Clean Water Services

Ms. Nina DeConcini
Northwest Region Administrator
Oregon Department of Environmental Quality

Ms. Lillian Shirley
Public Health Director
Oregon Health Authority

Dear Ms. Deconcini and Ms. Shirley:

Thank you for your letter dated May 2, 2014 regarding Clean Water Services' (District) goal to develop and maintain an innovative recycled water program that conserves waters of the state while protecting both public health and the environment. In your letter you expressed commitment to working with us on a specific proposal for human consumption of recycled water and noted your appreciation of maintaining clear communication on this topic. Your letter also requested a written proposal from the District and described what should be included in the proposal. The attached report describes the project that the District proposes and provides the supporting information that you identified. Avis Newel, Tualatin Basin Coordinator from DEQ, has in a subsequent email outlined a schedule for review and comment which we anticipate working with for our continued discussion. The pilot is summarized below.

We are implementing a pilot project to produce high purity water. This project monitors the results from a range of advanced treatment process to demonstrate the level of purification that can be achieved. The pilot project provides an opportunity to raise awareness and foster discussion about high purity water and the reusable nature of all water.

The District proposes a pilot project to create high purity water for potable re-use from advanced secondary treatment plant water available at our Forest Grove Facility to demonstrate the different uses for high purity water including products suitable for human consumption. The pilot will use well established treatment technology including ultrafiltration, reverse osmosis, and advanced oxidation to provide water that far exceeds drinking water standards and make that water available to craft brewers to make limited edition craft beer.

The District is working with Oregon Brewers Guild and the Oregon Brew Crew Homebrewers Association to use the high purity water to make select craft beer for non-commercial non-retail use. The amount of beer made will depend on the interest and volumes practical for the selected commercial and home brewers. To raise awareness our partners' will use the high purity water to make approximately 5-10 barrels of craft beer.

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The craft beer will be made available at tasting events that could include District sponsored events or selected water professional society events. The District is also partnering with professional societies expressing interest in the proposal including the Water Environment Federation and the WateReuse Association. By highlighting craft beer, a product Oregon is known for around the world, the project will seek to engage industry professionals, public leaders, and people everywhere in a conversation about water.

The attached report provides greater detail describing the proposal, treatment technology that will be used; supporting information as requested, and the monitoring that will be used to demonstrate the quality of the high purity water. Please let me know if you need any further information. I look forward to hearing back from you and arranging the opportunity to discuss the pilot with you.

Sincerely
Robert Baumgartner

Assistant Director
Regulatory Affairs Division
Clean Water Services

CLEAN WATER SERVICES

HIGH PURITY WATER PROJECT

DIRECT POTABLE WATER
REUSE DEMONSTRATION

DRAFT
June 20, 2014

Produced by

Clean Water Services

carollo

In association with

NWRI National Water Research Institute

CLEAN WATER SERVICES

HIGH PURITY WATER PROJECT

**DIRECT POTABLE WATER
REUSE DEMONSTRATION**

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DIRECT POTABLE WATER REUSE DEMONSTRATION

This document is a collaborative effort, prepared by Andrew Salveson (Carollo Engineers), a registered professional engineer in California and Texas, with review and guidance from Clean Water Services staff, including; Adrienne Menniti, Ph.D., PE (Oregon), Rick Shanley, PE (Oregon), Bob Baumgartner, and Steve Thompson. Jeff Mosher, the Executive Director of the National Water Research Institute, provided peer review. Equipment and installation support for this potable water reuse demonstration project was provided Clean Water Services staff, supported by Evoqua (formerly Siemens) and Trojan Technologies.

1.0 BACKGROUND

Water is one of our most precious resources. We take it for granted that we can turn on the tap and fill our glass with safe water. However demands on our water supplies from a growing population and environmental pressures are threatening water supplies for our communities, farms, and rivers. As the demand increases for reliable, sustainable water supplies, attention has turned to treated wastewater as a source of water. Clean Water Services (CWS) has Oregon's largest water reuse program and is exploring further options to address water needs within the Tualatin River Watershed. Alternative water sources are critical as a bridging strategy in light of the delay of the Tualatin Basin Water Supply Project (TBWSP). In addition, local water providers are interested in alternatives to address future water shortages.

