A Technique for Treating Contaminated Soil with Steam for Eradication of *Phytophthora*

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During a series of large riparian restoration projects in the San Francisco Bay Area, Phytophthoras on infected planting stock were inadvertently introduced into a number of sites. There are many planting basins at some of these sites where hosts from a nursery that had a high rate of *Phytophthora* positives were planted. These basins are scheduled for treatment once a potential mitigation approach to kill any introduced Phytophthoras is decided upon. Steaming has been shown to be an effective mitigation treatment to eliminate Phytophthoras from infested soil. In nursery and landscape sites where *P. ramorum* has been detected, steaming soils to reach a temperature of 50 ºC at 30 cm for 30 minutes is an accepted USDA APHIS mitigation treatment. In this project, two steaming techniques were tested. In addition, thermal cover materials for retaining heat in steamed soil were compared. Testing was done at a restoration site in California (CA) and at WSU Puyallup (WSUP).

At the CA site, a 24" diameter steam auger was attached to a hydraulic-powered shaft that passed through a transfer case welded to an excavator bucket. Steam was delivered to the auger via a 2-inch diameter hose that connected a steam generator to the transfer case. Steam was introduced through the auger during soil mixing. In another set of trials the soil was first augured to 24" depth, then a 1.5” diameter injector was used to introduce steam at the bottom of the hole. Temperatures were measured at several depths along the edges of the holes during and after steaming. Testing in a similar soil type at WSUP under several moisture conditions was done using the injector and temperature sensors mounted on a grid inside the hole. The temperature at each point on the grid was measured during and after steaming.

Preliminary results from auger and injector field tests in CA were not conclusive due to saturated soil conditions. Although a steam auger was not tested at Puyallup, the results with the steam injector indicate that the results of at least the steam injector tests at the CA site would have likely been acceptable if they had been done under dryer soil conditions. In the silt loam soil at WSUP, the conditions for killing *P. ramorum* (50 ºC for 15 minutes) and *P. pini*, which has a heat resistant spore stage (50 ºC for 40 minutes) were reached over most of the soil volume when soil at field capacity was steamed for 5 or 10 minutes.

Data collected during the steaming at both sites indicated that there is little risk of a negative impact to organisms in the bulk soils adjacent to augured and steamed planting basins unless the soil has larger channels for the steam to move outside of the soil in the augured hole.

A thermal cover used after steaming will retain heat in the soil after 10 minutes of steaming when sufficient heat has accumulated. There was little difference between the steamed, uncovered plots and plots with some type of thermal cover after 5 minutes of steaming. After 10 minutes, the differences between thermal cover treatments were significant at all depths. The

materials that prevented the most heat loss from the soil were an insulated metal drain pan, rubber floor mats, and denim insulation.