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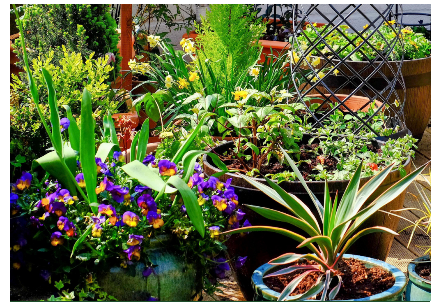

Addressing the Impacts of Wildfire on Water Resources

Fact Sheet 6.706 Natural Resources Series | Water

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Impacts to Drinking and Waste Water

Following a wildfire, the primary source of contamination to drinking water is from chemicals and microorganisms that can enter a fire-damaged well system. Human health could be adversely affected from either short or long term exposure to contaminants in the water and sediment may cloud water, or cause it to taste or smell smoky or earthy. Moreover, fire retardants can cause water to temporarily turn a reddish color. Fire retardants, made up of ammonium based compounds containing phosphate or sulfate, are usually red in color due to a small percentage of iron oxide (Figure 1). Generally considered harmless to humans and land animals, fire retardants do have some level of toxicity to aquatic organisms. The most toxic component of a retardant product is the corrosion inhibitor.

Figure 1. Fire retardant seen on trees two months after the High Park Fire in 2012. Photo by J. Kallenberger.

If a fire retardant was used near a wellhead, it could possibly seep into the well over time, particularly if the wellhead was damaged, or if it is located in an area where storm water drains. In these situations, monitoring ammonia and nitrate concentrations for a period of several months is recommended.

Assessing Your Drinking Water System

Following a wildfire, homeowners using a private well system are encouraged to first complete a visual inspection of their system and then promptly repair any damage before use. Typically, the underground components of the well, pump, and septic system are often unharmed by wildfire, while the wiring at the top of the well, the junction box, and PVC casing may be damaged. Damage to electrical wires, controls, pipes, tanks, and other components may affect system operation as well as compromise the safety of the water supply, or affect the proper disposal of wastewater. If the outside of your home or the yard area near your well has burned, you should have a licensed well technician inspect the system. The pump may be functioning; however, burned wires not visible from the surface could result in problems with the pump.

Quick Facts

- Fire damage to ground level and underground structures can lead to well contamination and malfunction of wastewater systems.
- Well owners need to inspect and test well and septic systems following impact by wildfire.
- Wildfire impacts to irrigation water quality will most likely be from high levels of sediment and ash and a potential change in pH.
- Keep bottled water on hand for cooking and drinking until certain that well water is safe.
- f ponds have been adversely affected by post-fire ash and sediment, provide an alternative water source for livestock until steps have been taken to assure water quality.

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If you do not have power to your home following the fire, a generator can be used to run the well. Contact a licensed well contractor, electrician, or your power company to determine the proper generator size. The pumping system could be damaged by using undersized generators. Once you have your well working, flush the system both inside and outside the house. If your water still tastes or smells earthy, smoky, or burnt, flush the water lines again and test the water with a certified laboratory for routine well water quality parameters, including metals.

Treatment

Once damage to the system has been ascertained, and if a water test reveals that your drinking water has been compromised, the water should be treated before consumption. Metals, microorganisms, and other contaminants may be removed using the methods described below:

Well Disinfection Private water wells can be disinfected through continuous chlorination or shock chlorination.

Continuous Chlorination. A chemical feed pump is used to directly dispense chlorine into the well. Depending on the chlorine concentration, pH, and water temperature, the required contact time varies. For simple chlorination, the chlorine concentration is maintained at a low level of 0.2 ppm to 0.5 ppm with a minimum contact time of 30 minutes. In super chlorination, chlorine residues of 3 to 5 ppm are produced for approximately 5 minutes of contact time.

Shock Chlorination. This is the preferred method for disinfection of private water wells given its low cost, simplicity and effectiveness in most situations. This method of treatment is recommended for newly installed wells. It is a one-time treatment that is designed to kill bacteria in both the well and water system. The diameter of the well and the depth of water determine the amount of chlorine to be used for treating the well. The volume of water in the well can be determined using Table 1. Table 2 can be used to determine the amount of chlorine needed per 100 gallons of water in the well. An additional 100 gallons is added for the plumbing system.