CWS produces a high quality wastewater effluent that can be recycled. Advanced water treatment technologies make it affordable and feasible to treat water to any level. As a result, CWS is conducting a pilot project to treat municipally treated water to produce high purity water that could be used for a variety of purposes, including semiconductor processing, agriculture and food crops, product manufacturing, and human consumption., Existing drinking water regulations in Oregon do not address the potable reuse of recycled water. However, other states (California, Arizona, and Texas) have potable reuse regulations and projects in place. CWS is interested in demonstrating to the public that advanced treatment of wastewater can be a viable source of water supply.

Through a pilot project, CWS will demonstrate the ability to produce a high quality water through advanced treatment processes. CWS is working with other interested groups in the U.S. to advance public awareness and understanding of water as a reusable resource.

For this effort, CWS's goal is to provide the Oregon Environmental Quality Commission with documentation on the performance of the advanced treatment facility to allow the production of highly purified water to be used for potable purposes. One purpose would be to brew beer that would then be made available to interested participants at a national water trade show. Oregon's craft brewers are eager to participate because they are seeking more sustainable practices for brewing beer.

Based on information from other efforts, CWS has constructed and tested an advanced treatment system with a production capacity of 1.1 gallons per minute (gpm). The treatment processes include: ultrafiltration (UF), reverse osmosis (RO), and ultraviolet light advanced oxidation process (UV AOP). These processes are used in series to purify disinfected secondary effluent from CWS's Forest Grove Facility (FGF). The testing, as documented in this report, demonstrates a purified water suitable for potable use and public consumption.

This testing had several goals:

- Demonstrate the performance of the advanced treatment technologies to the Oregon Department of Environmental Quality (DEQ) and the Oregon Health Authority (OHA);
- Review the relevant literature on indirect potable reuse (IPR) and direct potable reuse (DPR), in terms of treatment, public health protection, and implementation nationally and internationally;
- Provide the public with information and confidence regarding the ability of our industry to provide high purity water for various potential uses, including potable reuse.

1.1 Potable Reuse Demonstration

Successful potable reuse projects nationally and globally demonstrate the safety of the technology to purify wastewater. The single greatest barrier to potable water reuse is public perception. The "yuck" factor is strong in some communities looking to implement potable water reuse. As observed by USEPA (2012), the technical issues of potable reuse can be addressed through advanced treatment; however, thesignificant task is to develop public education and outreach programs to achieve public acceptance of this practice[2012]). To initiate engagement of public discourse, the demonstration testing at the FGF includes a limited demonstration of product manufacturing for human consumption. The project team envisions working with local brewers to provide a limited batch of beer that would be made available to individuals at internal District events and at hosted events at professional society meetings (e.g., WEFTEC, NACWA) for the purpose of generating professional discussion of the use of highly purified water systems. Once regulatory approval is obtained, the pilot project would create single batches of less than 1,000 gallons of purified water. The batches of purified water will be contained in individual secure totes, which would be later used by the brewer for beer. Prior to the production of purified water for use, a series of tests were run to document treatment performance, as detailed further on in this document in the section titled "Batch Production Quality Control."

1.2 Potable Reuse Projects

Throughout the United States it is common for drinking water plant intakes to be downstream of wastewater facilities. The U.S. National Research Council (NRC) of the National Academies adopted the term “de facto” reuse (NRC, 2012) where secondary treated wastewater is a significant fraction of the drinking water supply, noting that during drought it may constitute the majority of a water body. Water treatment standards are the same regardless of the source.

Planned indirect potable reuse (IPR) occurs when highly purified water is discharged into a groundwater aquifer or surface water reservoir that is a known drinking water source (Figure 1). IPR has occurred in the United States for decades and is continuing to grow. It is called “indirect” because there is an environmental buffer between the purified water discharge and the drinking water intake.

