

Recycled Water & Related Terms Relevant for Agriculture

There are many types of water, as well as water treatment technologies, processes, and products that are used in agriculture. This sheet combines definitions from U.S. federal agencies and national organizations related to water used in agriculture. Definitions often differ between specific states. We have identified definitions that differ by state with a star (*).

TYPES OF WATER

AGRICULTURAL WATER: Water used on produce normally consumed raw in activities such as growing (including directly applied irrigation water, water used for preparing crop sprays, and water used for growing sprouts), harvesting, packing, and holding (including water used for washing or cooling harvested produce and water used to prevent dehydration). Also includes water intended or likely to come in contact with food-contact surfaces. – *Food and Drug Administration (FDA), 2013*

BRACKISH WATER: Distastefully salty but less saline than seawater (between 1,000 to 10,000 ppm [parts per million] in total dissolved solids [TDS]). Brackish water can be found in estuaries as well as aquifers. – *National Ground Water Association, 2010*

DESALINATED WATER: Saline water that has had its dissolved salts removed. – *U.S. Geological Survey (USGS), 2016a*

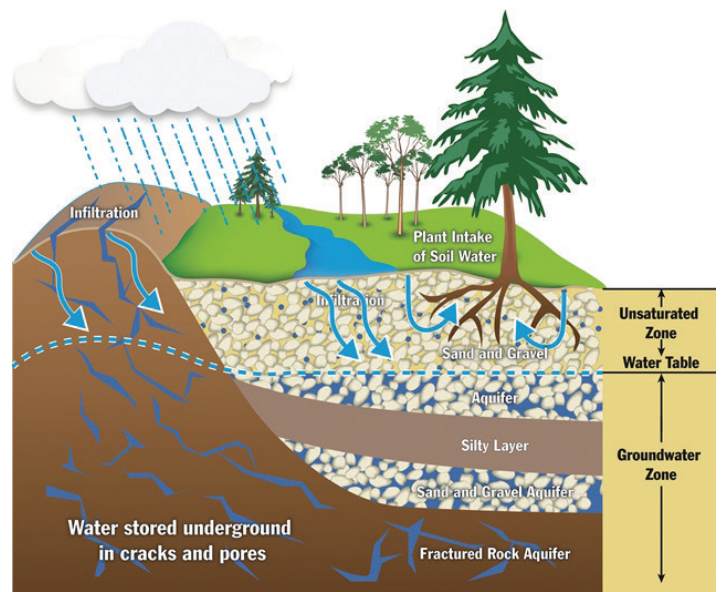


Effluent leaving a wastewater facility.
Courtesy of Dr. Rachel Rosenberg Goldstein.

EFFLUENT: The final product from a treatment or purification process, specifically water or wastewater treatment plants. Water quality varies depending on the type and amount of treatment; its quality can even meet or exceed drinking water standards. – *WaterReuse, 2015*

GRAYWATER/GREYWATER*: Wastewater from a domestic collection system that is reused on site. This water can come from showers, bathtubs, washing machines, and bathroom sinks. Water from toilets or wash water from diapers is not graywater. In many states, kitchen sink water is also not considered graywater. Many buildings or individual dwellings have systems that capture, treat and distribute greywater for irrigation or other nonpotable uses. – *WaterReuse, 2015*

GROUNDWATER*: The zone beneath the earth's surface saturated with water that has seeped down through soil and rock. – *EPA, 2004*



Groundwater flow. Image courtesy of Government of Newfoundland and Labrador.

INDUSTRIAL WATER: Water used for fabrication, processing, washing, and cooling in industries including chemical, food, mining, paper, petroleum refining, and steel industries. – *USGS, 2016*

IRRIGATION WATER*: Water applied by an irrigation system to grow plants in agricultural, horticultural, and landscaping practices. Irrigation can also include water used for pre-irrigation, frost protection, application of chemicals, weed control, field preparation, crop cooling, harvesting, dust suppression, and leaching salts from the root zone. – *USGS, 2016a*



Examples of a drip irrigation system (L) where the water is applied close to the soil surface and an overhead spray irrigation system (R) where the water is applied from above the plant. (L) Adobe Stock Images. (R) iStock Photos.