Given the dangers posed by the use of chlorine gas for private well disinfection, most often liquid chlorine (sodium hypochlorite) or dry chlorine (calcium hypochlorite)is used. Sodium hypochlorite is the disinfectant in laundry bleach.

It should be noted that bleach loses its disinfecting capacity over time; therefore a fresh container of bleach should be used, free of fragrances and other additives. Electricity to the well should be turned off prior to starting the disinfection process. The exterior and accessible interior surfaces of the well should be scrubbed clean using a strong chlorine solution (1/2 gallon of chlorine laundry bleach per 5 gallons of water). This strong chlorine solution should be used to clean the well cap prior to removal. A 200 ppm solution of chlorine can be used in the well and plumbing system for at least 2 hours, but preferably overnight.

It should be noted that solutions above 200 ppm can cause the water to be too alkaline and reduce the effectiveness of the disinfection process. After removal and disinfection of the well cap, the diluted chlorine solution should be poured into the well. Water is then run back down the well for at least 15 to 20 minutes in order to recirculate the chlorinated water. The sides of the well casing and pitless adapter should be thoroughly rinsed during recirculation.

The household plumbing system should then be disinfected. Carbon filters or reverse osmosis equipment should be bypassed or disconnected prior to disinfection of the plumbing system. Both the cold and hot water faucets should be opened (one at a time) to let water run through until a strong chlorine odor is detected from each faucet. Toilets should also be flushed until a chlorine odor is obvious. The chlorine should be allowed to stand overnight once it has reached all points of the system. The following day, the chlorinated water should be flushed out of the system.

Water Disinfection Filter

To disinfect by filtering, run your water through a two-micron filter (or smaller). Activated carbon, ultrafilters, or reverse osmosis filters can also be used. Cleaning the filter is essential to keep both a high rate of water filtration and bacteria from developing. Boiling. To disinfect water by boiling, bring the water to a rolling boil for a least one minute. Boil longer at high attitudes or if the water is from a source suspected to have Giardia or other protozoa (five minutes boiling time is recommended at 10,000 feet above sea level). Boiling will kill microorganisms, though it will concentrate non-volatile chemical contaminants. Therefore, it is unwise to boil for longer than necessary.

Table 1. Storage capacity of well casing or pipe

Well Diameter (inches)	Storage per foot of water depth (gallons per foot)
2	0.16
3	0.37
4	0.65
5	1.02
6	1.47
8	2.61
10	4.08
12	5.87

Allow the water to cool for at least 30 minutes before use. You can re-oxygenate the water by pouring the water back and forth between two clean containers to help improve its taste.

Emergency Drinking Water Supplies

Until you have assessed and repaired any damage to your well, consume an alternative source of drinking water. If fire has damaged the well to a point where an electrical problem has occurred and no water is coming to the tap, small amounts of emergency drinking water can be acquired from the hot water heater or the pipes in your home. To use the water in your hot water tank, first turn off the gas at the intake valve or turn off the electricity at the circuit breaker by unplugging the unit. Place a clean pail or bucket under the drain at the bottom of the tank to recover the water. The drain may look very similar to an outdoor water faucet. Remember, the water coming from the tank can be very hot. Turn off the water intake valve (usually located above the water heater) and open a hot water faucet at one of your sinks. This provides a vent so that water can flow from the tank. Only after the water at the main supply valve and the intake valve of the hot water tank are turned back on and the hot water tank is filled with water should the gas or electric be turned on to the hot water heater. To use the water in your pipes, let air in by turning on the faucet at the highest level in your house; then use a clean container to capture water drained from the faucet located on the lowest level in your house.