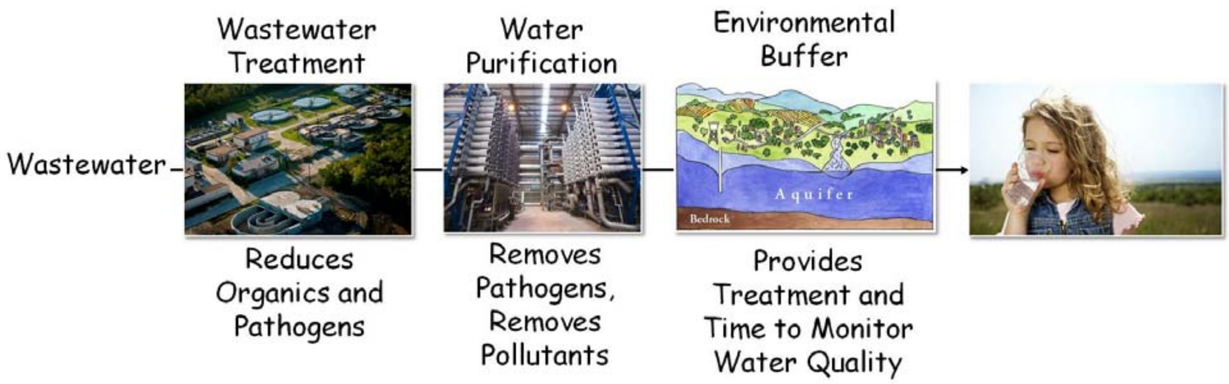

Figure 1 Potable Reuse Using Advanced Treatment and an Environmental Buffer

DPR applications do not include an environmental buffer and discharge purified water immediately upstream from a drinking water intake, blend purified water with conventional drinking water, or introduce purified water into a potable water distribution system (Trussell *et al*., 2013), as shown in Figure 2. DPR is held to the same high treatment standards as IPR. The environmental buffer functions primarily to help detach the public’s association of the purified water from its wastewater origin. The NRC (2012) concluded that it cannot be demonstrated that such natural barriers provide public health protection that is not also available by other engineered processes, such as those used by the pilot treatment technologies detailed in this report. As water sources become more constrained worldwide, DPR is becoming more common and is in use in the United States., It will soon be implemented in Wichita Falls Texas and the Village of Cloudcroft New Mexico.

Figure 2 Potable Reuse Using Advanced Treatment with Treatment Redundancy and Improved Monitoring, but without an Environmental Buffer

The NRC concluded that environmental buffers in most potable reuse systems provide no public health protection that is not also provided by processes such as advanced treatment trains and reservoir storage. The NRC recommends eliminating the distinction between indirect and direct potable reuse to focus instead on the single concept of potable reuse (NRC, 2012).

As highlighted in Trussell *et. al.* (2013), IPR projects have been successfully operated for more than 40 years in the United States. Treatment processes vary, from spreading projects using water equivalent to DEQ's Class A standards to advanced membrane and advanced oxidation processes, resulting in a water that is nearly pure H_2O and requires stabilization prior to distribution and use. These IPR projects are not confined to the United States, with similar successful projects being done internationally. Many of these treatment processes are listed in Trussell *et. al.* (2013), with a few highlighted here:

- Primary Treatment, Secondary Treatment, Media Filtration, Chlorination or UV Disinfection, Surface Spreading and Groundwater Recharge – County Sanitation Districts of Los Angeles California, Inland Empire Utility Authority California
- Primary Treatment, Secondary Treatment, Membrane Filtration (microfiltration [MF]), RO, and UV AOP, Direct Injection into the Groundwater – Orange County Water District California, West Basin Municipal Water District California

DPR is also now operational in one location in the United States, the Colorado River Municipal Water District's Raw Water Production Facility in Big Spring, Texas. This facility, in operation since Spring 2013, accepts municipal wastewater effluent that has already undergone primary treatment, secondary treatment, and tertiary filtration, and further treats it with MF, RO, and UV AOP. This new water is then blended (20 percent purified water, 80 percent conventional raw water) with the conventional raw water supply and subjected to sand filtration and chlorination at one of several water treatment plants. A second DPR example is Windhoek Namibia, where they have been using DPR for decades and successfully protecting public health.

1.3 Public Health

The safety of potable reuse is best defined by a recent NRC report in which the authors examine three water use scenarios and compare the relative risk due to water consumption. Potable reuse was deemed to provide equal or higher quality water, in terms of public health risk, compared to our standard practice of water treatment (NRC, 2012). The three scenarios are summarized below.

