Overview of Artificial Recharge

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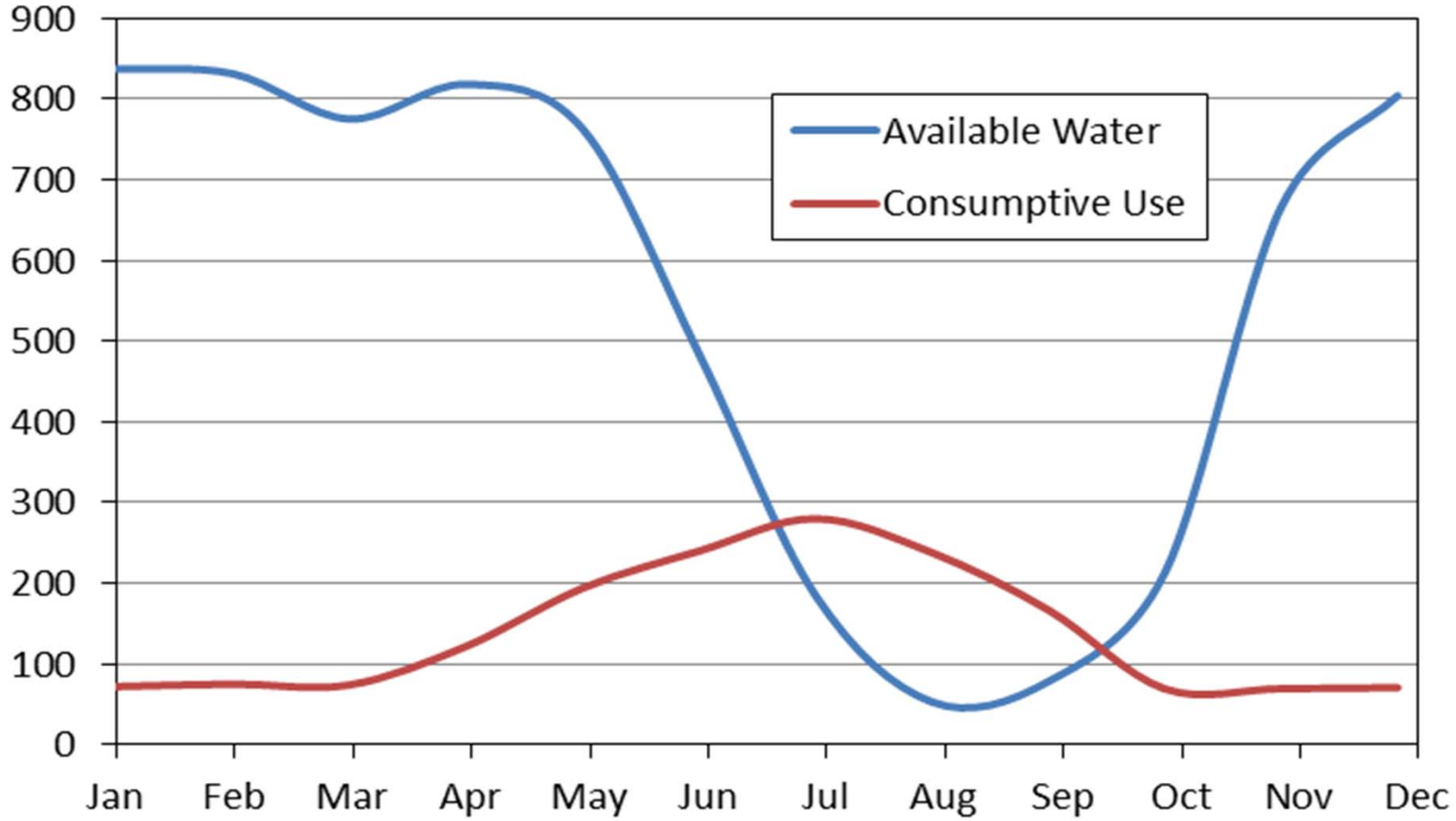
Hydrologic Cycle

Inflow = Outflow ± Change in Storage

Seasonal Available Water



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Forms of Groundwater Recharge

- Natural recharge
  - (Precipitation + infiltration from natural water bodies) – (evapotranspiration + runoff)
  - From 0 to > 25% of precipitation depending on location
- Incidental recharge
  - Septic-tank drain fields
  - Deep percolation of irrigation water
  - Runoff in urban areas
- Artificial recharge

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What is “Artificial Recharge”

- Augmentation of groundwater by putting water on or in the ground for subsequent movement to aquifers or injection of water into aquifers
- General purposes are:
  - Water storage
  - Filtration
  - Enhanced baseflow
  - Conveyance
  - Groundwater preference for drinking water

