ASSESSING THE USE OF DRY WELLS AS AN INTEGRATED LID TOOL FOR REDUCING STORMWATER RUNOFF WHILE PROTECTING GROUNDWATER QUALITY IN URBAN WATERSHEDS

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[3] Ludhorff & Scalmanini: groundwater hydrology
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Dry Wells

- Gravity fed excavated pits lined with perforated casing filled with gravel
- Deeper than wide
- Used in conjunction with LID systems to improve rate of stormwater infiltration and groundwater recharge

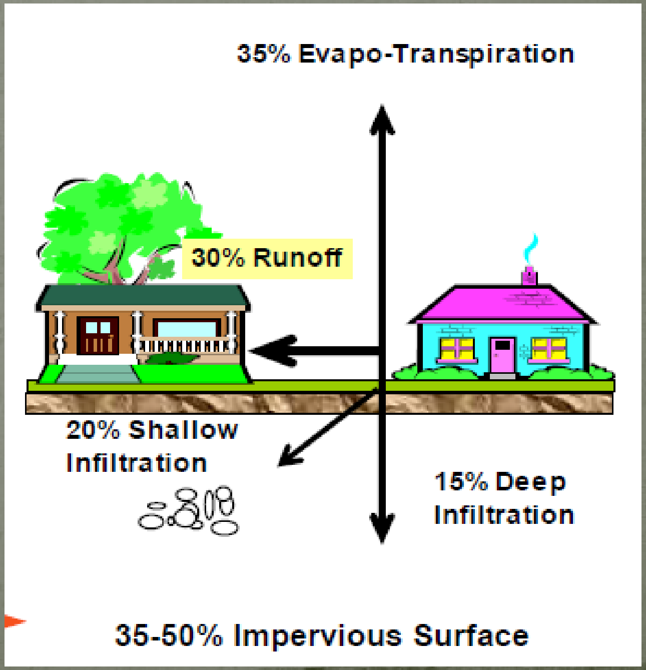
http://www.howardsexcavating.com/images/DryWellSystems02.jpg

Outline

- Goals of the Project
- What we have learned about dry wells from others
  - Portland – Underground Injection Control System Program
  - Modesto – USGS
  - Los Angeles – Water Augmentation Study
- Elk Grove Study

Goals of the Project

1. Assess safety of using dry wells to infiltrate stormwater run off
   - LID requirement of NPDES permit
   - Supports natural hydrologic regime
   - Reduce damage to aquatic ecosystem
2. Assess groundwater recharge capacity of dry wells
   - 30+ % of rain lost to runoff
   - Treat runoff as a resource



Goals of the Project

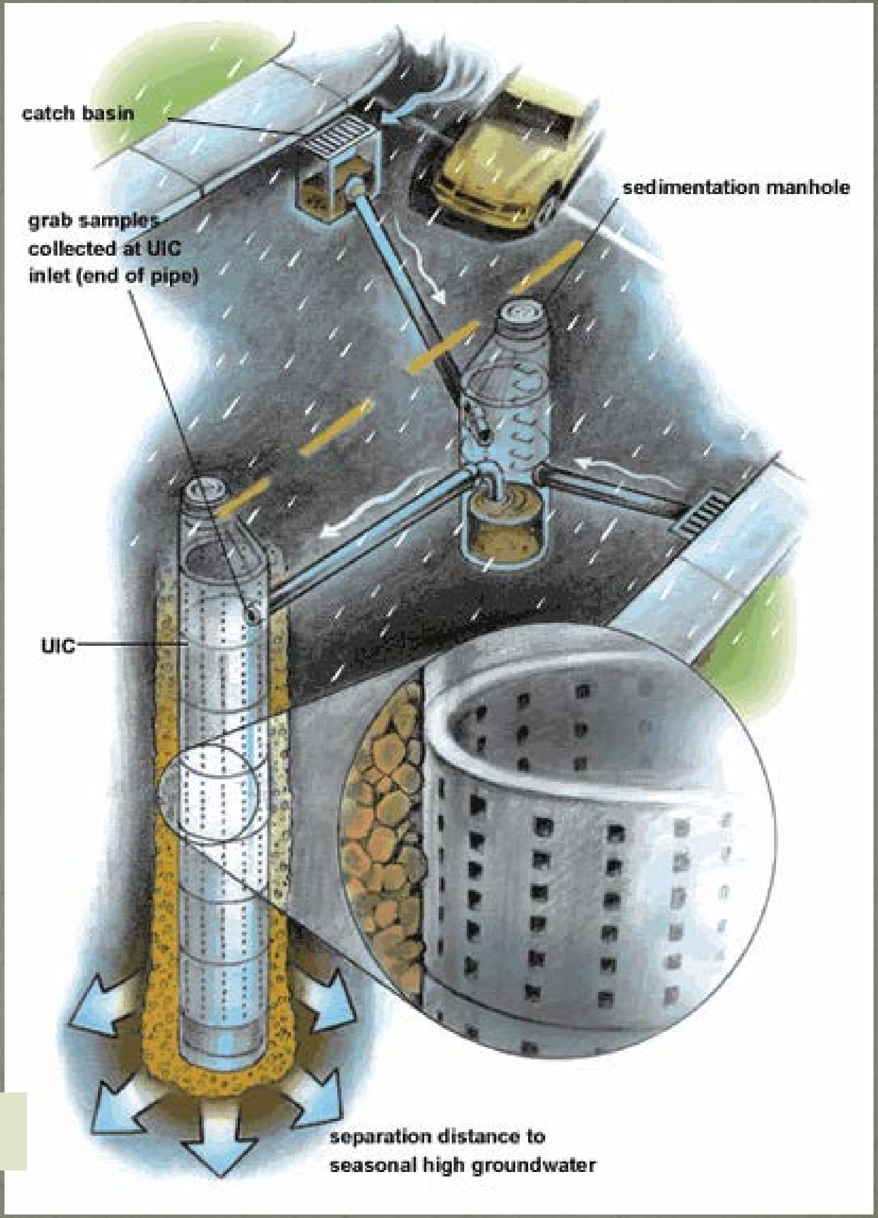
3. Investigate use of dry wells as climate change adaptation
   - "I can state unequivocally that past and future climate change is making subsurface storage and recovery in the Central Valley critically important…
   - I predict that 10 years from now dry wells in urban areas of the Central Valley could become a major mechanism for recharging groundwater…"
   - Graham Fogg, Professor, UC Davis Land Air and Water Resources, Letter of Support, 2012

