Surface irrigation systems with water reuse deliver *E. coli*

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Abstract

The US Food and Drug Administration proposed in 2013 to adopt the EPA's primary contact recreational water standard (235 colony-forming units (CFU) *E. coli*/100ml and 126 CFU *E. coli*/100ml on a 5-sample geometric rolling mean) for as the water quality standard for vegetable crop production. In the Treasure Valley of Oregon and Idaho, surface irrigation water delivery systems maximize scarce water by reusing runoff water from other growers. Agricultural drain water is mixed with relatively clean project water to provide ample supply to all growers. Agricultural drain water in runoff reuse systems enhances the amount of water available but results in *E. coli* contaminated water.

Introduction

In 2011 Congress, through the Food Safety Modernization Act, assigned the Food and Drug Administration (FDA) the task of creating food safety standards for fresh produce. FDA's proposed rule for fresh produce was published at the beginning of 2013 and comments were due by 15 November 2013. FDA's proposed rule would require weekly testing of surface irrigation water by growers. The proposed standard is identical to the EPAs primary contact recreational water standards. If the water exceeds 235 colony-forming units (CFU) of *E. coli* in any one sample or 126 CFU in the average of any five consecutive samples, growers would have to cease using that water in any way that directly contacts the surface of fresh produce. Onion growers would have no option but to cease irrigation. Fruit producers would be unable to use that water for cooling sprays. If adopted, these rules could provide a strong disincentive to local growers.

Throughout the Intermountain West, many irrigation water delivery systems rely on the reuse of water to provide a scarce resource to multiple users. In these systems, return flows of on-farm runoff water are added to source water to be delivered onward to downstream farms. Even where source water would meet EPA's stringent primary contact recreational water standards, as it does in many of the impounded waters of the Intermountain West, only the first users of this water would be able to meet the FDA's proposed agricultural water standards. On-farm runoff waters carry substantial bacterial loads contributed by livestock and wildlife including small mammals and birds. These runoff waters can be intermixed with source water to provide sufficient quantities for delivery to downstream users. With successive on-farm uses, bacterial loads in surface irrigation water tend to increase. Bacterial loads in agricultural drain waters typically far exceed the FDA's proposed agricultural water standards for much of the irrigation season.

Different irrigation systems in the region differ in their exposure to this potential regulatory risk. In the Treasure Valley of Oregon and Idaho runoff reuse has been the primary water conservation method throughout the history of the system. Without the reuse of runoff, it would not be possible to supply water to all the current acreage. In particular, furrow irrigation dominates the landscape. Furrow irrigation uses water intensively and returns much of that water as runoff.

Although irrigation in the region shares a similar technological history, many Magic Valley Idaho and Eastern Idaho growers converted to large scale sprinkler systems beginning around the 1950s. In these systems there is limited runoff. The irrigation delivery systems no longer depend on returned runoff water; however, the potential for *E. coli* contamination still exists in the long stretches of unfenced open canals that cross rangelands and natural habitat have the potential to contaminate water supplies with *E. coli*.

Four U.S. Bureau of Reclamation (USBR) projects within Idaho and Malheur County, Oregon generate irrigated crop farm gate value of $1.933 billion and provide water to support a livestock industry worth $1.337 billion. The USBR Owyhee Project generates yearly irrigated crop farm gate value of $135 million and provides water for an $81 million livestock industry (USBR, 2009). The two divisions of the USBR Boise Project generate yearly irrigated crop farm gate value of $581 million and provide water for a $600 million livestock industry (USBR, 2012). The USBR Minidoka Project generates yearly irrigated crop farm gate value of $642 million and provides water for a $342 million livestock industry (USBR, 2010a). The USBR Palisades Project in the Upper Snake River Valley provides "supplemental water for about 650,000 acres of irrigated lands in the valley. Principal crops are grain, alfalfa, pasture, dry beans, potatoes, sugar beets, other vegetables, and seeds" totaling $575 million. The project supports a $314 million livestock industry (USBR, 2010b).