NONPOTABLE WATER: Water not for drinking. – *EPA, 1998*

NONTRADITIONAL WATER: Any water source other than groundwater including agricultural runoff, treated wastewater, recycled water, produced water, untreated surface water**, and brackish surface and groundwater. – *USDA, 2017*

PRODUCTION WATER: Water that contacts produce usually eaten raw during the growth process. Includes irrigation, fertigation, foliar sprays, and frost protection. – *Produce Safety Alliance (PSA), 2016*

POSTHARVEST WATER: Water used during or after harvest of produce usually eaten raw. Includes water used in the field as well as packing and holding activities. – *PSA, 2016*

POTABLE WATER: Meets federal and state drinking water standards and is considered safe for human consumption. – *WateReuse, 2015*

PRODUCED WATER: Water resulting from oil and gas processes in sub-surface hydraulic aquifers. – *U.S. Bureau of Reclamation, 2017*

RAW WATER: Surface or groundwater that has not gone through an approved water treatment process. – *WateReuse, 2015*

RECLAIMED WATER*: Treated municipal wastewater that meets state-specific water quality standards and is intended to be reused for multiple purposes. Some states and organizations use “reclaimed” and “recycled” interchangeably. – *EPA, 2012*

RECYCLED WATER*: Treated domestic wastewater used more than once before passing back into water cycle. The terms “reused”

and “recycled” are often used interchangeably depending on geographic region. The treatment allows for its reuse for a beneficial purpose. Can include grey water, produced water, fracking water, and wastewater among others. – *WateReuse, 2015*

RETURN FLOW: Surface and subsurface water that leaves a field after the application of irrigation water. – *Womach, 2005*

RUNOFF: Surface flow of water from a specific area. – *Alliance for Water Efficiency, 2016*

SURFACE WATER*: Water located on the surface of the earth including ponds, streams, rivers, reservoirs, lakes, and tidewater. Surface water may also include springs, wells, or other collectors that are directly influenced by surface water. – *MDE, 2016; PSA, 2016; Stoeckel et al., 2016*

TAIL WATER: The runoff of irrigation water from the lower end of an irrigated field. – *Federal Remediation Technologies Roundtable, 2016*

WASTEWATER: Used water discharged from homes, businesses, industry, and agricultural facilities. – *EPA, 2012*

CORE TERMS & CONCEPTS

ACRE-FOOT: A volume of water equal to one foot in depth covering an area of one acre, or 43,560 cubic feet; approximately 325,851 gallons or 1234 cubic meters. – *Rock et al., 2012*

BEST MANAGEMENT PRACTICE (BMP): A practice or combination of practices established as the best means of increasing water use efficiency. – *Alliance for Water Efficiency, 2016*

BENEFICIAL REUSE: The use of recycled water for purposes that benefit a community’s water needs, economy, and/or environment. – *WateReuse, 2015*

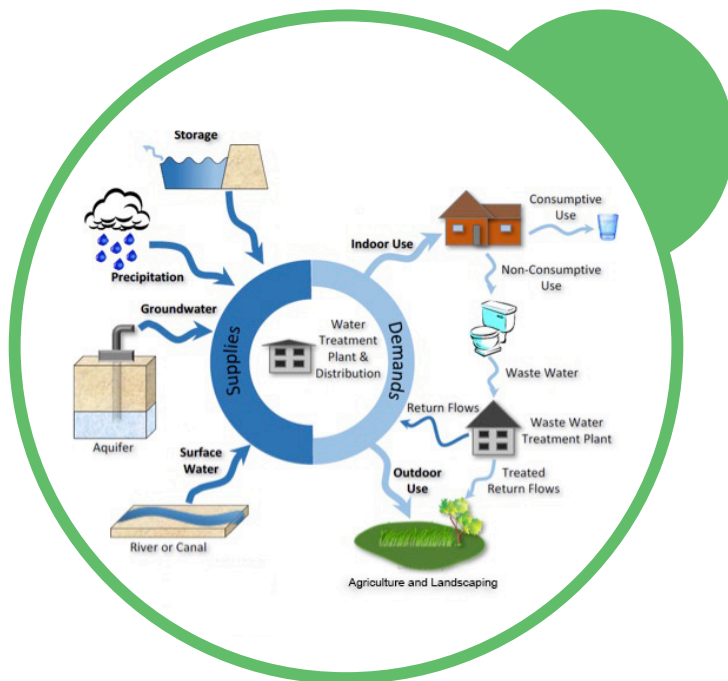
CONSERVATION: Preserving water resources by reducing water demand, loss, and waste. – *Alliance for Water Efficiency, 2016*