Dry Well Use in Other Places

- Thirteen states have dry well regulations
- One of the most developed programs is in Portland, OR
  - 20,000 UICS in City – in some place, only SW management practice
  - Principle underlying their program: If contaminants in SW are below the MCL levels, do not need to worry about GW contamination
  - Extensive SW monitoring program
  - Modeling of fate and transport of most common contaminants in the vadose zone

Typical UICS in Portland

- Catch basin
- Sedimentation manhole
- Dry well

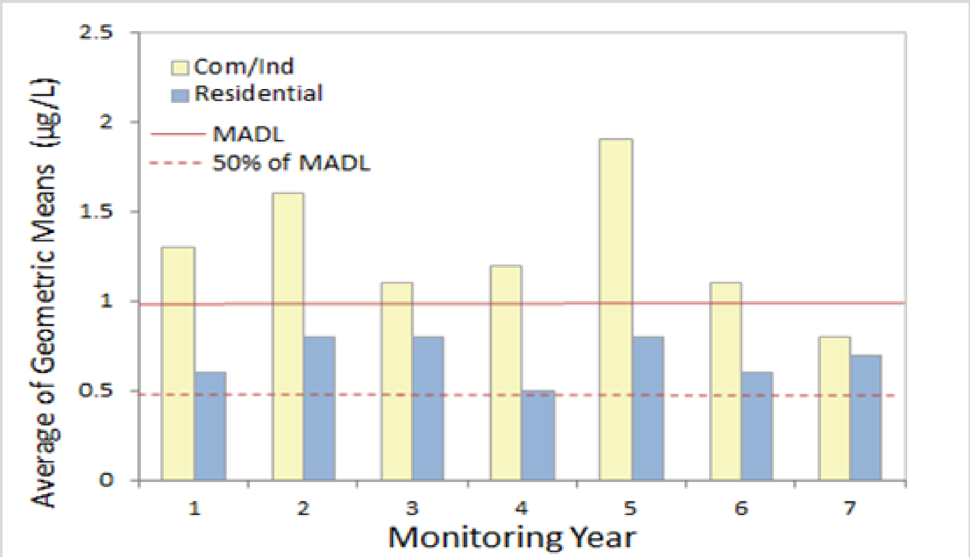


http://www.portlandoregon.gov/bes/48213

Monitoring Program in Portland

- Designed by Oregon State scientist/statisticians
- Multi-million dollar effort over 7 years
- Stormwater only, little/no groundwater
- Contaminants evaluated
  - Metals
  - Volatile organics and semi-volatiles
  - PAHs
  - Pesticides and herbicides
- Key benchmark: maximum allowable discharge level - the MCL

- Common bad actors
  - DEHP
  - B[a]P
  - **PCP**
- Pentachlorophenol – pesticide, preservative on utility poles
- Fate and transport modeling: Soil binds PCP, limiting migration to < 4 feet



Conc.(ug/L)	1	2	3	4	5	6	7
Com/Ind Min-Max	0.16-5.48	0.40-4.7	0.28-3.64	0.42-4.4	0.15-6.3	0.03-5.23	0.02-2.4
Residential Min-Max	0.02-5.5	0.10-4.31	0.02-2.25	0.04-6.29	0.09-4.2	0.02-3.25	0.09-5.8

