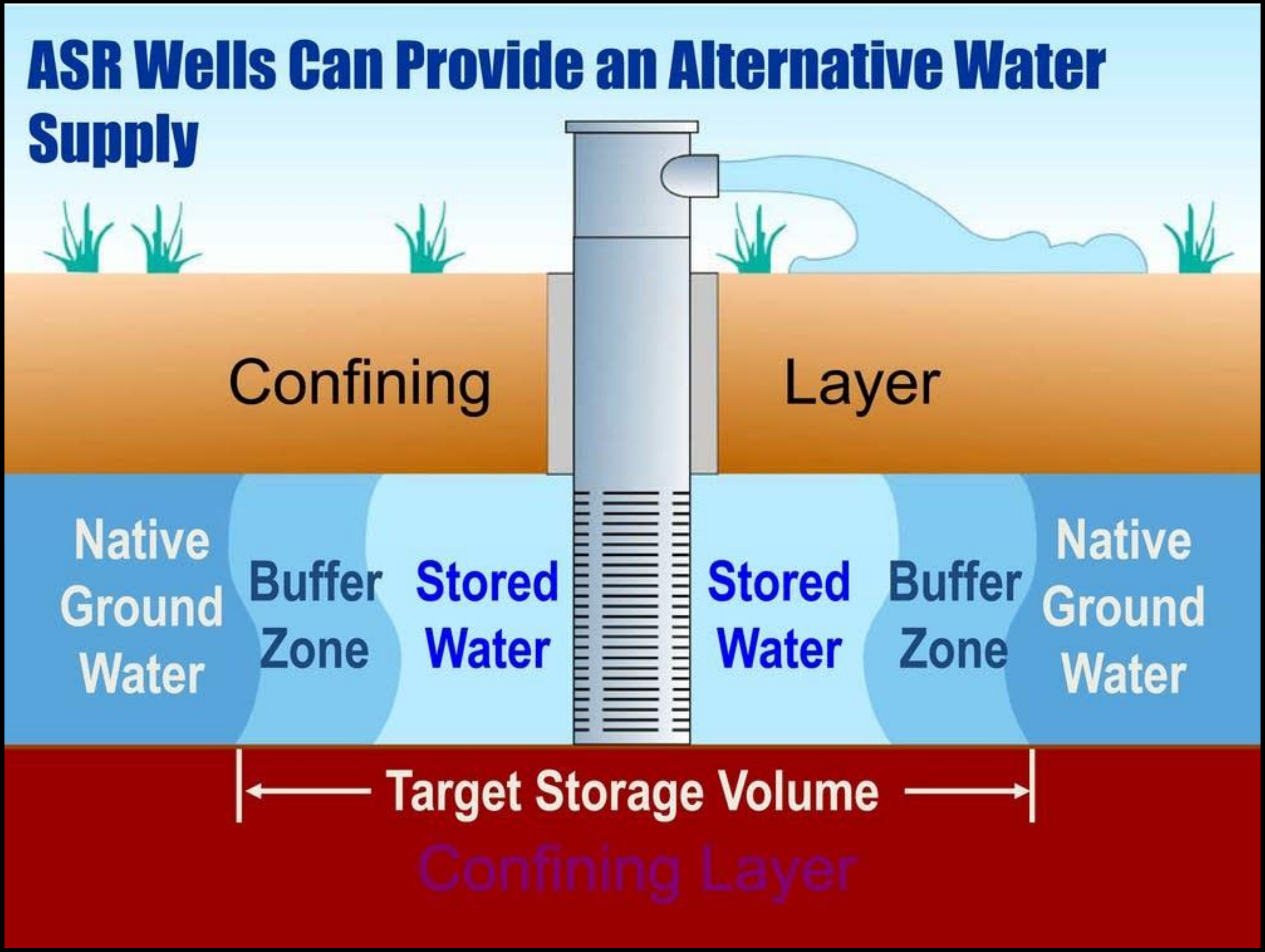
What You Can Expect

Recharge Technology	Capacity Range
Recharge basins	0.2 - 10 feet per day
Vadose zone wells	200 - 600 gpm
ASR wells	200 - 2,000 gpm