DROUGHT: A long period of decreased precipitation and streamflow. – *USGS, 2016b*

INTEGRATED RESOURCE PLANNING (IRP): A forward-looking method that incorporates environmental, engineering, social, financial, and economic considerations. IRP uses the same criteria to evaluate both supply and demand options while involving stakeholders in the process. – *Rock et al., 2012*

MAXIMUM CONTAMINANT LEVEL (MCL): Maximum level of a contaminant allowed in water delivered to any user of a public water system. – *EPA, 2017*

WATER TREATMENT TECHNOLOGIES, PROCESSES & PRODUCTS



One Water concept. The image is by Dr. Allegra D. DaSilva. Courtesy of Stantec and WaterReuse Association.

ONE WATER: Integrated and inclusive approaches to water resource management that emphasize that all water has value and should be managed in a sustainable, inclusive, integrated way. The aim is to integrate planning and management of water supply, wastewater, and stormwater systems to minimize environmental impacts and maximize contributions to social and economic vitality. – *Howe & Mukheibir, 2015*

PATHOGENS: Disease-causing microorganisms including bacteria, viruses, helminths, and protozoans. – *EPA, 2004*

PLANNED WATER RECYCLING: Projects developed with the goal of beneficially reusing a recycled water supply. – *EPA, 1998*

REUSE*: Treating wastewater to sufficient levels to allow it to be used more than once. – *WaterReuse; EPA, 2012*

UNPLANNED WATER RECYCLING: Occurs when cities draw their water supplies from rivers that receive wastewater discharges upstream from those cities. Water from these rivers has been reused, treated, and piped into the water supply a number of times before the last downstream user withdraws the water. – *EPA, 1998*

WATER (HYDROLOGIC) CYCLE: Describes how water moves on the earth. Water evaporates from water bodies (such as oceans, lakes, and rivers), forms clouds, and returns to earth as precipitation (rain or snow). The yearly amount of evaporated water and amount that falls back to the ground are virtually constant; the amount of water on the earth does not change. – *WaterReuse, 2015*

ADVANCED OXIDATION: Process that can be used as a safety barrier in the water purification process. Hydrogen peroxide, ultraviolet (UV) light, and other processes are used in combination to form a powerful oxidant that provides further disinfection of the water and breaks down remaining chemicals and microorganisms, providing further disinfection. – *WaterReuse, 2015*

AUGMENTATION: The process of adding recycled water into an existing raw water supply (such as a reservoir, lake, river, wetland, and/or groundwater basin). – *WaterReuse, 2015*

CHLORINATION: The process of adding chlorine gas or chlorine compounds to wastewater for disinfection. – *EPA, 2004*

DIRECT INJECTION: Injecting recycled water through an injection well directly into a groundwater basin. If the water will later be used for drinking, the recycled water will receive advanced treatment prior to injection. – *Rock et al., 2012*

DISCHARGE: The release of effluent, that meets regulatory standards, into the environment. – *WaterReuse, 2015*

DISINFECTION: The killing of pathogens. – *EPA, 2004*

DUAL MEDIA FILTRATION: Filtration method that uses two different types of filter media, usually sand and finely granulated anthracite. – *WaterReuse, 2015*

FILTRATION: A process that separates small particles or microorganisms from water by using a porous barrier to trap the particles while allowing water to pass. – *Rock et al., 2012*

GRANULAR ACTIVATED CARBON: Process used to remove chemicals that are dissolved in used water with activated carbon. – *WaterReuse, 2015*

GROUNDWATER RECHARGE: Naturally occurring as part of the water cycle and can be enhanced using constructed facilities to add water into a groundwater basin. – *WaterReuse, 2015*