Average geometric mean (min/max) PCP; Sample size = 30

Lessons from Portland

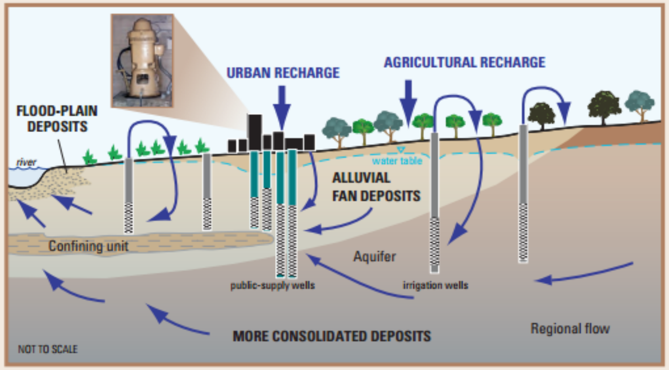
- Stormwater from streets might not be as contaminated as typically assumed
- Settling of solids important
- Appears to be a successful program
- Caveat:
  - CA geology: Contains many toxic metals (As, Cr) which could be mobilized by high specific conductivity, alkalinity of SW
  - Need to investigate this potential by-product of using a dry well system

Impacts of Dry Wells on Drinking Water Quality in Modesto

USGS
science for a changing world

National Water-Quality Assessment Program
Transport of Anthropogenic and Natural
Contaminants (TANC) to Public-Supply Wells

Hydrogeology, Water Chemistry, and Factors Affecting the Transport of Contaminants in the Zone of Contribution of a Public-Supply Well in Modesto, Eastern San Joaquin Valley, California

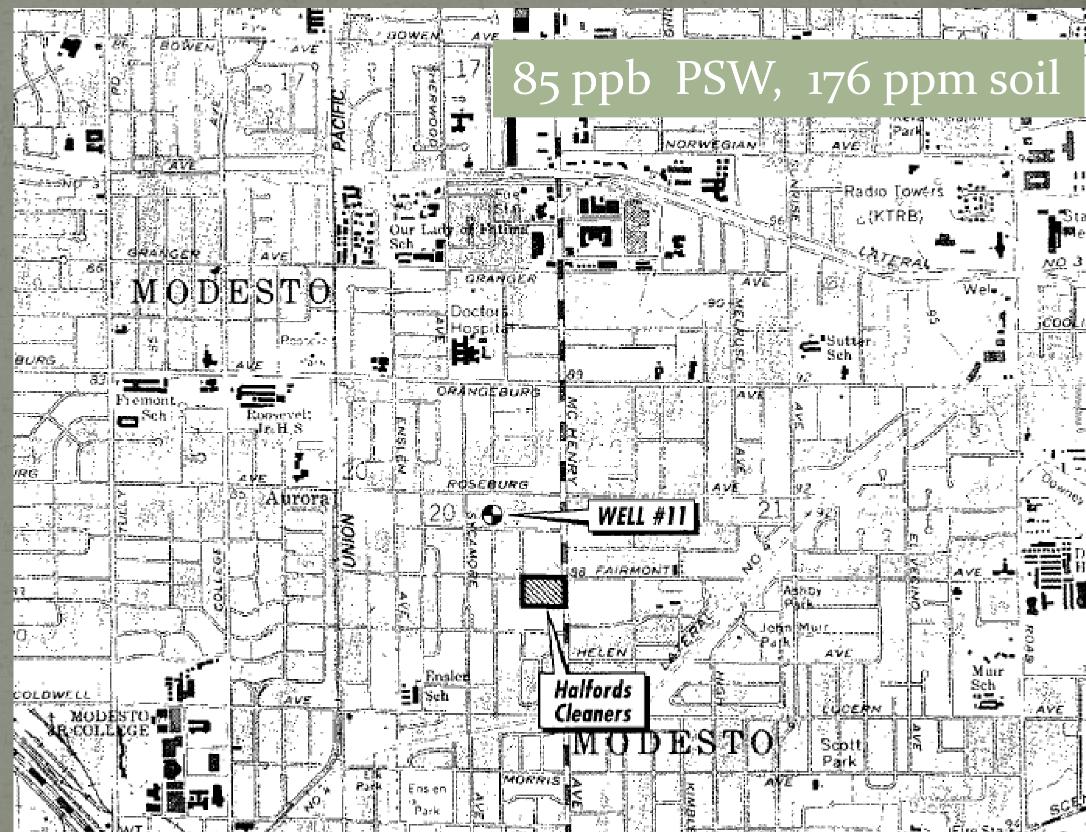


Scientific Investigations Report 2008–5156

U.S. Department of the Interior
U.S. Geological Survey

Background on Modesto Perc Spill

- Over 11,000 dry wells since the 1950s
- 1985 - PCE spill at Halford's Cleaners contaminated groundwater detected
  - Associated with defective dry cleaning machines
  - PCE entered leaking sewer line
- Public supply well 11 contaminated



