

What Is Recycled Water?

Wastewater that has been *treated* to meet specific *water quality criteria* with the intent of *being used* for a range of purposes. The term *recycled water* is synonymous with *reclaimed water*.



Recycle Water Vegetable grower, Castroville, CA

Benefits:

Supplies are highly reliable and typically increases with population growth.

Energy efficiency and sustainability are key drivers of water reuse, water infrastructure requires large amounts of energy

Municipal reclaimed water might be the higher quality than groundwater on farm.

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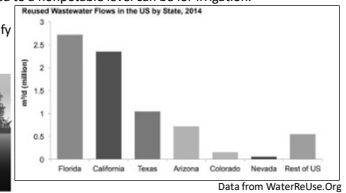
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Recycled Water Sources

Municipal:

- Secondary Treatment Biological Oxidation, Disinfection is a process where dissolved and suspended biological matter is removed to a nonpotable level can be for irrigation.

- Tertiary Treatment processes that purify water can remove nitrogen and phosphorus



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Municipal Example: Irvine Ranch Water District

The district began delivering recycled water to its agricultural customers 1967.

It takes about 16 to 18 hours to produce recycled water – from the time the sewage enters the plant until the finished product is disinfected and ready for distribution.

The IRWD service area through our extensive recycled water distribution system.

Deliver more than 25 million gallons of recycled water per day to more than 4,000 customers.



Source: www.irwd.com

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Recycled Water Sources

Personal: Farm catchment

- Catchment/retention ponds should be designed with capacity to retain about 90% of the maximum daily irrigation water applied
- Catchment/retention ponds should be designed with capacity to retain the first 1/2 inch of rainwater runoff.



Construction large catchment



Completed catchment

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Quality: Physical and Biological

PHYSICAL FILTRATION



BIOLOGICAL STERILIZATION PAIRED W/ SAND



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Quality: Chemical



"...Of particular importance are the salts and nutrients in [Recycled] water, and special management practices for both end uses may be required depending on the concentrations in the [Recycled] water. For example, in some areas where landscaping is irrigated, the salt sensitivity of the irrigated plants should be considered."

Section 3.1.1. EPA 2012 Guidelines

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Salts

Salts: any chemical compound formed from the reaction of an acid with a base, with all or part of the hydrogen of the acid replaced by a metal or other cation

Total Conc: Measured in Electrical Conductivity (dS m^{-2}) or Total Dissolved Solid (TDS) (ppm).

The suitability of a water for irrigation is determined not only by the total amount of salt present but also by the kind of salt.



Morton Salt Girl™

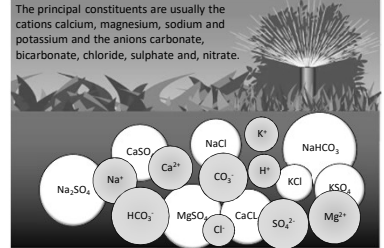
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Sources of Salinity

Groundwater - dissolution or weathering of the rocks and soil, including lime, gypsum and other slowly dissolved soil minerals.

Recycled Water: salts depend on supply sources, the influent waste streams (i.e., domestic and industrial contributions), salts from the excess fertilizers, sterilizers, and the treatment processes.



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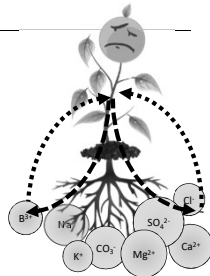
Salinity-Related Problems

Osmotic balance —

- Yield reductions occur when the crop is no longer able to extract sufficient water from the salty soil solution.
- Each subsequent irrigation pushes the salts deeper into the root zone where they continue to accumulate until leached.

Ion Toxicity —

- The ions of primary concern are chloride, sodium and boron.
- The degree of damage depends on the uptake and the crop sensitivity. Damage often occurs at relatively low ion concentrations for sensitive crops.
- The more tolerant annual crops are not sensitive at low concentrations but almost all crops will be damaged or killed if concentrations are sufficiently high.