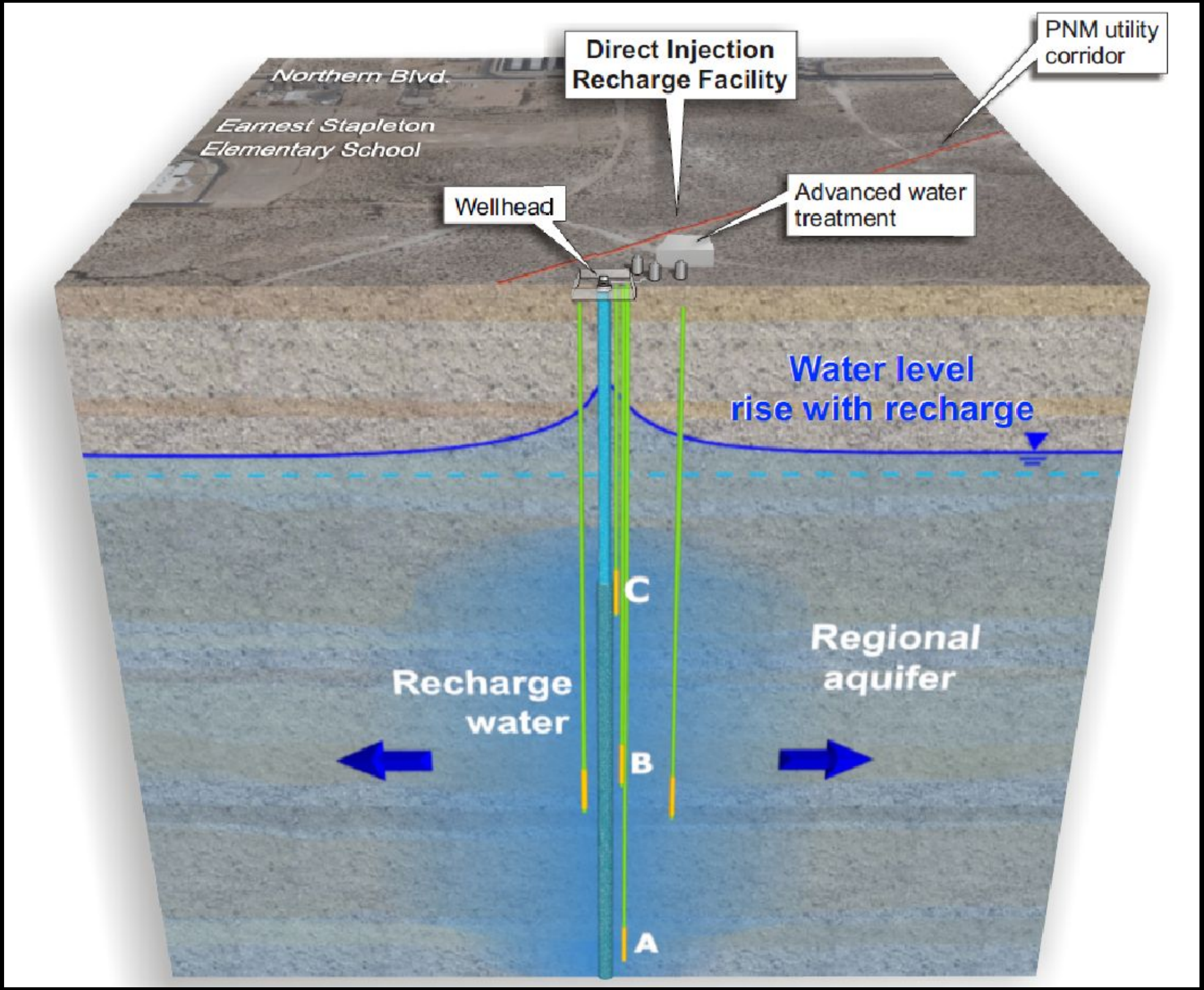
Aquifer Storage and Recovery

ASR Wells

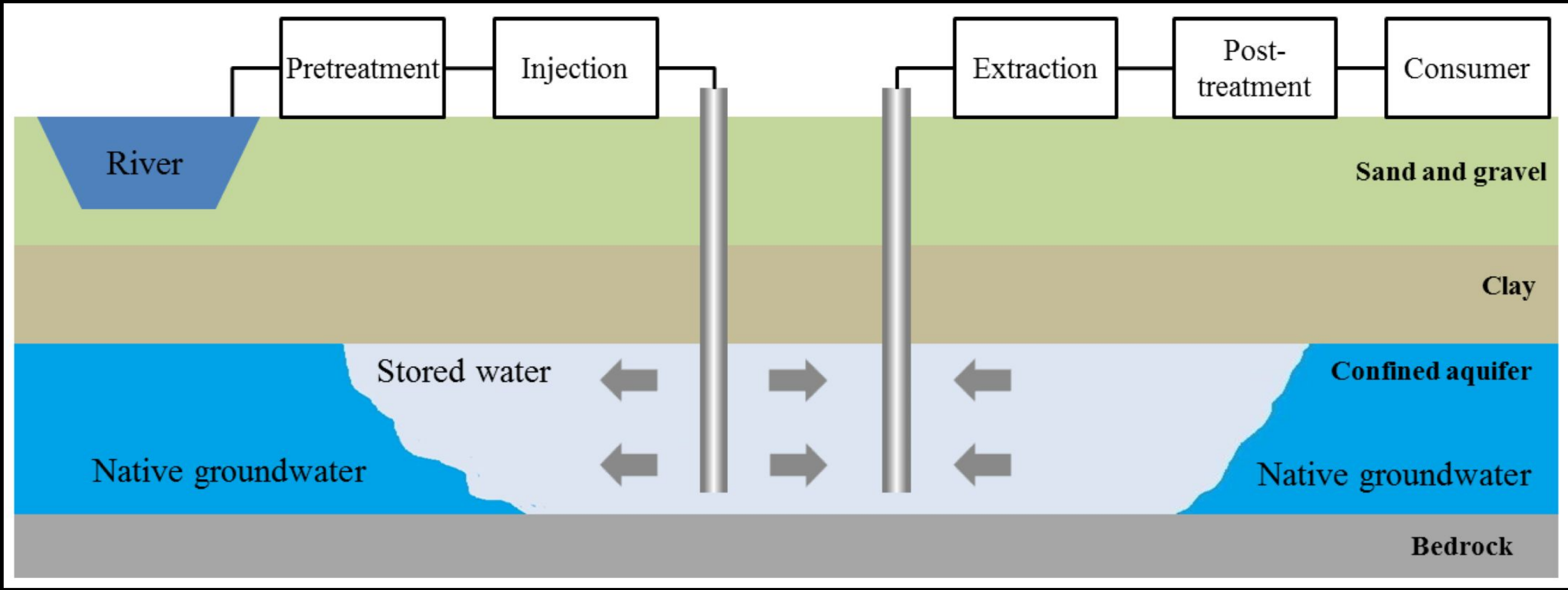
- Dual purpose wells for injection/extraction
- Excellent source water quality
- Low space
- High energy
- Short term/seasonal storage cycle
- Non-potable aquifer for storage
- Well confined aquifer to maintain bubble
- Optimization of injection and recovery efficiency



Rio Rancho ASR



Aquifer Storage, Transfer, Recovery (ASTR)



- Separate injection and recovery wells
- Excellent source water quality
- Low space, high energy
- Long term storage is possible
- Target aquifer is potable
- Optimization of injection and recovery efficiency