Background on Modesto

- Superfund site late 1990s
- Clean up and monitoring…… 2000+
- Some made the linkage: dry wells = groundwater contamination?
    - US EPA reports: conduit for PCE - sanitary sewer lines, not dry wells

USGS Study

- Study goal
  - Determine whether and how contaminants might enter drinking water supply wells
- Relevance of study for our purposes
  - Given long history of dry well use – assess **long term** potential risks to groundwater quality

USGS Study Design

- Analyzed water quality from 1 drinking water well
- Series of monitoring wells at various depths
  - Water table – up to 38 ft.
  - Shallow zone – 115 ft.
  - Intermediate zone – 200 ft.
  - Deep zone – 300 + ft.
- Monitoring wells along a gradient of agricultural and urban land uses as well as groundwater gradient

USGS Water Chemistry Analysis

- Conventional water parameters
  - pH, dissolved oxygen, major ions, water age
- Gasoline related compounds (BTEX)
  - Benzene, toluene, ethylbenzene, xylenes
- Pesticides
  - About a dozen pesticides including chlorinated forms, simazine and atrazine
- Volatile organic compounds
  - Chloroform, PCE, TCE, ethyl benzene, xylene, etc.
- Refrigerants

USGS: Brief Summary of Results

- Younger water (shallow depths) more susceptible to contamination
  - Mainly agriculture influences, e.g. nitrate
  - Uranium and arsenic contamination
  - Some evidence of typical urban contaminants, but below MCLs
- Older water (deeper zones)
  - No anthropogenic contaminants

Main Message from USGS Study

- No contaminants associated with urban runoff near the MCL in public supply well water
  - Some urban contaminants present in shallow aquifer
  - Possible mobilization of naturally occurring toxic metals

Los Angeles Water Augmentation Study

Background on LA Study

- Ten year study by Council on Watershed Health and partners
  - City of Los Angeles Department of Water and Power
  - Metropolitan Water District of Southern California
  - United States Bureau of Reclamation
- Overall goal
  - Assesses feasibility of the capture and infiltration of stormwater to augment local water supply (reduce dependency in imported water)
  - Assess effects of infiltrating stormwater on groundwater quality

Office Building

- Roof runoff drained to dry well
- 31 ft. depth to water table
- Poorly infiltrating soils
- Groundwater and vadose zone monitoring wells

Private Residence

- Driveway sheet flow to dry well
- 200 ft. depth to water table
- Slow-moderate infiltrating soils
- Vadose zone monitoring

LA Study: Monitoring Program

- Stormwater samples taken during storm events for 5+ years
- Post-storm samples taken 2 – 10 days after event
- Analytes
  - General physical and chemical
  - Metals
  - Oil, grease, and vehicle-related contaminants
  - Volatile and semi-volatile organic compounds
  - Bacteria

Summary of Monitoring Results
Los Angeles Study

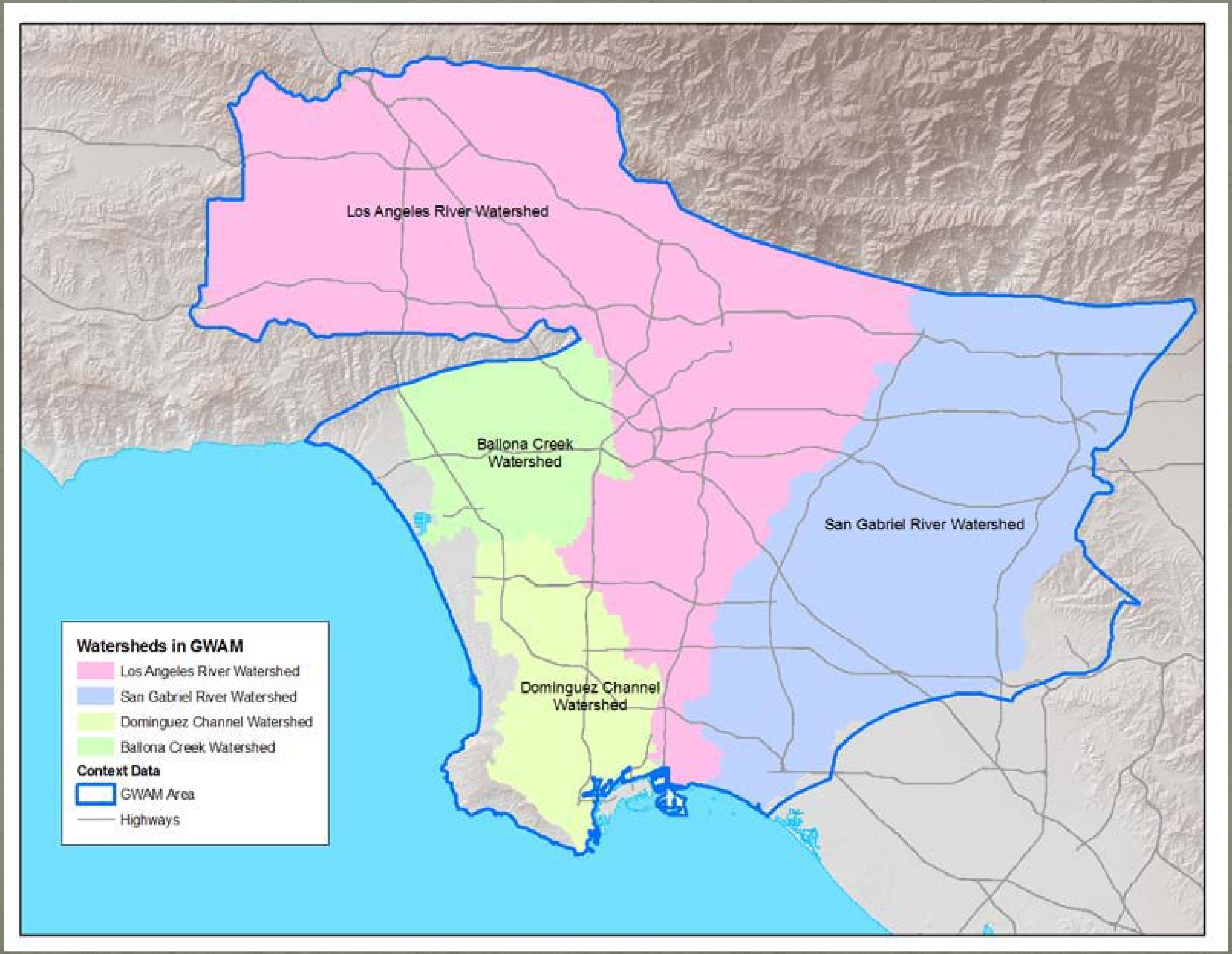
- Contaminants detected at high levels in groundwater were at low levels in SW
- Contaminants at high levels in stormwater were at low levels in GW