- Scenario 1: A conventional water treatment plant extracts water from a river that is 95 percent “fresh” water and 5 percent treated wastewater. The wastewater is a primary and secondary treated wastewater, disinfected to a standard of 200 fecal coliform/100mL. The surface water is assumed to be 100 percent free of pathogens with no measurable trace organic chemicals prior to combining with the treated wastewater.

- Scenario 2: A utility treats wastewater with primary treatment, secondary treatment, and sand filtration, with no disinfection, then spreads the water for groundwater recharge, and later extracts the water for public consumption with no further treatment other than a chlorine residual. For this example, there is 0-percent blending with other groundwater, resulting in 100-percent potable reuse to the customer.

- Scenario 3: A utility treats wastewater with primary treatment, secondary treatment, MF, RO, and UV AOP, and then injects the water for groundwater recharge, later extracting the water for public consumption with no further treatment other than a chlorine residual. For this example, there is 0 percent blending with other groundwater, resulting in 100-percent potable reuse to the customer.

The three scenarios are compared for pathogen risk and pollutant risk, and the results support the safety of potable water reuse. For Norovirus, Adenovirus, Salmonella, and Cryptosporidium (the only examined pathogens in this work), Scenario 2 provided a safer water for public consumption by a factor of safety of 10 to almost 10,000. For Scenario 3, the safety increase was greater, with a factor of safety of 1,000,000. Regarding chemical constituents, the analysis is more extensive, examining the relative risk related to disinfection byproducts (11 chemicals), pharmaceuticals (7 chemicals), and “other” (6 chemicals). Disinfection byproduct safety is similar for the three Scenarios, but Scenarios 2 and 3 do have the least risk. Pharmaceutical risk is least for Scenario 3, as is the risk due to “other” chemicals.

This risk analysis clearly concludes that potable reuse with specific treatment trains is safe. Epidemiological work, also summarized in NRC (2012), provides further support. Key summarized items in NRC (2012) include:

- Windhoek Namibia, in operation since 1968, with up to 35 percent of the water supply being reclaimed water. “Epidemiological evaluations of the population have found no relationship between drinking water and diarrheal disease, jaundice, or mortality.”

- Montebello Forebay Project (County Sanitation Districts of Los Angeles), in operation since 1962, with 4 percent to 31 percent of potable water being reclaimed water. Three sets of studies have been conducted, evaluating mortality, morbidity, cancer incidence, and birth outcomes. “The authors concluded that the study results did not support the hypothesis of a causal relationship between reclaimed water and cancer, mortality, or infectious disease.”

As one last point, the California Medical Association (CMA) published an open letter to WateReuse California, dated November 14, 2012, which states “That CMA encourage efforts to expand potable and non-potable water reuse” (CMA, 2012).

1.4 Regulatory Framework

At this moment, DPR regulatory efforts are underway in Texas, New Mexico, California, and nationally. These regulatory efforts may provide useful reference for process and quality control. While DPR is not currently regulated in Oregon, per Oregon Administrative Code (OAR), DEQ may approve other beneficial water reuse purposes currently not identified in rule [OAR 340-055- 0016(6)] and as conditioned for potable re-use [OAR 340-55-0017(5)].

1.4.1 <u>DEQ May 2, 2014 Letter</u>

On May 2, 2014, DEQ provided a letter of initial guidance for this project. Within that letter, DEQ and the Oregon Health Authority (OHA) expressed support for the project and outlined key steps for potential approval. These recommended steps are repeated here.

Under Oregon Administrative Rules Chapter 340, Division 55, the use of recycled water for direct human consumption is prohibited unless approved in writing by the OHA, and after a public meeting and authorization by the Environment Quality Commission (EQC) [OAR 340-055-0017(5)]. For regulatory consideration, CWS must submit a written proposal that includes the following information:

- Information described in section 2.2.2 of DEQs recycled Water IMD (http://www.deq.state.or.us/wq/pubs/imds/RecycledWater.pdf) A detailed description of the proposed treatment system.
- Data demonstrating that all current requirements under the Safe Drinking Water Act will be met or exceeded at the point of reuse.
- Data on the treatment, removal and final concentrations of unregulated contaminates (e.g., personal care products, pharmaceuticals, etc.) likely present in wastewater effluent prior to advanced treatment.
- Information on any additional requirements from the Oregon Department of Agriculture or the U.S. Food and Drug Administration or both.