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Water Sources

- Streams or rivers
- Storm runoff
- Drinking water
- Reclaimed water
- Groundwater from overlying, underlying, or nearby aquifers

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Aquifer Water Storage – Advantages Over Dams

- Lower evaporative losses
- Lower cost
- Greater storage volume
- Less environmental and sociological impact
- Smaller land areas needed

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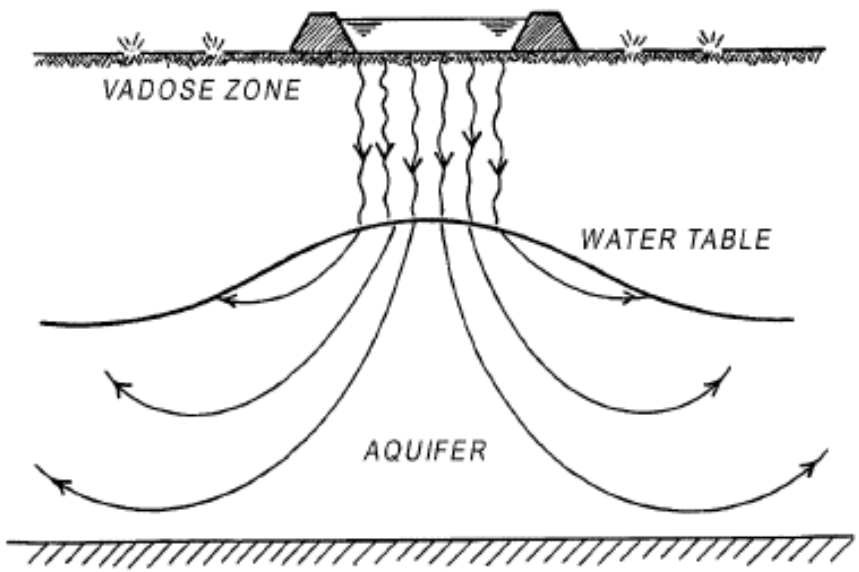
Recharge Systems – Surface Infiltration

- In-channel
  - Dams placed across streams to increase wetted area
- Off-channel
  - Constructed infiltration basins



Bouwer, 2002

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Recharge Systems – Surface Infiltration

- Requires permeable surface soils
  - Less permeable surface soils can be removed
- Permeable unconfined aquifer
- Large amounts of suspended solids and organic carbon can create clogging layer
- Presence of underlying low permeable layers (e.g. clay) that restrict downward flow
- Soils and aquifer free of contaminants

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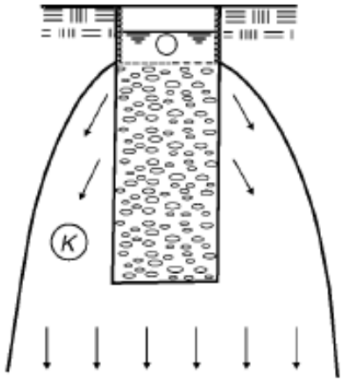
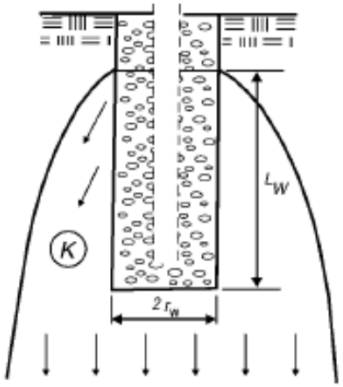
Recharge Systems – Unsaturated Zone Infiltration

- When sufficiently permeable soils and/or sufficient land areas for surface infiltration not available.
- Trenches
  - Backfilled with coarse material
  - Water applied on surface
- Dry Wells
  - Vertically placed perforated supply pipe
  - Backfilled with coarse material

Trench



Dry Well



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Recharge Systems – Injection Wells

- When sufficiently permeable soils and/or sufficient land areas for surface infiltration not available or aquifers are deep and/or confined
- Water quality standards for injected water meets drinking-water standards to:
  - Minimize clogging
  - Protect quality of groundwater
- Injection well often serves as extraction well (a.k.a. Aquifer Storage and Recovery System)