- Little evidence for a groundwater contamination

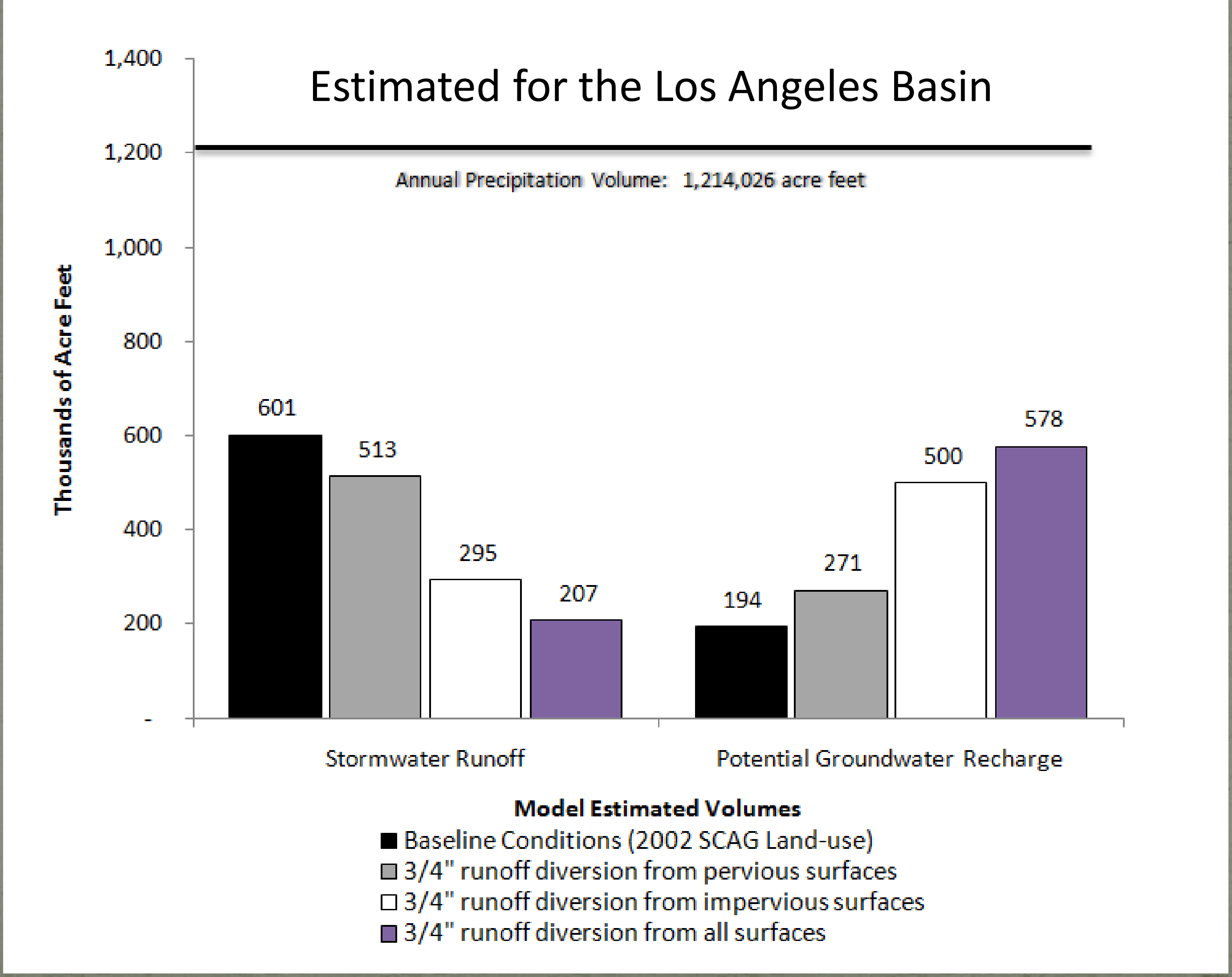
LA Study - Groundwater Augmentation Model