Table 2. Chlorine mix ratio for a 200 ppm solution

Chlorine Product	% Active Chlorine	Amount needed for 200 ppm solution
Liquid laundry bleach	5.25 %	3 pt/100 gallon
Concentrated chlorine bleach	12-17 %	1 pt/100 gallon
Chlorine powder	25-30 %	11 oz/100 gallon (2/3 lb/100 gallon)
Chlorine tablets	65-75 %	4 oz/100 gallon (1/4 lb/100 gallon)

The above tables can be utilized as follows: Given a 6-inch diameter well casing with a depth of 150 feet and 50 feet to the static water level. The volume of water stored in the well casing can be estimated from Table 1 as: 100 feet of water x 1.47 gal per foot of 6" pipe = 147 gallons. An additional 100 gallons is added for the plumbing system. Therefore, approximately 250 gallons of water needs treatment. If using liquid laundry bleach for treatment, from Table 2, 3 pints of bleach is required per 100 gallons. Therefore for 250 gallons, 7.5 pints of bleach is required.

Assessing Your Wastewater System

Onsite wastewater (septic) systems have most of their functional components below ground and are typically more resistant to fire damage. However, it is important to inspect your system for damage to PVC piping above or near the ground that may have been affected by heat. If your wastewater disposal system has been damaged, or if your system is backing up or malfunctioning, discontinue use and contact your local health department for guidance and instruction on repair and restoration of the system.

Impacts to Livestock Water

Following wildfire, surface water bodies—such as ponds and streams—are vulnerable to an influx of sediment, ash, fire retardant, nutrients, and other potential contaminants. Testing the water prior to turnout of livestock is recommended if you suspect the quality of your pond water has been impacted. Ash may contain trace levels of lead, antimony, arsenic, copper, mercury or zinc, but concentrations in water that exceed guidelines for livestock drinking water have rarely been documented. Indications that livestock have consumed poor quality water often include reduced food and water intake and changes in behavior and performance. If livestock appear to have signs of sickness, a veterinarian should be consulted and an alternate water source should be used until their normal drinking source has been tested and treated. Assuming your pond is refreshed by clean stream water or groundwater, its quality should improve over time. However, if steps are not taken to prevent up-gradient erosion, the pond water can continue to deteriorate.

Impacts to Fish and Wildlife

Large quantities of post-fire sediment and ash can overwhelm the habitat requirements for fish, as well as organisms that depend on water for some life stage, such as amphibians and insects. Although wildlife might be directly affected in the wake of a fire, they are not usually affected by water quality issues because of their ability to travel to new water sources. However, continued monitoring and inventory of fish and other aquatic organisms in a fire-impacted area is warranted.

Impacts to Irrigation Water

Surface water that has deteriorated due to runoff from a fire is usually dark in color. It may have an increase in pH (will become more basic), total salt content, ash, and sediment concentration. A pH greater than 8.5 is considered high for irrigation water and can temporarily affect the availability of some plant nutrients and increase the sodium hazard if the water already has a high sodium adsorption ratio. In most cases, however, high concentrations of ash and sediment will be more of a physical problem with irrigation infrastructure and systems than a chemical hazard to crops. These components can clog filtration systems of sprinklers and drip systems, restrict head gates and diversion structures, and settle out in canals and ditches, reducing flow. The use of settling ponds and the addition of linear polyacrylamide may be one solution for reducing excessive sediment and ash if these are causing significant problems. In some cases, however, the increase in sediment may be beneficial as it can help seal leaky ditches and canals.

Improving Surface Water Quality

Post-fire delivery of ash and sediment is the greatest concern for surface water health following a wildfire. High-alkalinity runoff from burned areas may increase surface water pH temporarily but tends to become neutralized as it is diluted by sufficient quantities of fresh water. Maximum impacts from ash and other fine-grained sediment tend to occur soon after the fire though may linger for several years. Ash input can contribute to increased nutrient levels as well; concentrations return to pre-fire conditions within several days to several months. To help improve surface water quality that could be adversely affected by post wildfire runoff, landowners can implement hill slope or channel treatment to trap sediment and prevent erosion (Figure 2). Hill slope treatment tends to be the most effective post-wildfire treatment; channel treatment is usually considered if hill slope treatment has proven ineffective. For the best location to install these treatments, landowners should assess the damage to their streams, ponds, and property.

Damage will most often be visible in the form of increased erosion of upstream land or increased turbidity of the water body. If damage is not extensive, treatments may not be necessary, and natural processes will allow the area to return to its original state.