This report includes a detailed point by point response to the above requests, which is detailed in Appendix A.

1.4.2 Groundwater Recharge Regulations in Oregon

While not directly applicable groundwater recharge with Class A water (OAR, 2008) is the currently regulated use of reclaimed water that most closely resembles DPR. Within the OAR, section OAR 340-044-0011(5)(e) allows the recharge, section OAR 340-055-0025(3) defines the recharge, and section OAR 340-040 defines groundwater quality protection. Class A regulations that provide a performance reference include: (OAR, 2008), [OAR 340-055-0012(7)(F)],

- Turbidity of 2 NTU, based upon a 24-hour mean.
- Turbidity of 5 NTU, no more than 5 percent of the time.
- Turbidity of 10 NTU max at any time.
- 7-day median total coliform concentration of 2.2 MPN/100mL.
- Maximum total coliform concentration of 23 MPN/100mL.

Other than the lack of a virus reduction target, these performance criteria are identical to the “tertiary recycled water” criteria found in California (CDPH, 2000). Within California, there are several long-standing groundwater recharge projects with tertiary recycled water that have been operating for over 40 years and are proven to be protective of public health (e.g., County Sanitation Districts of Los Angeles (Trussell *et al*., 2013)).

The Recycled Water Use Rules (OAR, 2008) specifically require the wastewater treatment system owner to demonstrate that recycled water will be used or land applied in manner and at a rate that minimizes the movement of contaminants to groundwater or does not adversely impact groundwater quality [OAR 340-055-0020]. The groundwater rules specify a minimum level of treatment to drinking water standards [OAR 340-040-0020(3)] by the time the recycled water reaches the aquifer.

The Oregon Groundwater Rules utilize Safe Drinking Water act quality to provide numerical quality reference levels and guidance levels for indicating when groundwater may not be suitable for human consumption. The groundwater rules [OAR 340-040-0020(3)] note that among the recognized beneficial uses of groundwater, domestic water supply (drinking water) is recognized as being the use that would usually require the highest level of water quality. Numerical quality reference levels and guidance levels in Tables 1-3 of the groundwater have been obtained from the Safe Drinking Water Act and indicate when groundwater may not be suitable for human consumption or when the aesthetic quality of groundwater may be impaired. Because it is the policy of the Environmental Quality Commission to maintain and preserve the highest possible water quality these reference and guidance levels should not be construed as acceptable groundwater quality. The groundwater rules [OAR 340-040-0030(4)] for permitted operations allows the Director to permit and grant variance for concentrations up to the numerical quality reference and guidance levels.

1.4.3 Indirect Potable Water Reuse Regulations in California

This section summarizes the regulatory monitoring requirements for IPR according to the CDPH (2013), which defines two allowable forms of potable water reuse, surface application (i.e., surface spreading) and subsurface application (i.e., direct injection via injection wells). In general, the regulations for surface spreading require substantially less treatment and monitoring compared to subsurface application. The level of treatment applied for this CWS demonstration project is comparable to that used for a subsurface IPR project in California, and thus only the key CDPH regulations associated with subsurface application are reviewed here.

1.4.3.1 TOC Requirements

For both surface and subsurface applications of recycled water to a drinking water aquifer, CDPH requires low levels of total organic carbon (TOC), as defined in CDPH (2013). For groundwater injection projects that utilize MF or UF, followed by RO and UV AOP, 100 percent injection (no dilution) may be permitted as long as the TOC is maintained at or below 0.5 mg/L, which is readily accomplished with functioning RO membranes. CDPH's goal is to reduce the risk of trace pollutants by maintaining a very low TOC.

1.4.3.2 Pathogen Control Requirements

For both surface and subsurface applications of recycled water to a drinking water aquifer, CDPH requires pathogen control that achieves at minimum 12-log virus and 10-log protozoa (*Giardia* and *Cryptosporidium*) removal or inactivation (CDPH, 2013). In addition to the pathogen control required by CDPH for groundwater replenishment reuse, a target of 9-log removal of total coliform is suggested to conform to the most recent industry recommendations, established by a panel of national experts convened by the National Water Research Institute in the context of WateReuse Research Foundation Project No. 11-02, Equivalency of Advanced Treatment Trains for Potable Reuse (NWRI, 2013). This level of pathogen control is calculated to result in a 1 in 10,000 annual risk of infection due to consumption, which is in accordance with the EPA's standard acceptable risk levels for waterborne pathogens.