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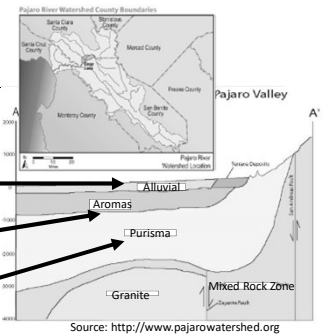
Nearby Concerns: Pajaro Valley

Groundwater is the main source of water for residents and farmers in the Pajaro Valley, making groundwater quality very important to monitor.

The Alluvial aquifer is most affected by agricultural run off and pollutants.

Overdraft has caused seawater intrusion for all three aquifers and its effects are most pronounced in the Aromas aquifer (the middle ground water aquifer).

The Purisma aquifer (the lowest) contains really old, mineral rich water that is not ideal for irrigation.



Source: <http://www.pajarowatershed.org>

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Salt Accumulation Over Time

A problem where salts are present in the groundwater, and/or areas with high evaporation, and low natural rainfall. The permanent, perennial-type crops (tree crops) are the more sensitive

- Field grown crops in irrigated horticulture (Central, San Joaquin, Imperial Valleys.
- Field grown crops where salt intrusion present in ground water (Coastal)
- Container Nurseries Perennials with high evaporative demand (Inland Empire, Santa Clara Valley, etc)
- Golf Courses



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How sensitive are plants to the salt?



"...Of particular importance are the salts and nutrients in [Recycled] water, and special management practices for both end uses may be required depending on the concentrations in the [Recycled] water. For example, in some areas where landscaping is irrigated, the salt sensitivity of the irrigated plants should be considered."

Section 3.1.1. EPA 2012 Guidelines

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Two Experiments: Investigate Thresholds

CONCENTRATION AND ION TOXICITY LONG LIVED CONIFERS



CONCENTRATION HERBACEOUS PERENNIALS



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Concentration and Ion Toxicity Long Lived Conifers

C. Barnes M.S. Research Oki Lab

Santa Clara Valley Water District goal 10% recycled water. Concern about charismatic Redwood trees in urban landscapes.



1.5 yrs

102 *Sequoia sempervirens* 'Aptos Blue' saplings
2 gal pots

Four salts:

- sodium chloride (NaCl)
- calcium chloride (CaCl₂)
- sodium chloride + calcium chloride (NaCl + CaCl₂)
- sodium sulfate. (NaSO₄)

Each salt type was applied at four different concentrations: 1.0, 3.0, 4.5, and 6.0 dS m⁻¹.

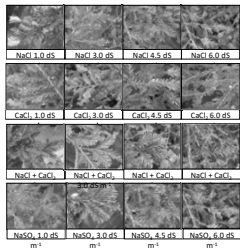


Nackley, Barnes, Oki, 2015
<https://doi.org/10.1093/aobpla/plv035>

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All Ions Toxic, at Low Rates >1.0 dS m⁻¹.



Moderately saline soils (4–8 dS m⁻¹) would decrease the relative height growth by 30–40 %.

Regardless of the specific ions growth and appearance of coast redwoods will be negatively impacted when recycled water electrical conductivity exceeds >1.0 dS m⁻¹.

Others have reported foliar damage from low levels of Boron ions.

Wu & Guo. 2006. *Environmental and Experimental Botany*
<https://doi.org/10.1016/j.envexpbot.2005.07.003>

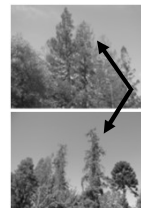
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Horticultural Implications



Natural Range
Coast Redwood



Top-kill and death in mismanaged, irrigated, mature Coast Redwoods

- 1) If your market, or production facility, is outside narrow range then you need to be very aware of salinity
- 2) Irrigation with recycled water should be restricted to under the canopy of the and that soil salinity accumulation should not exceed 2 dS m⁻¹