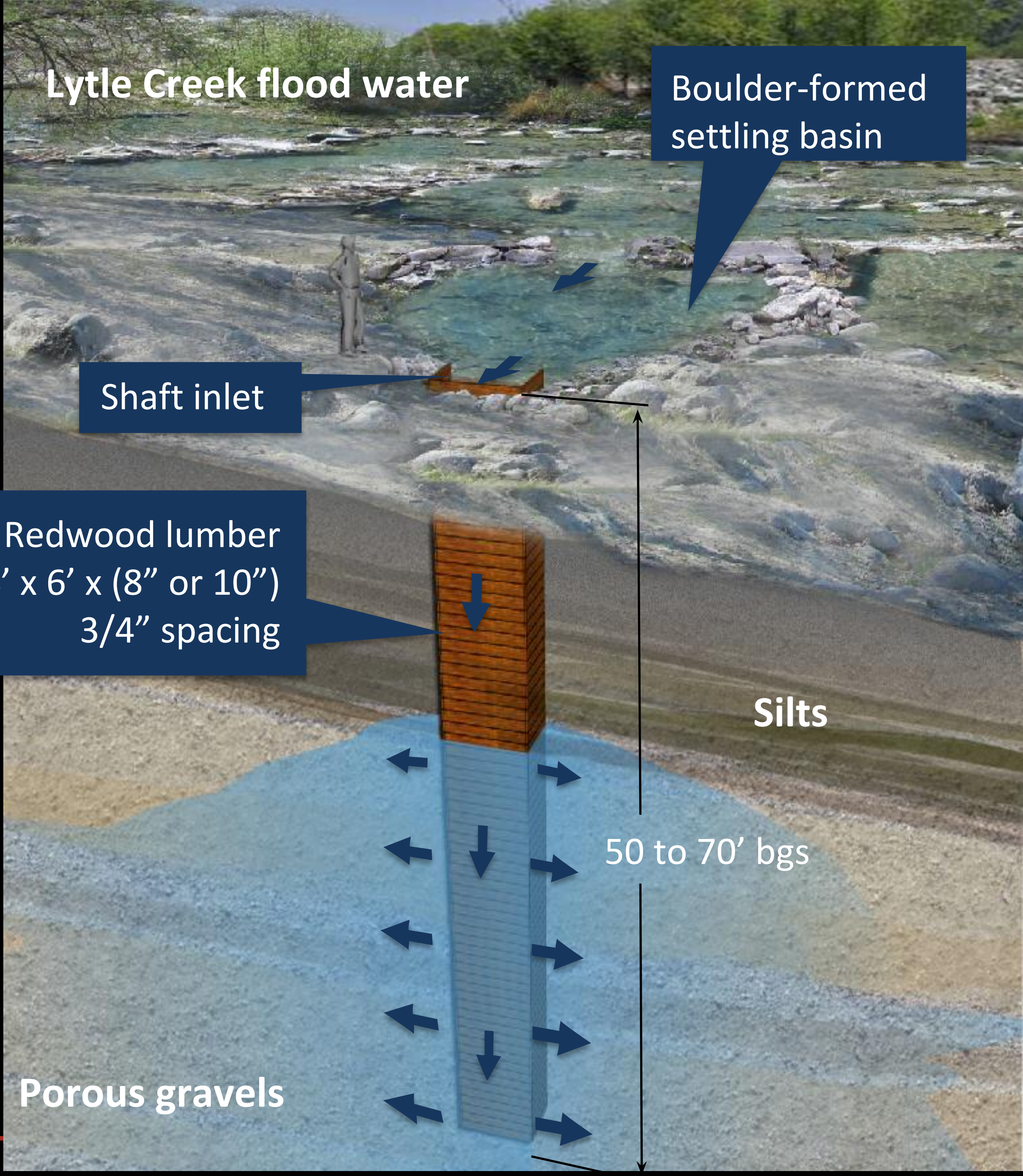
ASTR is more flexible than ASR

Vadose Zone Wells and Trenches

- Shallow subsurface
- Variable source water quality
- Soil Aquifer Treatment (SAT)
- Short term or long term storage
- 5-10 year life span

“Shaft” Method of Groundwater Recharge (1912)

- Recharge rate = 1-2 ft^3/sec

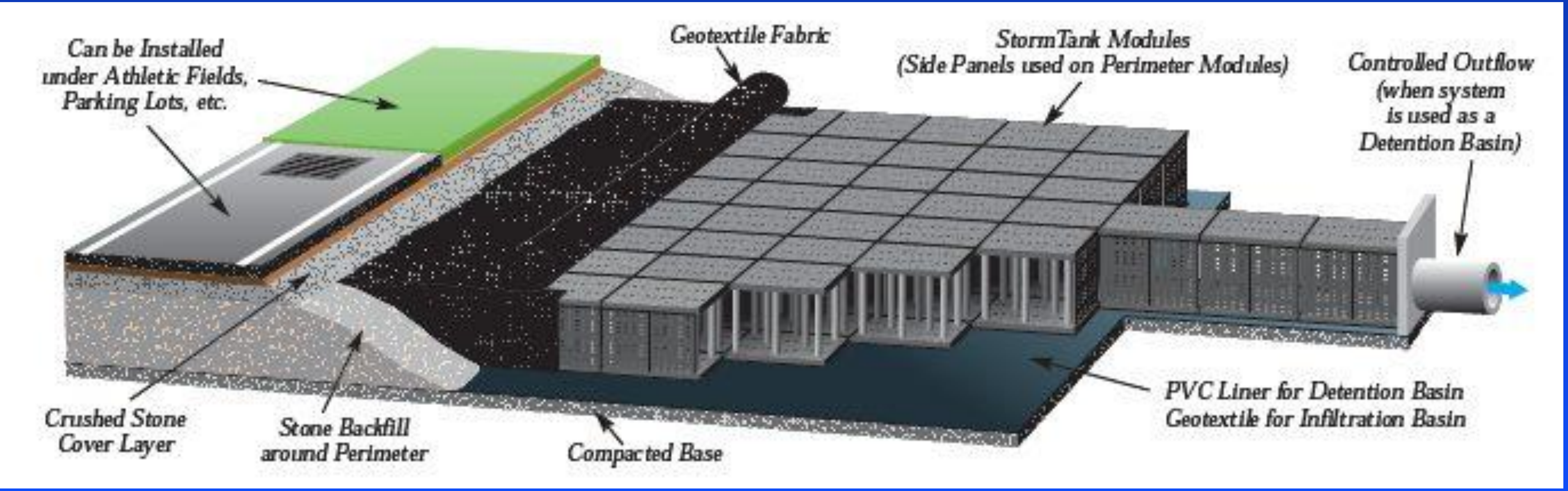


Source: William Richardson, Conservation Commission of the State of California, 1912

Mariposa WRF - Surface Infiltration Gallery Construction

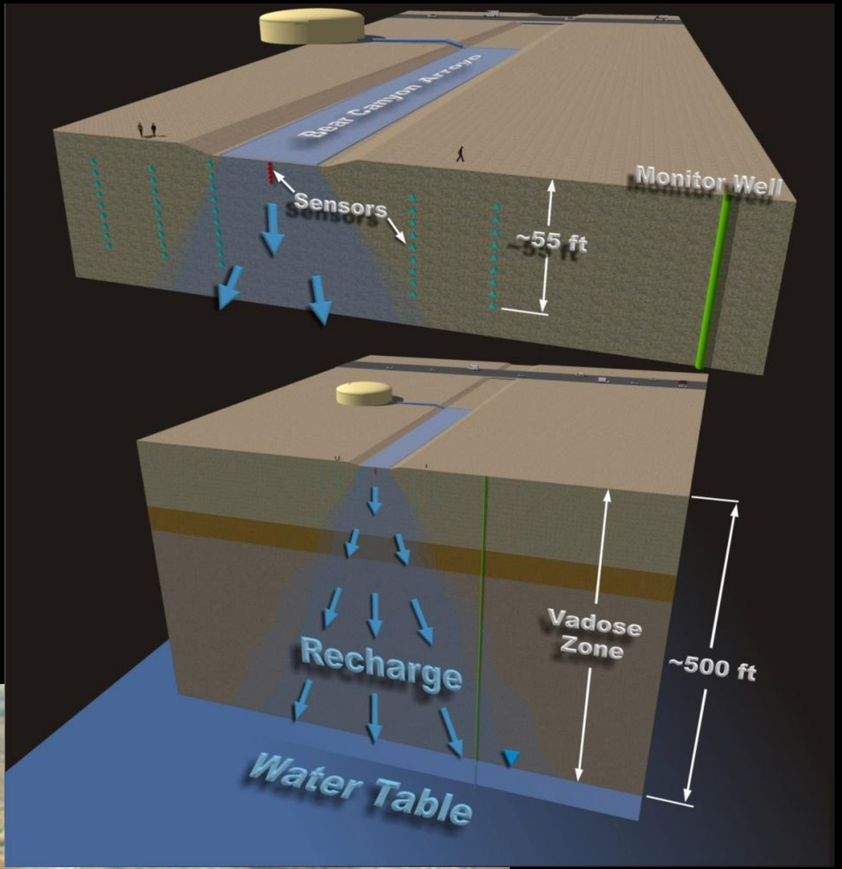
- A single 10-inch distribution manifold feeds system
- Polyethylene chambers installed within 37 rows
- 2-acre footprint