1.4.3.3 Treatment System Testing Requirements

Table 1 provides a summary of the testing and monitoring requirements described in the CDPH (2013) for full-scale IPR facilities. These requirements are integrated into this particular CWS demonstration project, as detailed further on.

Table 1 Testing & Monitoring Requirements for Full-Scale IPR (CDPH, 2013)

	Parameter for Direct Injection Projects
Startup Testing	
RO	Weekly TOC
AOP	0.5-log removal of 1,4-dioxane *OR* Occurrence study for CECs
Process Monitoring	
RO	Continuous online monitoring (EC or TOC)
AOP	Continuous surrogate monitoring
Water Quality Monitoring	
Total Nitrogen(1)	2 per week
Regulated Contaminants(2)	Quarterly
Priority Pollutants(3)	Quarterly
Chemicals with Notification Levels(4)	Quarterly
Chemicals "specified by CDPH"	Quarterly
Secondary Drinking Water Contaminants(5)	Annual
TOC	Weekly[4]

Notes:
(1) Total nitrogen samples must not exceed 10 mg/L as N..
(2) Regulated contaminants include (table references from CDPH, 2013): The inorganic chemicals in Table 64431-A, except for nitrogen compounds; the radionuclide chemicals in Tables 64442 and 64443; the organic chemicals in Table 64444-A; the disinfection byproducts in Table 64533-A; and lead and copper. Copies of these tables are provided in Appendix B.
(3) Priority Toxic Pollutants as specified by CDPH, which may include any of the "chemicals listed in the Water Quality Standards, Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, and 40 CFR Part 131, Federal Register 65(97), May 18, 2000, p. 31682" (CDPH, 2013).
(4) Chemicals with California Notification Levels are listed in Appendix C.
(5) Chemicals with secondary MCLs are listed in Appendix D.
(6) Weekly TOC sample is collected as a 24-hour composite and must not exceed 0.5 mg/L. New RO membranes used for IPR must demonstrate a TOC of 0.2 mg/L or less at startup.

1.4.4 Direct Potable Water Reuse Guidelines – New Mexico

The New Mexico Environment Department (NMED) has contracted with the National Water Research Institute (NWRI) to form an expert panel to develop DPR guidelines for New Mexico. Further, the same NWRI expert panel is being asked to review and approve (if warranted) the DPR system under construction in the Village of Cloudcroft. The expert panel (Jim Crook, Joe Cotruvo, Andrew Salveson, Bruce Thompson, and John Stomp) has concluded the initial review of the Cloudcroft facility (based upon a 3-day site visit in May of

2014), met (Figure 3) and reviewed the public health risk from that facility, and made some initial conclusions regarding the particular facility. These preliminary findings include:

- Treatment process is robust and sufficient to protect public health and meet risk standards (NWRI, 2013).
- Additional process monitoring is recommended to improve confidence in the final product water:
  - Online TOC to monitor RO performance.
  - Online chloramines to monitor UV AOP performance.
  - Online CT to measure chlorination performance.
  - Offline microbial testing.
- Operations and maintenance is key to success:
  - Training.
  - Retraining.
  - Staff Redundancy (small community).
  - Budgeting, this will be a large increase in O&M costs, and a budget is required to keep the system successfully operating.
- Outreach and education are critical for project success.

Figure 3 Photos from NWRI Expert Panel Site Visit to Cloudcroft, NM, including the expert panel meeting (left) and an RO train (right).

1.4.5 Direct Potable Water Reuse Guidelines – National Panels

Two national panels, again led by NWRI, have been assembled to evaluate DPR. The first panel's work is complete and their findings have been published (NWRI, 2013). These findings include specific targets for pathogen reduction and trace pollutants:

- From raw sewage to potable water, the treatment processes must provide 12-log virus reduction, 10-log *Cryptosporidium* reduction, and 9-log total coliform reduction.

These reductions account for extreme cases of pathogen outbreak in a community, and thus represent very conservative standards.