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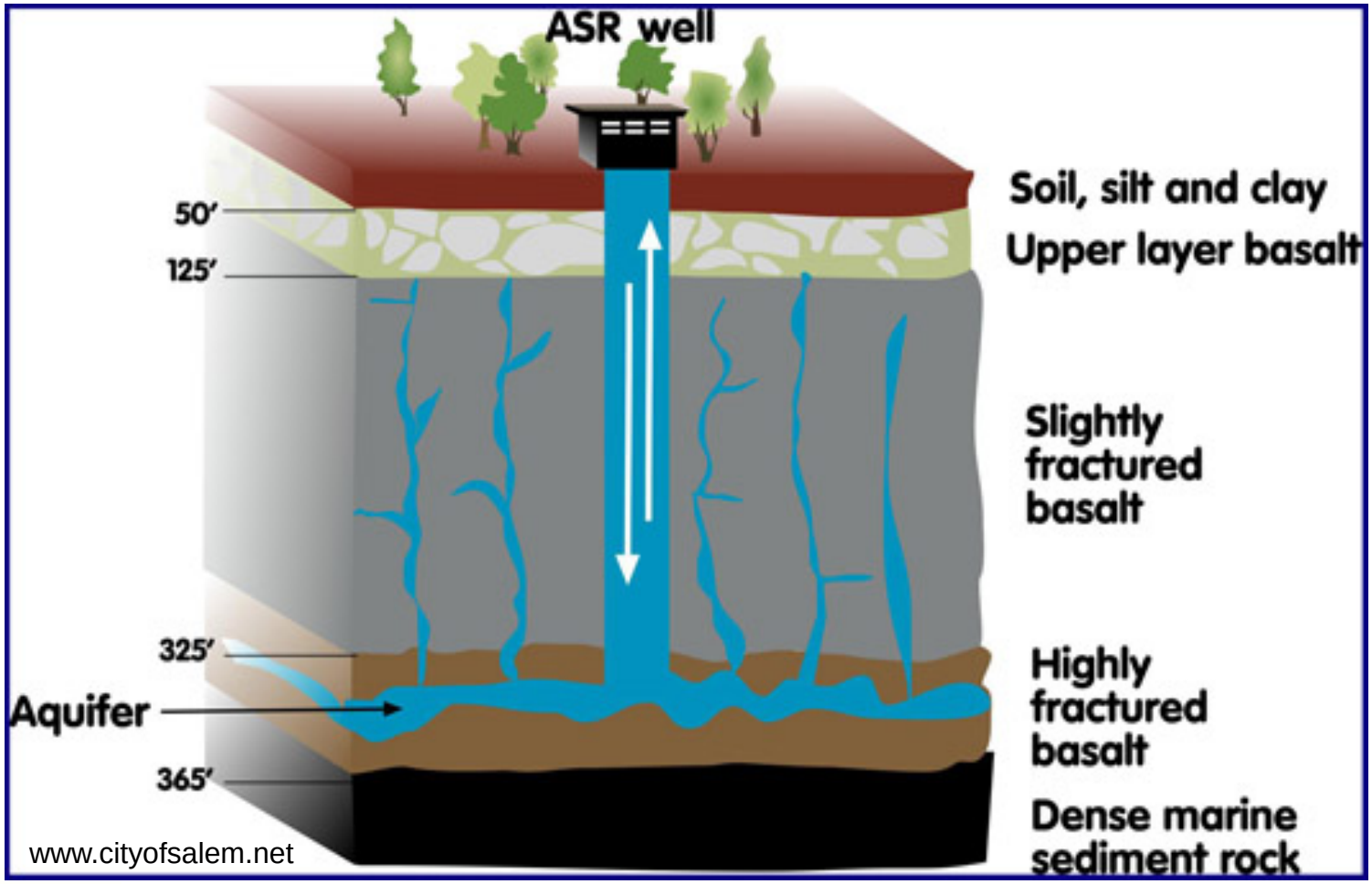
Recharge Systems – Injection Wells