- Worked with Bureau of Reclamation to develop model to:
  - Estimate the maximum amount of recharge that might occur in area of study
  - Currently ~600,000 acre/ft. becomes runoff
  - Key finding: if 1st ¾” rain of every storm on all property captured, about 47% of precip could be infiltrated, or ~578,000 a/f; enough for ¾ million households

Area included in the GWAM

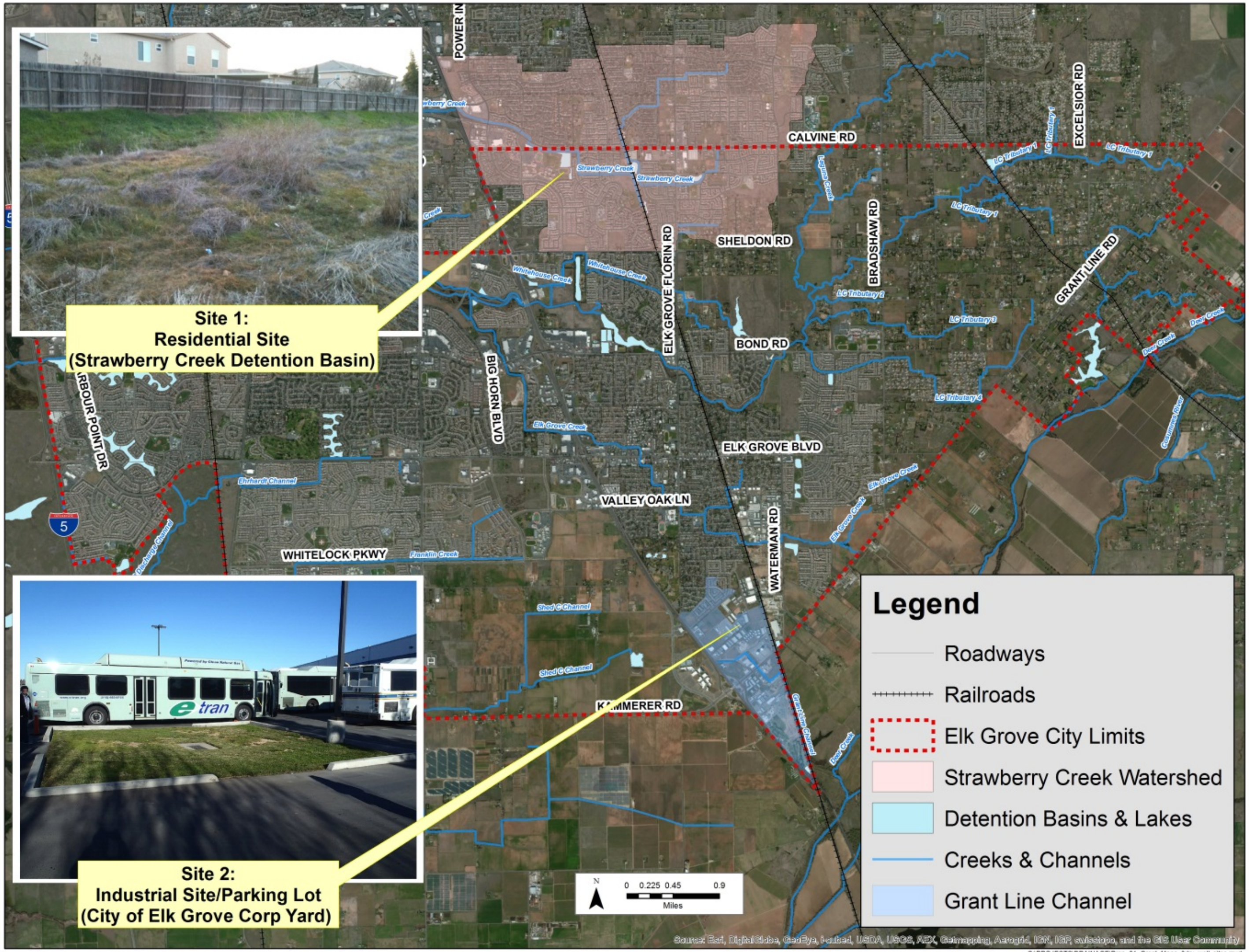


Groundwater Augmentation Model



Elk Grove Dry Well Project

Location