Historical water quality

To discover the extent to which delivered surface water fails to meet the proposed standard we analyzed the historical water testing results. This analysis was limited to the available data. Although many growers test water for *E. coli*, the risks of regulation and litigation make growers leery of contributing these data toward a public record. Since on-farm data are not accessible, the analysis of historical *E. coli* loads in surface irrigation water relied on test results in the public domain. The water testing sites, in roughly descending order of availability, consisted of streams, reservoirs, ponds and wetlands, agricultural drains, and canals. We relied on these indirect measures to show the pattern of microbiological loads in water that is delivered to growers.

The analysis show that although source waters in the region carry low *E. coli* loads that would nearly always meet the standards of the proposed rule, agricultural drains and streams with high runoff returns carry high loads of *E. coli*. Most have historically exceeded, often frequently, the 235 CFU single-sample standard of the proposed rule.

The Food Producers of Idaho commissioned an historical water quality database comprising 33,901 surface water *E. coli* samples from Idaho and Malheur County, Oregon covering twenty-one years (1993-2013). These historical samples are either in the public domain or have been contributed to our database by irrigation districts and watershed councils. Analysis of this database shows definitively that the conservation practice of returning runoff flows to be combined with source water that meets the EPA primary contact recreational water standard causes the combined water to consequently to fail to meet the *E. coli* water quality standards of Section 112.44(c), barring dilution by an overwhelming quantity of source water. This effect can be shown in irrigation systems within the U.S. Department of the Interior Bureau of Reclamation (USBR) Owyhee Project in Malheur County, Oregon and, and Boise Project Payette Division, Boise Project Arrowrock Division (USBR 2009, 2012). Agricultural drains that fail to meet the *E. coli* water quality standards of Section 112.44(c) and small streams that receive runoff return flows, consequently failing to meet the *E. coli* water quality standards of Section 112.44(c) can moreover be found throughout the USBR Minidoka Project and USBR Palisades Project (USBR 2010a, 2010b).

Example of the Treasure Valley:
As an example of the water bodies in the Treasure Valley, irrigation systems mix clean water with runoff water. Runoff water in the Owyhee River basin typically has around 570 CFU /100 ml. Runoff water in the Malheur River basin typically has around 1,000 CFU /100 ml. Some water *E. coli* levels are very high.