Underground Infiltration Basins



Surface Recharge

- Suitable soils
- Variable source water quality
- Soil Aquifer Treatment (SAT)
- Short term or long term storage
- Longer life span
- Large surface area
- Lower energy requirements

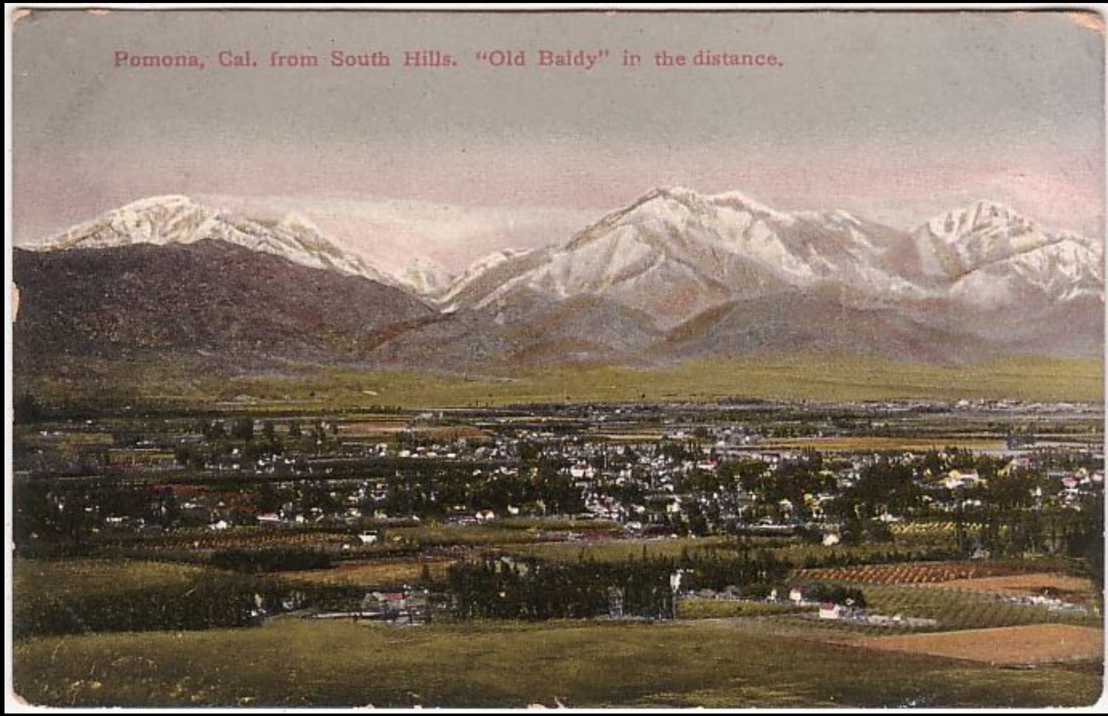


The Early Years

- 1896: Small scale *spreading* from Santiago Creek
- Irvine Ranch Company
- Perhaps the first for intentional storage
- OCWD still has one nearby

The Early Years

- 1901: Small scale *spreading* on debris cone of San Antonio Creek near Claremont
- Water companies in Pomona, CA
- 1915: Pomona Valley Protective Association constructed weir at mouth of canyon to divert water to spreading grounds