MICROFILTRATION: A physical separation process where tiny, hollow, straw-like membranes separate particles from water. It is used as a pretreatment for reverse osmosis. – *WaterReuse, 2015*

MULTI-BARRIER PROCESSES: Purification processes that consist of several barriers to ensure sufficient reduction and/or elimination of various substances that need to be controlled. Monitoring is an important component to verify that the processes are working properly and efficiently. Components of a multi-barrier process may include some or all of the following: membrane filtration, reverse osmosis, advanced oxidation, riverbank filtration, soil aquifer treatment, and constructed wetlands. – *WaterReuse, 2015*



Spinach in a beaker undergoing ozonation, a process used to disinfect water. Ravishankar Lab. University of Arizona. August 2017.

OZONATION: Process of applying ozone (O₃) for the disinfection of water/wastewater. Ozone is a strong oxidant. – *WateReuse, 2015*

REVERSE OSMOSIS: Method of removing dissolved salts, ions and other constituents from water. Pressure is used to force the water through a semi-permeable membrane that transmits the water but stops most dissolved materials from passing through the membrane. This treatment method is commonly used in desalination. – *WateReuse, 2015*

SOIL AQUIFER TREATMENT: When water, including recycled water, soaks into the ground and is purified by the physical, chemical, and biological processes that naturally occur in soil. – *WateReuse, 2015*

TAILWATER RECOVERY: An irrigation system in which all facilities utilized for the collection, storage, and transportation of irrigation tailwater for reuse have been installed. – *USDA, Natural Resources Conservation Service, 2008*

ULTRAVIOLET TREATMENT (UV): The use of ultraviolet light for disinfection or as part of an advanced oxidation process. This usually renders the pathogens inactive by changing the DNA so that the pathogens cannot replicate. – *WateReuse, 2015*

ZERO-VALENT IRON (ZVI) BIOSAND FILTERS: Iron hydroxides, oxides and oxyhydroxides are formed from ZVI's reactions with dissolved oxygen and protons in water. The hydroxides, oxides and oxyhydroxides have high pH point of zero charge (pHpzc) that strongly adsorb viruses and negatively charged microorganisms. Unlike other chemical treatments, ZVI does not create potentially harmful by-products. – *Ingram et al., 2012*



ZVI filter used in experimental spinach irrigation study plot. Courtesy of Ingram, et al. 2011. The tubs contain sand mixed with ZVI particles (below). Courtesy of Dr. Prachi Kulkarni.

*Terms differ by state.

**The term “nontraditional water” defined by the USDA includes untreated surface water to emphasize that its quality can be impacted by external environmental factors such as runoff. The agricultural community (dependent upon region and availability) already uses surface water to irrigate, and considers surface water to be a “traditional water” source.

REFERENCES

Alliance for Water Efficiency. http://www.allianceforwaterefficiency.org/Glossary.aspx#Def_R

Environmental Protection Agency (EPA), 1998. Water Recycling and Reuse: The Environmental Benefits. Water Division Region IX. EPA 909-F-98-001. <https://www3.epa.gov/region9/water/recycling/>

EPA, 2004. Primer for Municipal Wastewater Treatment. Office of Water; Office of Wastewater Management; EPA 832-R-04-001. <https://www3.epa.gov/npdes/pubs/primer.pdf>

EPA, 2012 Guidelines for Water Reuse. Office of Water; Office of Wastewater Management; National Risk Management Research Laboratory, Office of Research and Development; U.S. Agency for International Development. EPA/600/R-12/618 <https://water-use.org/wp-content/uploads/2015/04/epa-2012-guidelines-for-water-reuse.pdf>

EPA, 2017. <https://www.epa.gov/dwregdev/how-epa-regulates-drinking-water-contaminants>

Federal Remediation Technologies Roundtable. Glossary. <https://frtr.gov/glossary/tterms.htm#T>. Last updated: 5/17/16. Howe, C. & Mukheibir, P, 2015. Pathways to One Water: A Guide for Institutional Innovation. Water Environment Research Foundation (WERF). http://www.werf.org/c/_FinalReport-PDFs/SIWM/SIWM2T12a.aspx

Ingram, D.T., Callahan, M.T., Ferguson, S., Hoover, D.G., Shelton, D.R., Millner, P.D., Camp, M.J., Patel, J.R., Kniel, K.E. and Sharma, M., 2012. Use of zero-valent iron biosand filters to reduce *Escherichia coli* O157:H12 in irrigation water applied to spinach plants in a field setting. *Journal of Applied Microbiology*, 112: 551–560.