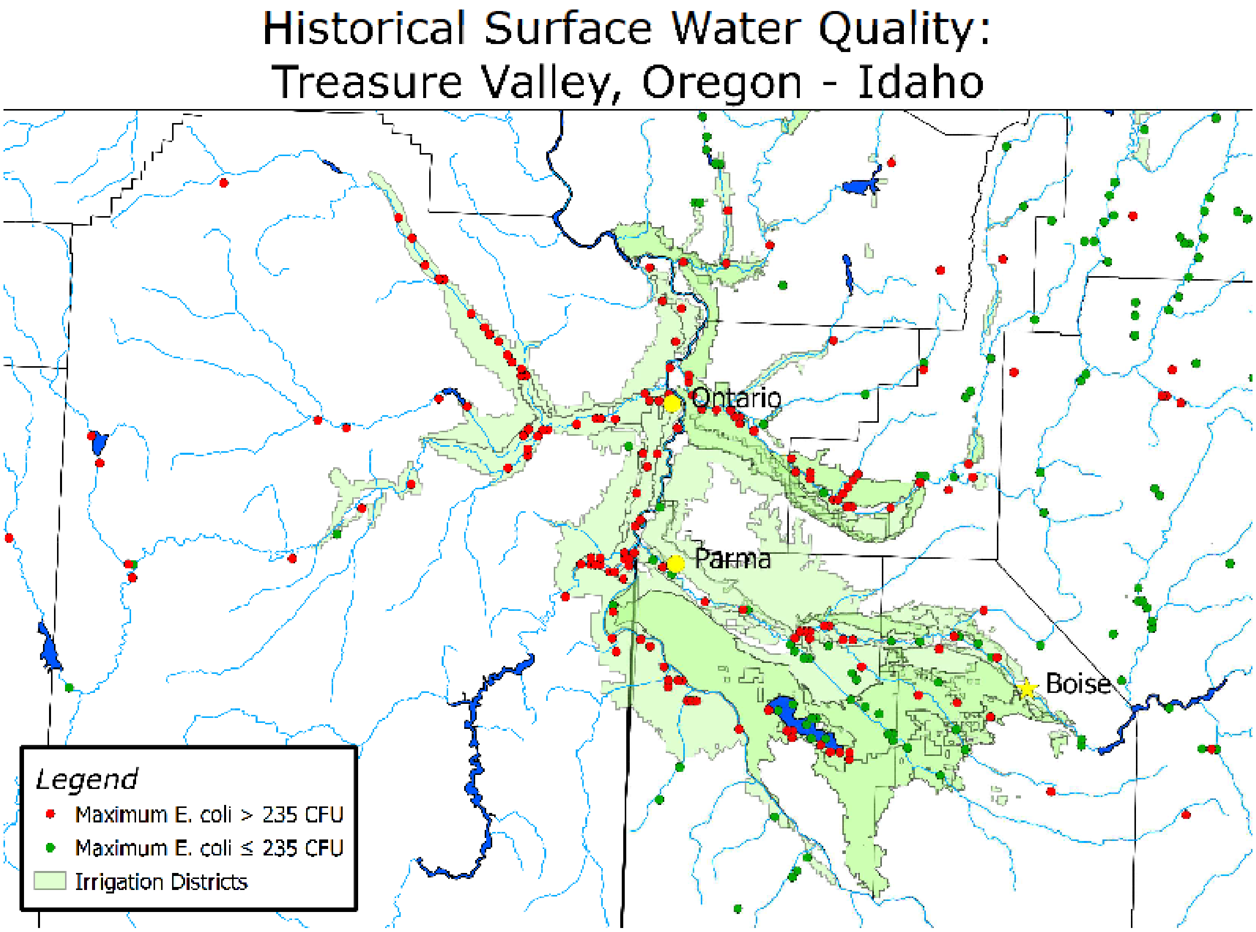

Figure 1. The Treasure Valley of Oregon and Idaho straddles the Snake River. Irrigation water is delivered predominately by gravity fed ditches. The ditches both deliver water to farms and collect runoff from adjoining irrigated land uphill from the ditch. Irrigation water often exceeds 235 CFU of *E. coli*.

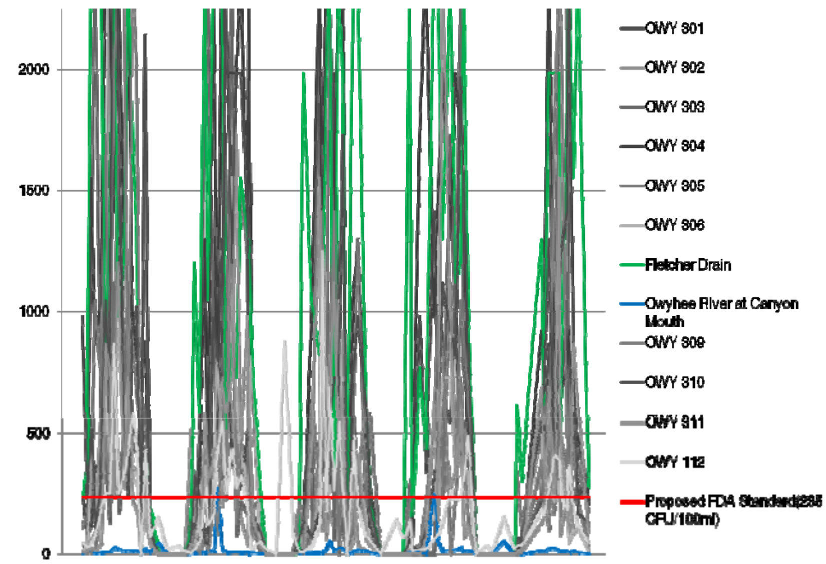

Figure 2. Variations in the *E. coli* levels are very large in the drains and other sampling sites in the Owyhee Basin.

We conclude that growers receiving water with a significant proportion of returned runoff cannot rely on receiving surface irrigation water that would meet the proposed rule throughout any irrigation season.

There are many ongoing efforts to improve irrigation systems in the Owyhee and Malheur River Basins. It might eventually be possible to redesign irrigation water delivery systems to deliver clean water to each farm.

References

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