Montebellow Forebay Spreading Grounds - 1930s

Central AZ Project

-AZ: 2.8 MAFY

-Tucson: 0.135 MAFY

-1995 vote prevents direct use

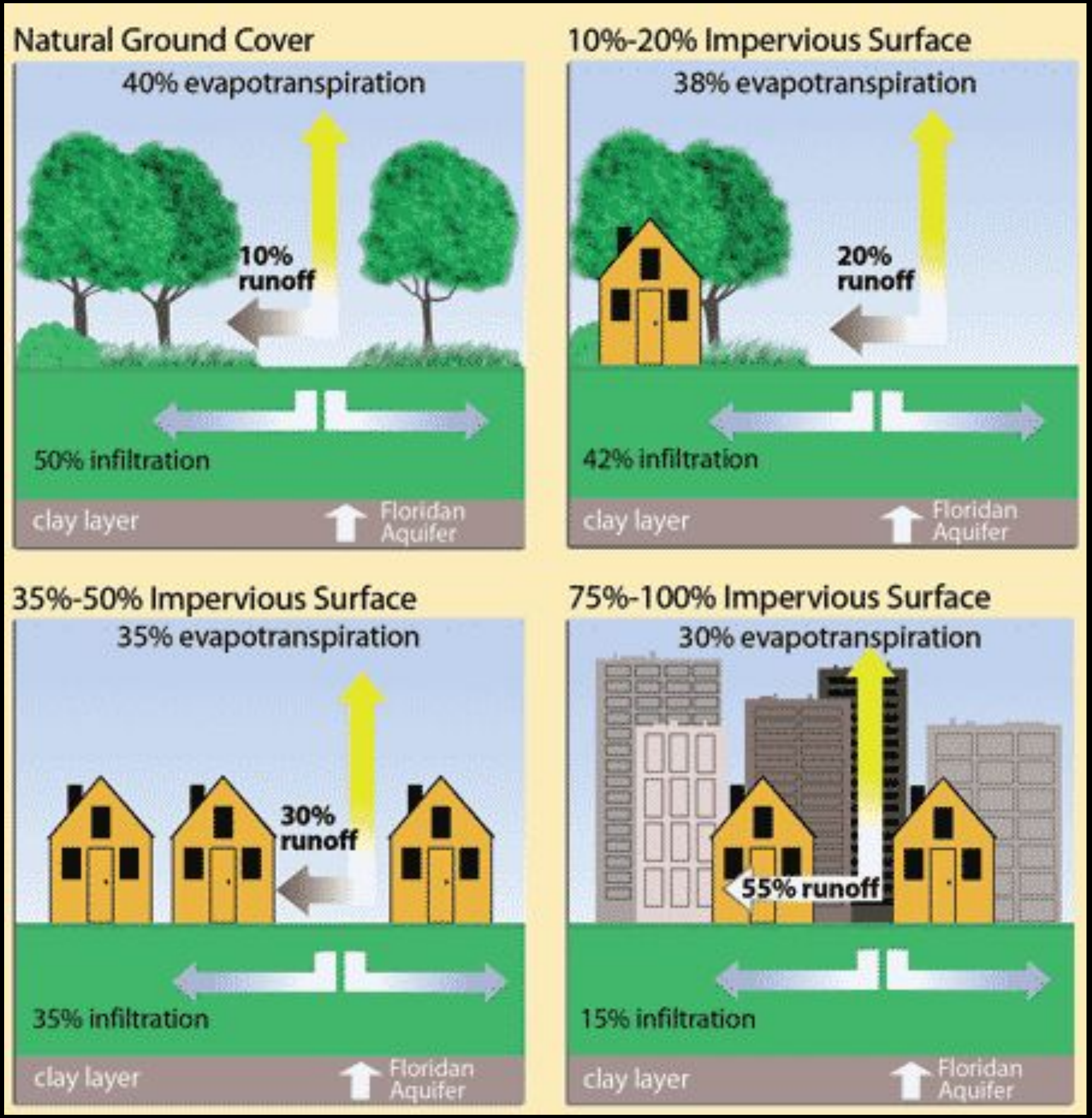
-CAVSRP started 2001

- 60,000 AFY
- 300 AC Basins
- 27 Recovery Wells
- Native Water Blend
- Treated

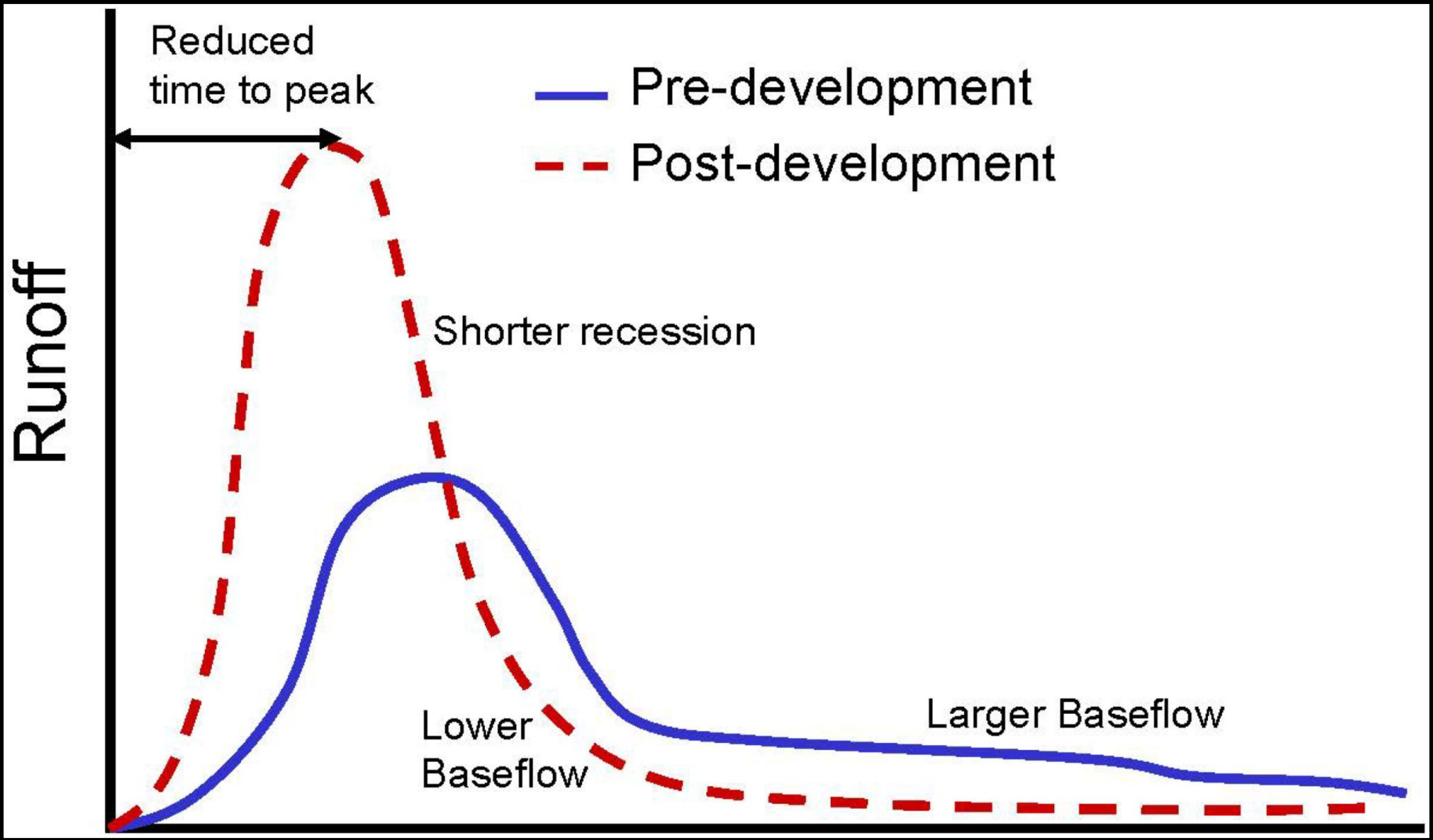
Source: www.ci.tucson.az.us/water/docs/waterplan, pg 4-8.