- Chemical constituents based on criteria including (in order of decreasing preference, with EPA MCL the most preferred) the EPA MCL, World Health Organization Drinking Water Advisory Level, State MCL, State provisional level (e.g., California NL), de minimus concentration, de minimus dose, medical benchmark, and de minimus benchmark from secondary source (NWRI, 2013). Suggested chemicals were included because of health based concerns and for surrogate reasons.

The second panel, tasked with Developing Potable Reuse Guidelines, is co-funded by the WateReuse Association. The work, in very early draft form, is being done by a group of seven experts, including George Tchnobanoglous, Joe Cotruvo, Jim Crook, Ellen McDonald, Shane Trussell, Adam Olivieri, and Andrew Salveson.

1.4.6 Direct Potable Water Reuse Guidelines – Texas

The State of Texas regulates water reuse through several methods, including the requirements for direct reuse (non-potable) described in Division 30 of the Texas Administrative Code Chapter 210 (30 TAC 210) and 30 TAC 321 Subchapter P (satellite facilities), and indirect reuse through the Texas Water Code Paragraph (TWC) 11.042 governing bed and banks permits and TWC 11.046 governing return flows. The regulations for direct reuse include water quality requirement for Type I and Type II reclaimed water, which are both limited to non-potable uses, whereas the regulations governing indirect reuse do not include water quality requirements.

Faced with an extreme need for additional water supplies in parts of the state, the Texas Commission on Environmental Quality (TCEQ) has been approving direct potable reuse projects, on a case-by-case basis in accordance with the innovative / alternative treatment clause in 30 TAC 290 that allows "any treatment process that does not have specific design requirements" listed in that chapter to still be permitted. Project approval by TCEQ is based on validation data from operation of a pilot or "full scale verification." This second approval mode allows treatment facilities to be approved for construction without pilot data. The full-scale facilities are then operated in pilot mode to collect the data necessary for final approval while finished water is sent to waste pending final approval by TCEQ to deliver water.

Treatment requirements for direct potable reuse (DPR) are based on the achievement of pathogen log removal credits, which are awarded to treatment processes following conventional wastewater treatment, i.e. the advanced treatment that occurs at a facility like the RWPF and the treatment that follows, if any, at downstream water treatment plants. The current baseline log removal goals required by TCEQ are 8-log virus (9-log if achieved with chloramines), 6-log *Giardia*, and 5.5 log *Cryptosporidium* (Berg, 2014). However, these targets are evaluated on a case-by-case basis and may be adjusted by TCEQ depending on the water quality in the source water.

1.4.7 Proposed Treatment Performance Criteria for for CWS pilot project to provide high purity water to use in the production of specialty beer

The CWS treatment process and performance criteria are derived from the compilation of information from regulatory and performance criteria protective of human use. The process of producing beer will include boiling the water that will provide an additional level of protection. That additional disinfection credit is not included in this treatment and performance analysis.

As reviewed above (NWRI, 2013), an independent advisory panel recommended regulatory criteria for potable reuse, as part of WateReuse Research Foundation project 11-02. Any treatment train capable of achieving these specific treatment goals is protective of human health (Trussell et al., 2013). The information in Tables 2 and 3 are adapted from Trussell et al. (2013), with the proposed regulatory criteria for microbial removal summarized in Table 2, and the proposed regulatory criteria for chemicals summarized in Table 3. The pilot treatment train, detailed in the next section, is designed to meet or exceed these recommended regulatory criteria.

Table 2 Recommended Regulatory Criteria for Microbial Removal Requirements (reproduced from Trussell et al, 2013 Table 2.7).

Microbial Group	Criterion	Sources Used for Criteria[3]
Enteric Virus	12 $\log_{10}$ removal	Surface Water Treatment Rule (USEPA 1989a), CDPH (2013), NRC (2012), NRMMA/EPHC/NHMRC (2008)
Cryptosporidium spp.[1]	10 $\log_{10}$ removal	USEPA (1998, 2006b), CDPH (2013), NRC (2012), NRMMA/EPHC/NHMRC (2008)
Total Coliform Bacteria[2]	9 $\log_{10}$ removal	US EPA Drinking Water Rule (USEPA 1989b), NRC (2012)

Notes:
(1) Addresses *Giardia* and other protozoa as well.
(2) Addresses enteric pathogenic bacteria such as *Salmonella spp*.
(3) See Appendix A from Trussell *et. al* (2013), pages 162-178, for complete reference list.

