State of the Art Techniques in Characterizing, Design and Operating Optimum Surface Spreading Groundwater Recharge Projects

Session 3: Surface Spreading Applications

Michael Milczarek
Surface Spreading Applications

- MAR Basins
  - Dedicated surface water supply, effluent
- Riverbank/Bed Filtration
- Ag MAR, Flood MAR, On Farm Recharge (OFR)
  - Periodic flood/peak water
- Multi-benefit MAR
  - MAR to support riparian and wildlife habitat, Parks
- Stormwater Capture and Recharge
  - Detention, channel and basin recharge
- Recharge Enhancement Methods
  - Infiltration Galleries
  - Drywells and Vadoze Zone Injection wells
  - Wick drains, Parjana EGRP
Riverbank/Bed Filtration

- Surface water treatment to remove sediment and lower organic carbon and macronutrients
  - Orange County Water District (Milczarek 2010)
  - Fifteen Mile MAR/ASR project (this conference)
Ag-MAR, Flood MAR, On-Farm Recharge

- Recharging flood flows into basins or farm lands
- In CA, 2 to 3 wet years every 10 years
- Extensive research into crop effects
  - Bachand et al., 2012, 2014, 2017, Dahlke et al, 2018
- Potential water quality effects
- Watch Plenary Session and other papers

Provided by CA DWR
Off-channel Basins
Groundwater Banks/Dedicated Fields

• Just in Kern County
  – AVEK WSSP
  – AVWB
  – Kern Water Bank
  – Pioneer Water Bank
  – Berrenda Mesa WD Water Bank
  – Kern Delta WD Water Bank
  – North Kern WSD Water Bank
  – Shafter Wasco ID Water Bank
  – Semitropic WSD Water Bank
  – Buena Vista WSD Water Bank
  – Rosedale Rio Bravo WSD Water Bank

• Growers Recharging
  – Sun World
  – Wonderful (Paramount)
  – Pacific Resources & Pacific Ag
  – JG Boswell
  – Marvin Meyers
  – Maricopa Orchards

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Multi-benefit MAR

- Walla Walla Watershed MAR
  - Approximately 7,000 afa used to support agriculture and maintain low flows in Walla Wall River
    - Scherberg et al., 2014, 2018
- Colusa County Multi-benefit MAR Project
  - MAR to support agriculture, DACs and migratory bird habitat
    - Barfield – this conference
- Parks (Effluent MAR)
  - City of Tucson Sweetwater Facility
  - City of Gilbert Riparian Preserve at Water Ranch
  - City of Sierra Vista Environmental Operations Park
  - Many others

17th Biennial Symposium on Managed Aquifer Recharge
Resilience Through Recharge and Recovery
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Stormwater Capture and Recharge

• Numerous small-scale stormwater detention and recharge systems throughout AZ, CA, OR and WA

• Projects to quantify stormwater capture and recharge
  – Upper San Pedro River Basin
    • Lacher et al., 2014, Bunting – this conference
  – Stanislaus County Dry Creek Project

• Challenges:
  – How much runoff can be captured and when?
    • Most ephemeral/unallocated sources are ungauged
  – Sediment control and contamination?
  – Site hydrogeology?
  – Defining water rights/instream flow requirement/allocations
Recharge Enhancement Methods to Access Higher Permeability Sediments

- Over 50,000 drywells in Phoenix area alone
- Vadose zone injection needs very pure water and maintenance (Gastelum, et al, 2009)
- CA is developing new drywell guidance (water quality)

Infiltration galleries have higher benefits than drywells
  - Restricted to 10-15 feet bgs
Underground Infiltration Galleries

Atlantis Tanks

CMP

ChamberMAX
Other Potential Recharge Enhancement Methods

Vertical Wick Drains

Provided by American Wick Drain

Parjana EGRP

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How Do We Make Projects Successful?

- Course is focused on basins – but same tools are needed for other applications
- Riverbed/bank filtration should be considered for surface water pre-treatment
- Ag/Flood/On Farm MAR has significant potential benefits but water quality needs to be addressed
- ALWAYS think of Multi-benefit MAR
- Stormwater capture and recharge has significant modeling and design challenges
- Site limitations may require use of recharge enhancement methods
Ag MAR Water Quality Case Study
Keck’s Corner Water Bank

• Proposed 260 acre water bank
  – Five-acre pilot test (2019)
  – Water table approximately 80 to 90 ft bgs

• Monitoring:
  – Nested vadose zone and groundwater well (MW-1)
  – Inflow, weather station, stage
  – Drill core leaching tests

• Test ran for 3 months
  – Avg 1.0 ft/day infiltration
  – Wetting front arrival = 14 days
  – 1 PV = 38 days
Drill Core 1:1 EC Extract

Electrical Conductivity (dS/m)

Depth (feet)

- MW-1
- BH-2
- BH-3
Drill Core Flushing Data

Electrical Conductivity (uS/cm) vs. Estimated Pore Volume

- BH3 40-44.5
- MW1 39-40.5
- MW1 42-43.5
- BH2 46.5-48
- Tap Water EC

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25 ft Lysimeter Water Quality Data

Groundwater Quality Data

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Session 3: Surface Spreading Applications
Groundwater Data

![Graph showing groundwater data with various dates and measurements.](image)
Conclusions

- Potential water quality impacts depend on:
  - Length of historic agriculture and leaching fraction
  - By agricultural land use
  - By soil type

- Initial flush of water will most likely exceed SDWA parameters for TDS (secondary), possibly antecedent NO$_3$ and oxyanions
- Field studies indicate 1 to 3 pore volumes needed to flush majority of vadose zone
- Projected flushing is dependent on duration of recharge