MAR for Rainwater Harvesting, Capturing Flood Flow, Supporting Baseflow

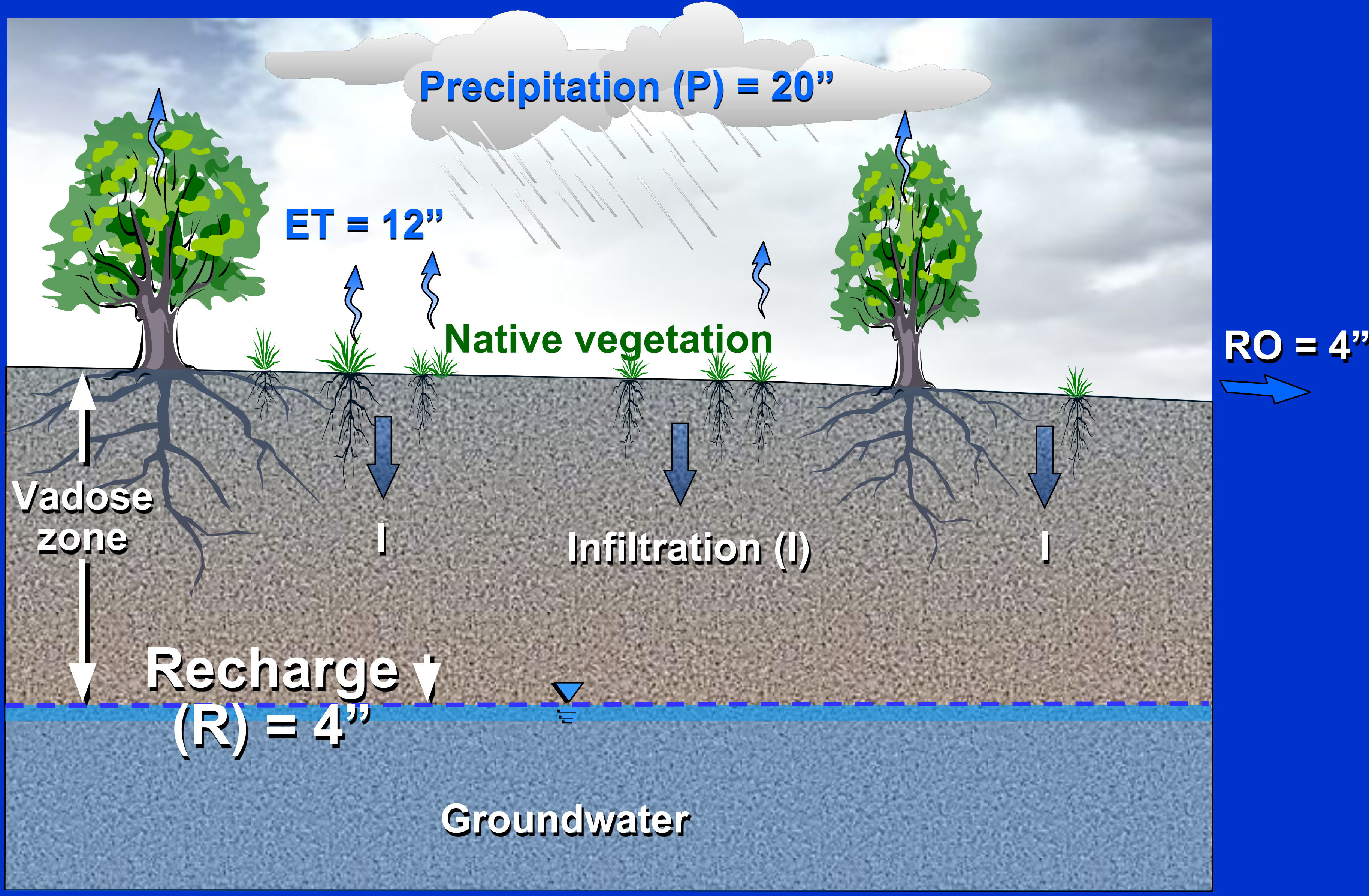
Urbanization:
Increases RO
Decreases ET
Decreases R