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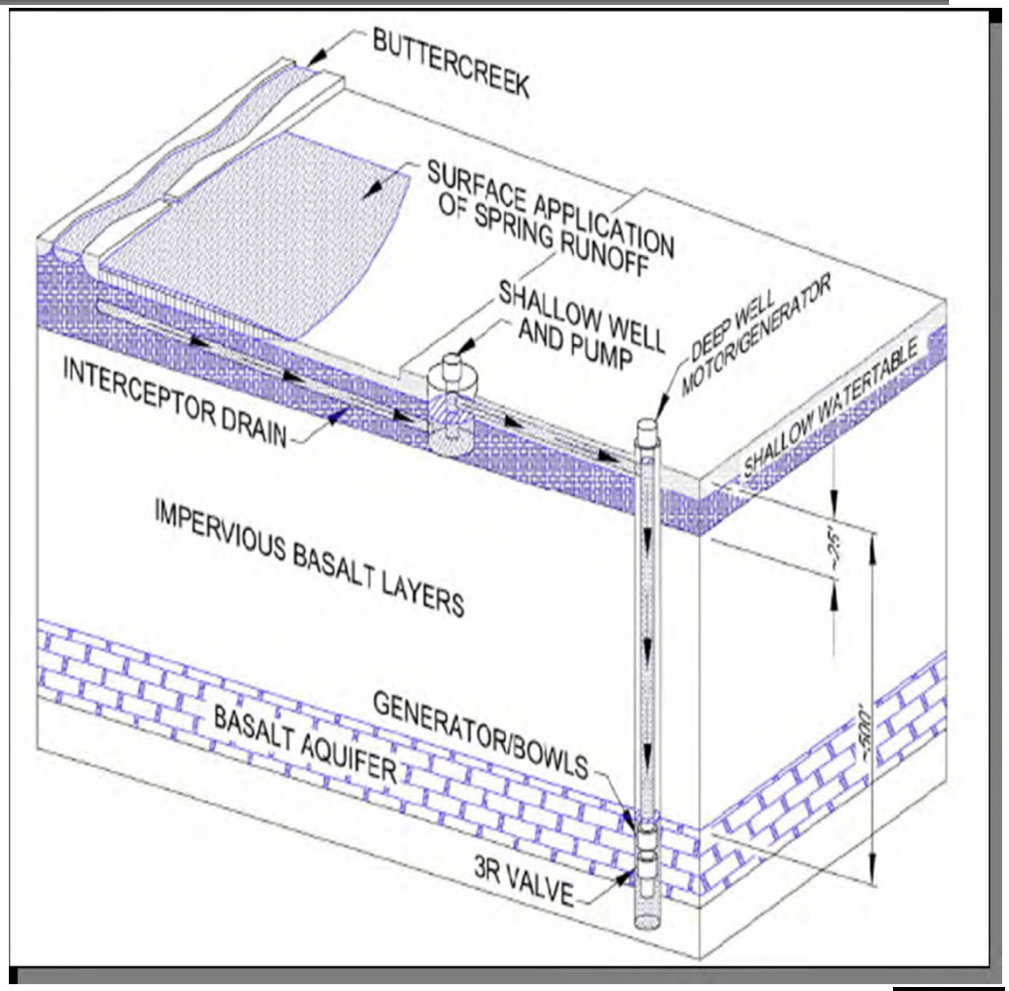
Recharge Systems – Combination

- Surface infiltration coupled with recovery and deep injection
  - Provides benefit of water treatment as filtered through soil



Kent Madison, 2008 AR/ASR Symposium

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Artificial Recharge in Oregon

- OWRD regulates artificial recharge
- Oregon code separates artificial recharge into two categories:
  1) Artificial recharge (AR)
  2) Aquifer storage and recovery (ASR)

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Artificial Recharge

- Not specific to placement method
- Permit required to appropriate water to recharge and second permit required to pump recharged water
- Recharge project must yield net increase in aquifer storage – up to 85% of recharged quantity can be recovered
- Drinking water standards do not necessarily have to be met

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Aquifer Storage and Recovery

- Well injection required
- Single permit required to appropriate water to recharge and recover
- Use of stored water must conform to existing right
- Up to 100% of recharged quantity can be recovered
- Injected water must meet drinking water standards

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Recharge Projects in Oregon (not inclusive)

- Walla Walla Basin and Umatilla Basin
  - Hudson Bay, Locher Rd – AR to enhance baseflow to Walla Walla River, rejuvenate wetlands, and restore shallow aquifers
  - Echo Meadows – AR to enhance baseflow to Umatilla River
  - Madison Farms – AR/ASR for irrigation
- Municipalities
  - Salem – ASR, injects up to 450 million gal/yr, recovers up to 500 million gal/yr
  - Beaverton – ASR, injects up to 400 million gal/yr, recovers up to 365 million gal/yr
  - Pendleton – ASR, injects up to 500 million gal/yr, recovers up to 450 million gal/yr

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General Thoughts

- Capital and maintenance costs:
  - Injection wells > vadose zone wells >> surface basins
- Feasibility studies should be phased to evaluate surface spreading initially, then ASR
- Opportunities for surface spreading and vadose zone recharge:
  - Areas of groundwater pumping (where water table has been lowered)
  - Alluvial basins
  - Off channel areas (for seasonal storage and enhanced baseflow)
  - Farming areas with sandy soils
- Opportunities for ASR
  - Areas of groundwater pumping (where water table has been lowered)
  - No alluvial basins present (i.e. basalt aquifer)
  - High land costs
  - Infrastructure for water treatment

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Opportunities in the Hood River Valley

- Winter shallow aquifer recharge in glacial/alluvial deposits to increase summer time base flows
  - Increase river flow
  - Decrease river temperature
- Winter alluvial aquifer recharge for storage and summer time pumping
- Basalt aquifer ASR
- Better understanding of hydrogeology necessary before implementing large scale recharge project

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