Seeding, a common form of hill slope treatment, establishes barriers through plant growth. Seeding of a hill slope is often accompanied by an initial layer of mulch, certified weed-free straw, woodchips, or fertilizer. Other forms of hill slope treatment use physical barriers (i.e., logs, hay bales, sand or soil bags, fencing, trenches, and geotextiles) set perpendicular to the hill slope. Hill slope treatment also involves disturbing the ash, sediment, and soil to increase soil infiltration. Mechanical methods, such as a tractor pulling a harrow, are the usual means to increase soil infiltration.

These practices can increase a potential supply of sediment unless the ground disturbance is followed by a substantial application of mulch, certified weed-free straw, or wood chips. In severe fires, the combustion of vegetative materials at the soil surface causes the soil to form a waxy layer that repels water, a phenomenon called hydrophobicity. This hydrophobic condition increases the rate of water runoff and can overwhelm water bodies in the event of thunderstorms.

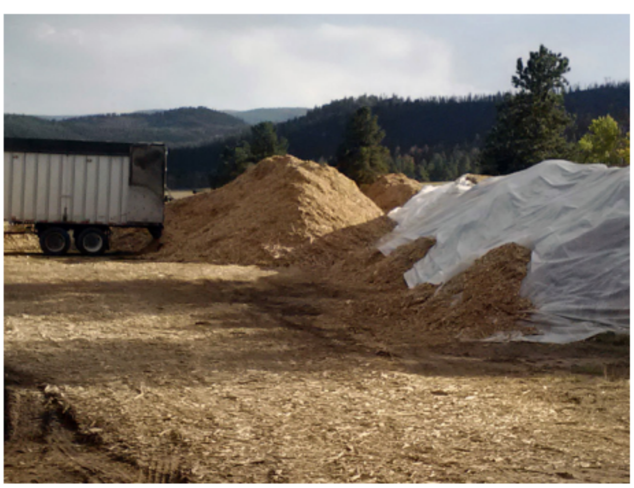

Figure 2. Mulch ready to be installed as a hill slope treatment shortly after the High Park Fire in 2012. Photo by B. Grotz.

Commercially available straw wattles and silt fences can be purchased and installed in areas where runoff is more dispersed over a broad flat area. Replacing lost organic matter on the soil surface will help to initiate the microbial activity that is important for reducing the hydrophobicity of the soil. Spreading pine needles or large organic material near streams or ponds to intercept runoff is also a common practice.

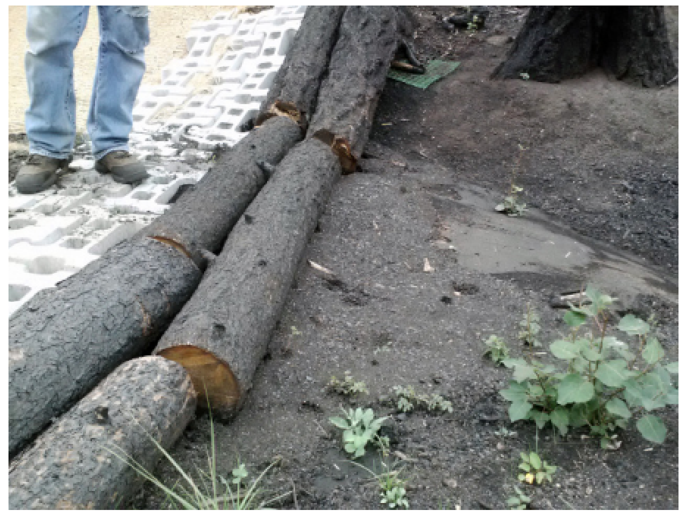

Figure 3. Sediment collected at the front of a log dam. Photo by B. Grotz.

Channel treatment involves installing temporary, in-stream stabilizers and check dams with the goal of preventing high speed runoff from downcutting the channel and eroding downstream riparian areas. Stabilizers slow the water in a stream by adding a physical barrier for the water to pass over; however, a stabilizer does not serve to trap sediment. Dams, on the other hand, collect sediment by detaining water for a period long enough for particles to settle out. Sediment, ash, and other material that has deposited above a dam must be removed (Figure 3). Once debris transport and erosion are reduced, hill slope and channel treatments can be removed and the ecosystem should be left to replenish itself