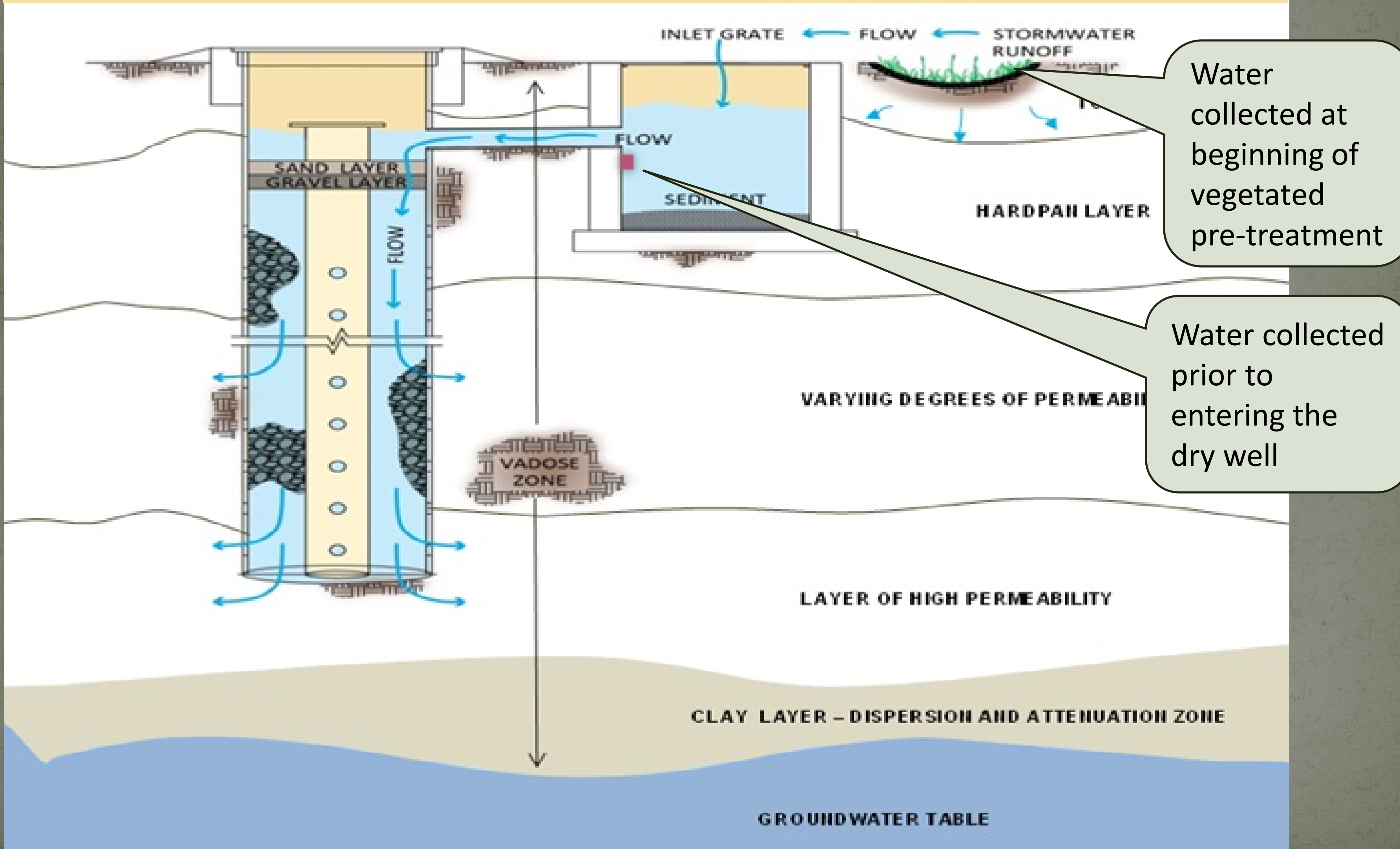


Site 1:
Residential Site
(Strawberry Creek Detention Basin)
Site 2:
Industrial Site/Parking Lot
(City of Elk Grove Corp Yard)
CALVINE RD
SHELDON RD
BOND RD
ELK GROVE BLVD
VALLEY OAK LN
WHITELOCK PKWY
KAMMERER RD
POWER INN
ELK GROVE FLORIN RD
BIG HORN BLVD
BRADSHAW RD
WATERMAN RD
EXCELSIOR RD
GRANT LINE RD
HARBOUR POINT DR
5
Legend
Roadways
Railroads
Elk Grove City Limits
Strawberry Creek Watershed
Detention Basins & Lakes
Creeks & Channels
Grant Line Channel
N
0 0.225 0.45 0.9
Miles