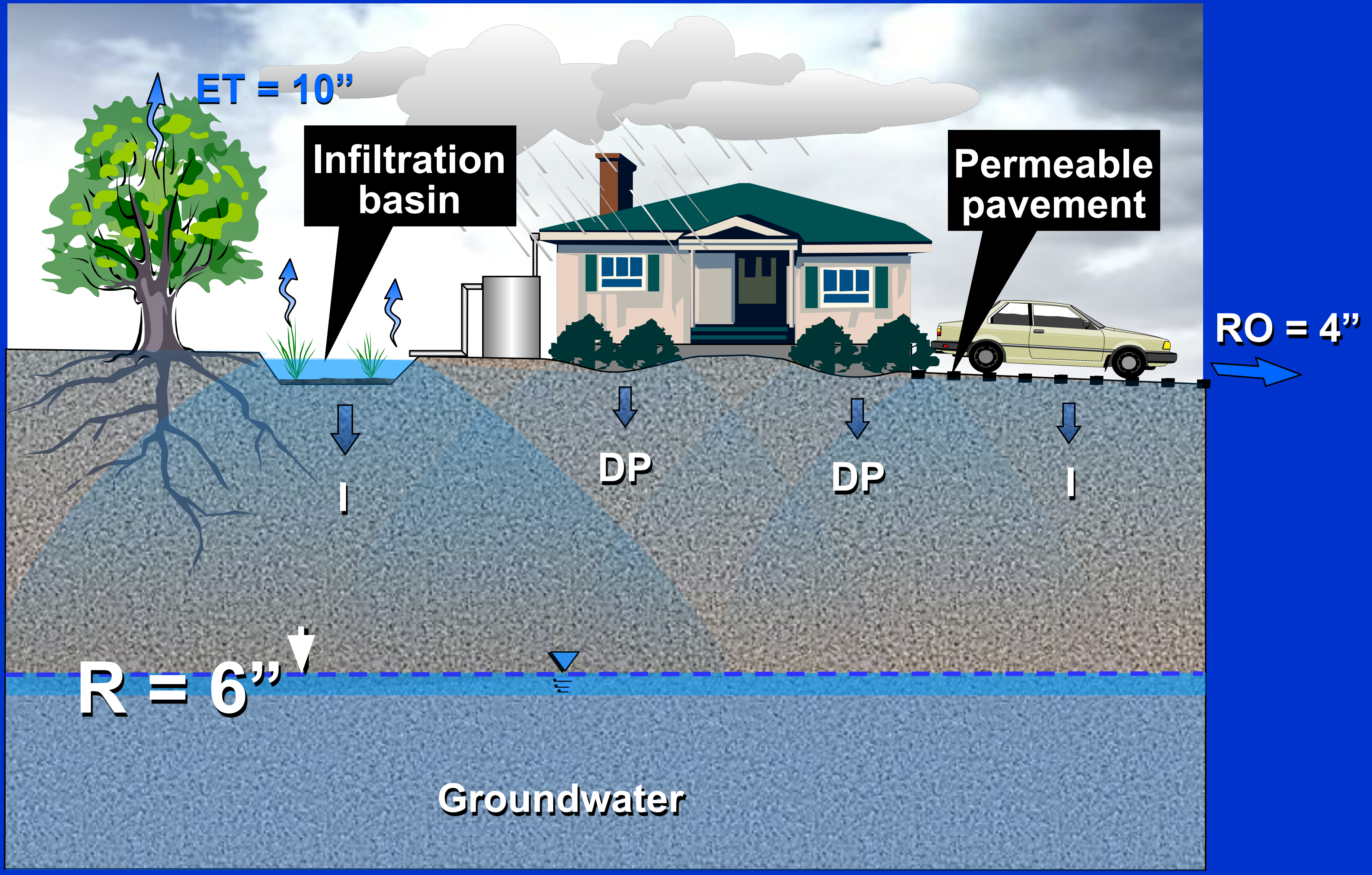
Rainfall-Runoff Response



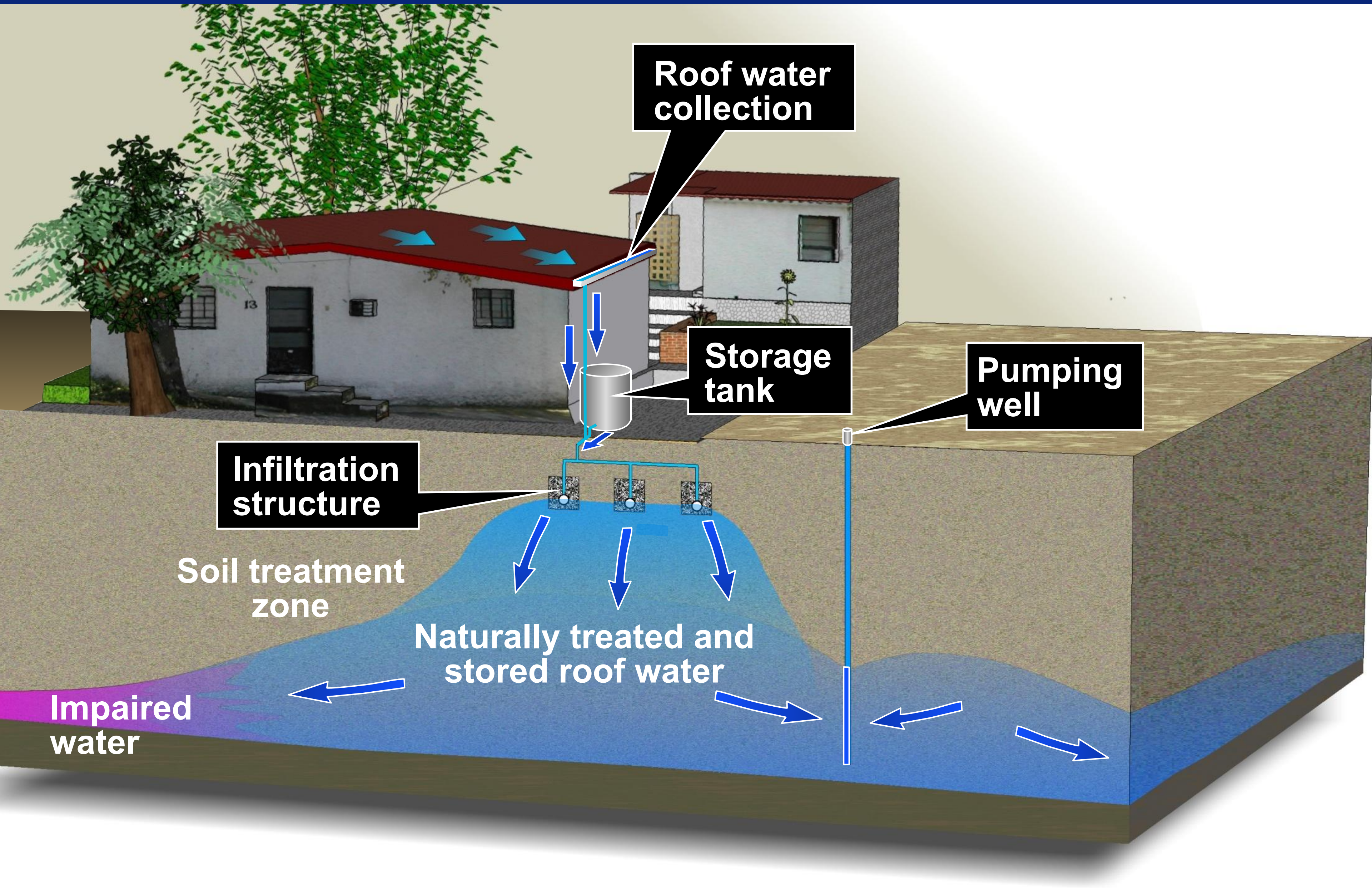
Capture Evapotranspiration (ET) and Restore Runoff (RO) for Improved Sustainability: Baseline Condition



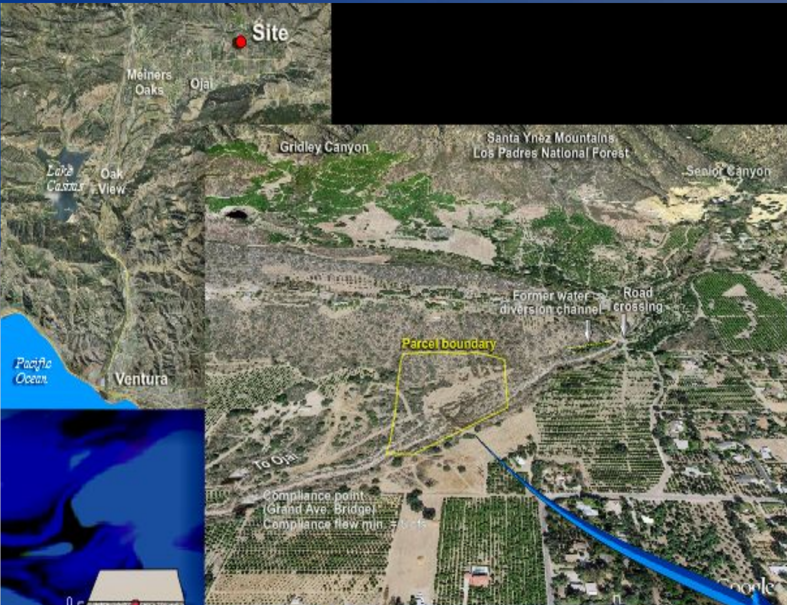
Choose Infiltration-Based LID Methods (not ET-Based)