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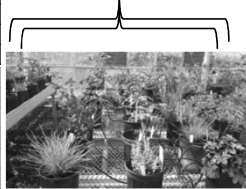
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Herbaceous Perennials: Perception and Reality

Species	Cultivar
<i>Hemerocallis</i>	Primal Scream
<i>Heuchera</i>	Dolce Blackcurrent
<i>Rosa</i>	SunBelt Desmond Tutu
<i>Calamagrostis</i>	Karl Foester
<i>Deschampsia</i>	Northern Lights
<i>Calabachoa</i>	Superbells Red
<i>Fuchsia</i>	Shadow Dancer Better
<i>Guara</i>	Perky Pink
<i>Lantana</i>	Luscious Bananarama
<i>Lavandula</i>	Sweet Romance
<i>Salvia</i>	Black and Blue

Half Received Potable irrigation water

Half Received Municipal Irrigation water. Source: IRWD

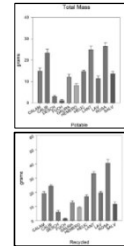


6 months May-Nov
Two irrigation sources
11 cultivars (n=10)
Measured for Growth
Aesthetics rated in a blind survey of 30 MGs

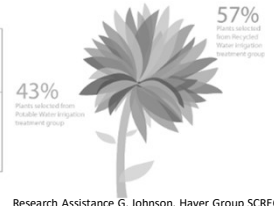
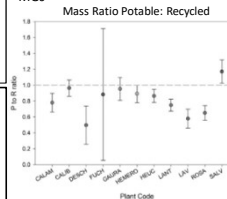
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Herbaceous Perennials grew Great on Municipal Recycled Water



On Average, plants grew about 15-25% larger on recycled water!! EC: <1.0 dS m⁻². Indistinguishable aesthetic appeal. Both groups looked pretty much the same to the MGs



Research Assistance G. Johnson, Haver Group SCREC

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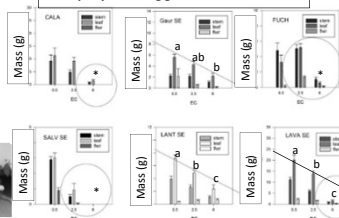
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Herbaceous Perennials: Subset Salt Threshold

6 cultivars (n=8); NaCl 3 levels: 0.5, 2.5, 6.0

<i>Calabachoa</i>	Superbells Red
<i>Fuchsia</i>	Shadow Dancer Better
<i>Guara</i>	Perky Pink
<i>Lantana</i>	Luscious Bananarama
<i>Lavandula</i>	Sweet Romance
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Rapidly declining growth >1.0 EC dS m⁻²



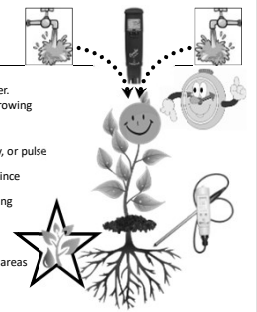
EC 0.5 EC 2.5 EC 6.0

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Management Implications

- ☐ Monitor:
 - Complete water quality tests at least twice a year, Spring/Summer.
 - In-line sensor or Leachate Extraction biweekly-monthly during growing season.
- ☐ Mitigate: Leaching is the key
 - Two water sources are ideal: blend fresh water to reduce salinity, or pulse low-salt water
 - Irrigate more frequently to maintain high plant-available water since greater soil tension.
 - Irrigate longer duration. to prevent accumulation increase leaching fraction >40%.
 - Increase drainage. Soilless media and pot shape
- ☐ Market
 - Grow salt tolerant plants. Wide range of selections from Coastal areas
 - Breeding programs for salt tolerance.
 - Beauty from Waste: Grown with water conservation practices.



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Questions?



Nursery Irrigation, Aurora, Oregon

 Oregon State University  Lloyd.Nackley@OregonState.edu  (971) 801-0385  @NackleyLab

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