Vadose zone well: 55 ft. bgs; water table wells: 120 ft. bgs

Monitoring wells: Vadose Zone and Water Table

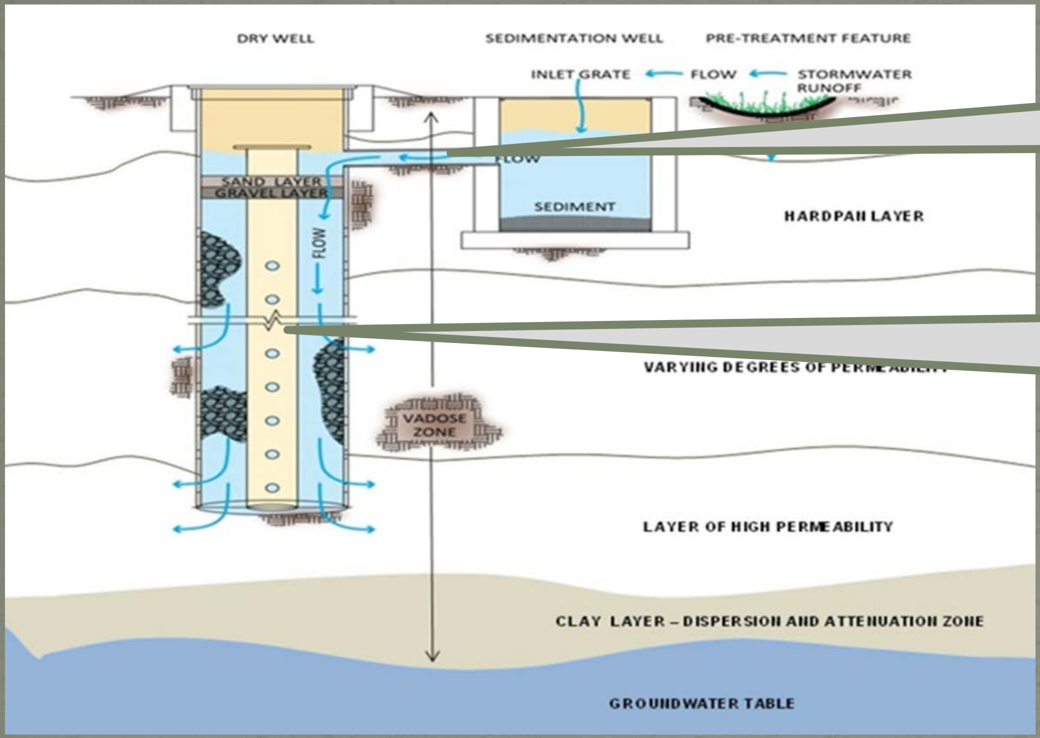
Dry Well | Structural Pre-treatment | Vegetated Pre-treatment



Water Quality Monitoring Plan

- Stormwater and groundwater samples collected for two years
  - Three wet weather stormwater samples
  - Three wet and one dry weather groundwater well samples
- Constituents to be tested
  - General physical & chemical
  - Metals (EPA 200)
  - Volatiles (EPA 8260)
  - Semi-volatiles (EPA 625)
  - Herbicides (EPA 515)
  - Pyrethroids (WPCL, DFW method)
  - TPH (EPA 8015)
  - Pyrogenic PAHs (EPA 8310)
  - Total coliform

Estimates of Recharge



Velocity sensor will permit monitoring of flow

Pressure transducer will provide info to verify initial estimate

Project Timeline

Task	2013				2014				2015				2016				2017	
Notice of Grant Award – Summer 2012																		
Project Commencement - March 1, 2013	☆																	
Task 1. Final Site Selection, Monitoring Study Design and Permitting																		
Task 2. Dry Well and Monitoring Well Installation																		
Task 3. Stormwater Quality Monitoring (3 events per wet season)								•	••			•	••					
Task 4. Groundwater Quality Monitoring (3 events per wet season; 1 event per dry season)						•		••	••		•	•	••					
Task 5. Data Analysis and Interpretation																		
Task 6. Education, Outreach and Organizational Capacity Building																		
6a. Prepare and publish two factsheets																X		
6b. Prepare and publish an literature review								X										
6c. Draft scientific paper																	X	
6d. Lessons Learned document																	X	
6e. Presentations at meetings/conferences																		
6f. Development and maintain a project website																		
Task 7. Project Assessment and Reporting																		
7a. Submit Quality Assurance Project Plan and Monitoring Plan																		
7b. Quarterly or annual reports																		
7c. Final report																	X	
Task 8. Project Administration																		☆

Project Follow-up

- Need for long-term monitoring of surface and groundwater
- Use of dry wells a regional issue
- Long term monitoring plan would be best accomplished as regional undertaking

Thank you

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