Harvest Roof Water, Recharge the Excess

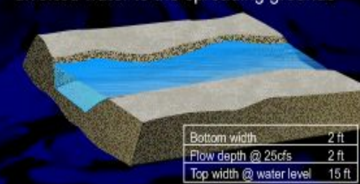


San Antonio Creek Spreading Grounds Rehabilitation Project

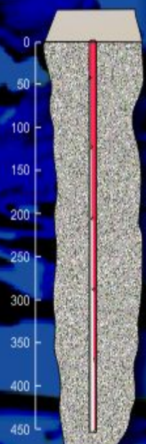


1 Diversion structure:
A notched abutment along the west bank of San Antonio Creek to allow 11 cfs to remain in stream and capture up to 25 cfs of run-off

2 Intake channel:
An open channel for transmittal of the diverted water to the spreading grounds



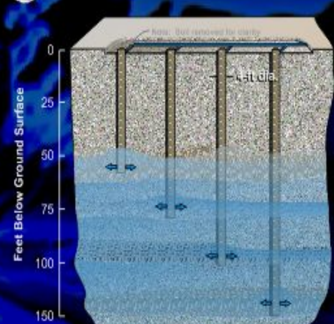
3 Spreading grounds rehabilitation:
Vegetation removal, fine sediment removal, minor reworking of embankments

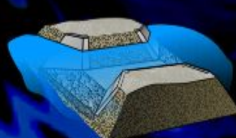


7 Depth Discrete Monitoring Well:
Consists of a nested series of six 2-inch-diameter PVC casings discretely screened and sealed at intervals between 40 and 450 feet below ground surface.

Recharge wells: 6
Four, large -diameter recharge wells with steel casings to facilitate transmittal of water to target aquifers at depths estimated to be between 60 and 150 feet deep.

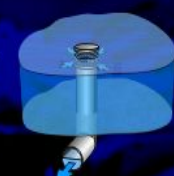
Depth of each well will depend on logs and results of depth discrete monitor well installation.





4 Pond transfer channel design:
Channel water from pond to pond while minimizing erosion and turbulence

5 End pond pipeline:
A stand pipe in the last pond to transfer water by gravity to recharge wells



Daniel B. Stephens & Associates, Inc.
1-800-933-3105
www.dbstephens.com

County of Ventura
California

The Nature Conservancy
Protecting nature. Preserving life.™

Cochise County Recharge Network

ASCE Guidelines for MAR

New ASCE Guidelines Coming Soon

American Society of Civil Engineers (ASCE) Committee on Managed Aquifer Recharge

- Revising old Standards
- Publishing new Guidelines
- Out for public comment soon

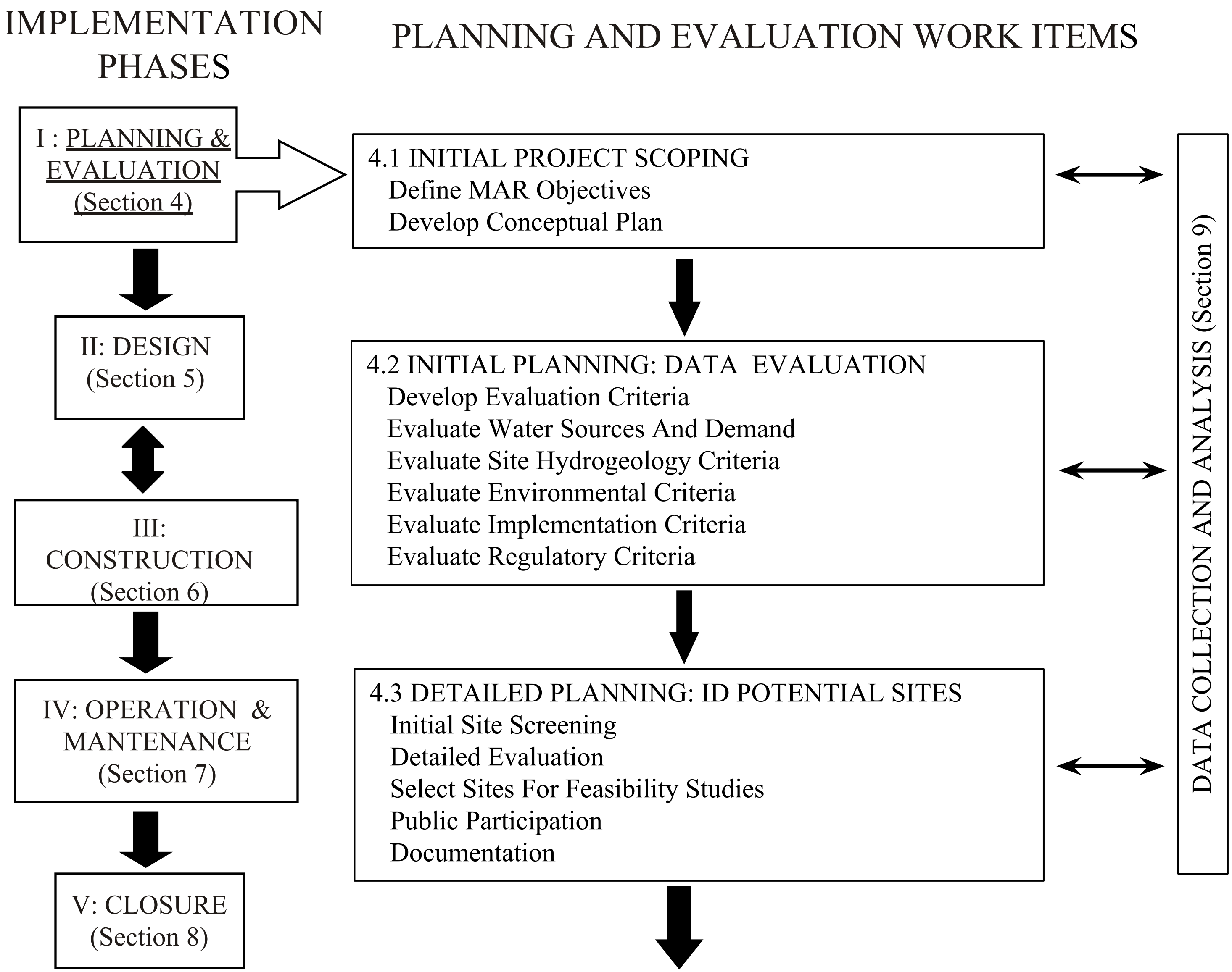


FIGURE 4.1. Details of the Planning & Evaluation Phase Leading to Design, Construction, and Operation of a MAR Project. Numbers refer to sections in the text.

Thank you!

Texas Groundwater Summit

Stephanie J. Moore, P.G.
August 29, 2018

Daniel B. Stephens & Associates, Inc.