Sustainable Conservation

WALNUTS

Guidance for Protecting Crop Health During On-Farm Recharge

On-farm groundwater recharge, also known as agricultural managed aquifer recharge (Ag-MAR), is the practice of applying surface water flows to farmed fields to replenish underground aquifers. This practice helps provide reliable groundwater supply for communities, ecosystems, and farming. When considering on-farm recharge, growers often ask:

"How much water can I apply, and for how long, without harming my crop?"

This guidance document will help growers conduct on-farm recharge while protecting their crop's health.

What factors should a grower consider to protect crop health during recharge events?

Factor	Low Risk	Higher Risk
Crops	Dormant / After Harvest	Actively Growing
Root Zone Oxygen and Temperature	Higher Oxygen, Lower Temperature	Lower Oxygen, Higher Temperature
Infiltration and Percolation Rate	Lighter Soils, No Hardpan	Heavier Soils, Hardpan

CROPS

Not all crops are compatible with on-farm recharge. Common perennial crops grown in California's Central Valley that may tolerate periodic flooding during dormancy include **almonds, pistachios, pasture, walnuts, vineyards, and alfalfa.** Recharge can also be done on fallow lands of annual crops like **cotton, sweet potatoes, and tomatoes** between harvest and planting.

ROOT ZONE OXYGEN AND TEMPERATURE

Higher oxygen levels in the soil's root zone are more conducive to plant health. Factors that can affect oxygen levels are duration of flooding events and both water and ambient temperature. On-farm recharge is safest in the **wintertime** (approximately December – February); air temperatures are cooler (below ~70°F is best), reducing the risk of disease and biological activity that creates low oxygen conditions, and crops are dormant or not yet planted.

INFILTRATION AND PERCOLATION RATE

Coarse-textured, lighter soils allow water to infiltrate into the soil and percolate through the soil profile faster, thus decreasing the chance of negative impacts from oversaturating a crop's roots. Soils with more clay, densely compacted soil, or hardpans can restrict percolation. **Cover crops** have been shown to improve infiltration rates. Soil infiltration and percolation rates and root-zone residence time are all factors in the Soil Agricultural Groundwater Banking Index (SAGBI), a suitability index for on-farm recharge.

HOW MUCH WATER CAN A GROWER SAFELY APPLY TO WALNUTS?

The table below summarizes the **daily winter recharge volumes** that can be applied to vineyards over a 5-day period while keeping soil moisture below 75% saturation to protect plant health (Flores-Lopez et al., 2025); beyond this threshold, root zone oxygen levels may drop to levels that create unhealthy conditions for crops, as shown in a study on almond, walnut, and pistachio fields (Bachand & Associates, 2017). It also lists the **time needed for the excess water to drain from the soil (i.e., allowing the soil to return to field capacity)** before additional recharge can occur. Extra time between recharge events to perform any necessary cultural practices is not included.

This is a conservative model; observations in the field have shown a range of recharge application amounts, some of which exceed the amounts determined by this model. Dry down periods can vary as well; the table also displays shorter dry down periods that have been observed in the field. In addition, several assumptions went into the model, and the values in the table should not be applied to fields without site-specific assessments prior to conducting recharge, as well as monitoring the crop and field conditions during and after recharge (e.g., sensors can be used to monitor soil moisture and oxygen levels). **Every field is different – one section of a field can even differ from another – and growers know their fields best!**

Maximum recharge application rates and dry down periods on one acre of a vineyard field based on soil type and size of the turnout delivering water onto the field. SAGBI categories Poor and Very Poor were excluded because recharge is not typically done on these soils.

Soil type	SAGBI rating	Turnout size (cfs)	Flooding period (days)	Maximum application rate (average inches per acre per day)	Minimum dry down period after flooding: model results (days)	Minimum dry down period after flooding: field observations (days)
Sand	Excellent	20	5	24.0	9	~2-3
		5	5	6.0	8	
Loamy Sand	Good	20	5	24.0	20	~3-7
		5	5	6.0	19	
Sandy Loam	Moderately Good	5	5	5.5	33	~3-7
Sandy Clay Loam	Moderately Poor	5	5	3.9	33	~7

ADDITIONAL RESOURCES

Interested in learning more about on-farm recharge? Follow the QR code to explore additional resources, including a recharge efficiency calculator, recharge methods manual, relevant research, and more!

This document was released in August 2026 by the Flood-MAR Network's Recharge & Crop Health Action Team made up of individuals from the following groups: growers, agronomists, academics, farm advisors, plant pathologists, and state agency representatives.