National Groundwater Association, 2010. Brackish Groundwater. http://www.ngwa.org/media-center/briefs/documents/brackish_water_info_brief_2010.pdf

Produce Safety Alliance (PSA), 2016. Grower Training Course: Version 1.0. Cornell University.

Rock, C, McLain, J.E., Gerrity, D., 2012. “Common Terminology of Water Recycling”. Arizona Cooperative Extension. <https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1569.pdf>



CONSERVE: A Center of Excellence at the Nexus of Sustainable Water Reuse, Food and Health” was awarded to the University of Maryland School of Public Health by the United States Department of Agriculture-National Institute of Food and Agriculture, Grant number 20166800725064

Jessica L. Dery¹, Mayhah R. Suri², Natalie Brassill¹, Daphne Pee³, Paul Goeringer², Amy R. Sapkota⁴, Channah Rock¹, Rachel E. Rosenberg Goldstein^{2,4†}

¹Department of Soil, Water & Environmental Science, College of Agriculture & Life Sciences, University of Arizona, Tucson, AZ 85721, USA; ²Department of Agricultural & Resource Economics, College of Agriculture & Natural Resources, University of Maryland, College Park, MD 20742, USA; ³University of Maryland Extension Family & Consumer Science, College Park, MD 20742, USA; ⁴Maryland Institute for Applied Environmental Health, University of Maryland School of Public Health, College Park, MD 20742, USA.

[†] Corresponding Author:

Rachel E. Rosenberg Goldstein, Ph.D., M.P.H.
Department of Agricultural & Resource Economics
University of Maryland College of Agriculture & Natural Resources
Maryland Institute for Applied Environmental Health
University of Maryland School of Public Health
2200 Symons Hall
College Park, MD 20742
Phone: 301-458-5125
Email: reosenb@umd.edu

Stoeckel, D., Wall, G., Bihn, B., 2016. FSMA Produce Safety Rule Water Requirements: Insights to Get You Organized! <https://producesafetyalliance.cornell.edu/resources/education-al-materials/fsma-produce-safety-rule-water-requirements-in-sights-get-you-organized>

United States Bureau of Reclamation, 2017. Produced Water Treatment Primer for Oil and Gas Operations. <https://www.usbr.gov/research/projects/detail.cfm?id=1617>

United States Department of Agriculture (USDA), Natural Resources Conservation Service, 2008. Irrigation System, Tailwater Recovery. Practice Code 447.

USDA, 2017. Water for Food Production Systems Challenge Area Fiscal Year 2017, Request for Applications. https://nifa.usda.gov/sites/default/files/rfa/FY2017_AFRI_Water_for%20Food%20Production%20Systems.pdf

U.S. Food and Drug Administration (FDA), 2013. Standards for the Growing, Harvesting, Packing and Holding of Produce for Human Consumption. Proposed § 112.3(c). <https://www.fda.gov/food/guidanceregulation/fsma/ucm334552.htm>

United States Geological Survey (USGS), 2016a. Questions and answers about droughts. The USGS Water Science School. <https://water.usgs.gov/edu/qadroughts.html>. Last updated: 12/2/16.

USGS, 2016b. Water Use Terminology. <https://water.usgs.gov/wa-tuse/wuglossary.html>

WaterReuse Association, 2015. “Water Reuse Terminology”. [Fact sheet]. <https://watereuse.org/water-reuse-101/glossary/>

Womach, Jasper. Agriculture: A Glossary of Terms, Programs, and Laws, 2005 Edition, report, June 16, 2005; Washington D.C.. (digital.library.unt.edu/ark:/67531/metacrs7246/; accessed November 21, 2017), University of North Texas Libraries, Digital Library, digital.library.unt.edu; crediting UNT Libraries Government Documents Department.