Table 3 Recommended Regulatory Criteria for Maximum Concentration Levels of Chemicals in Effluent from Potable Reuse Treatment Trains (reproduced from Trussell et al 2013 Table 2.8).

Chemical Group	Criterion	Rationale	Sources Used for Criteria
Disinfection byproducts that should be measured to evaluate treatment trains			
Trihalomethanes (THMs)	80 ug/L	Prominent chlorination byproducts	MCL
Halogenated acetic acids (HAA5)	60 ug/L	Polar group of chlorination byproducts	MCL
N-nitrosodimethylamine (NDMA)	10 ng/L	Byproduct of chloramination	CDPH notification level
Bromate	10 ug/L	Byproduct of ozonation	MCL / WHO guideline
Chlorate	800 ug/L	Reflective of hypochlorite use	CDPH notification level

Table 3 Recommended Regulatory Criteria for Maximum Concentration Levels of Chemicals in Effluent from Potable Reuse Treatment Trains (reproduced from Trussell et al 2013 Table 2.8).

Chemical Group	Criterion	Rationale	Sources Used for Criteria
Non-regulated chemicals of interest from a public health stand point (if present in wastewater source)			
Perfluoro-octanoic acid (PFOA)	0.4 ug/L	Known to occur, frequency unknown	Provisional short-term US EPA Health Advisory
Perfluoro-octane sulfonate (PFOS)	0.2 ug/L	Known to occur, frequency unknown	Provisional short-term US EPA Health Advisory
Perchlorate	15 ug/L 6 ug/L	Of interest, same analysis as chlorate and bromate	US EPA Health Advisory California MCL
1,4-Dioxane	1 ug/L	Occurs at low frequency in wastewater, but likely to penetrate RO membranes	CDPH notification level
Ethinyl Estradiol	None, close to detection limit if established	Steroid hormone, should evaluate presence in source water.	Bull et al. (2011)
17-ß-estradiol	None, close to detection limit if established	Steroid hormone, should evaluate presence in source water	Bull et al. (2011)
Pharmaceuticals of potential health concern that should be useful to evaluate the effectiveness of organic chemical removal by treatment trains.			
Cotinine/Primidone/ Dilantin	1/10/2 ug/L	Surrogate for low molecular weight, partially charged cyclics	Bruce et al. (2010); Bull et al. (2011)
Meprobamate/ Atenolol	200/4 ug/L	Occur frequently at the ng/L level	Bull et al. (2011)
Carbamazepine	10 ug/L	Unique structure	Bruce et al. (2010)
Estrone	320 ng/L	Surrogate for steroids	Based on an increased risk of stroke in women taking the lowest dose of conjugated estrogens
Other chemicals of potential health concern that should be useful to evaluate the effectiveness of organic chemical removal by treatment trains.			
Sucralose	150 mg/L	Surrogate for water soluble, uncharged chemicals of moderate molecular weight	CFR Title 12, revised 4/1/12
Tris[2-chloroethyl]phosphate (TCEP)	5 ug/L	Chemical of interest	Minnesota Department of Health (2011) guidance value
N,N-diethyl-meta-toluamide (DEET)	200 ug/L	Chemical of interest	Minnesota Department of Health (2011) guidance value
Triclosan	2,100 ug/L	Chemical of interest	Risk-based action level (NRC, 2012)

2.0 TREATMENT SYSTEM

The treatment train defined by NRC as providing the standard for potable reuse applications consists of secondary effluent from conventional wastewater treatment treated by MF or UF, RO and UV AOP (Trussell et al, 2013). These processes have been referred to as “Full Advanced Treatment”, or “FAT”. This treatment train is the only treatment approved by the California Department of Public Health for groundwater injection applications in the State of California (CDPH, 2013). Advanced treatment facilities using these technologies, such as the Orange County Water District’s (OCWD’s) Groundwater Replenishment System (GWRS), have been producing high quality potable water meeting all drinking water standards for many years. The OCWD has been using variations of advanced treatment for potable reuse (groundwater recharge) since the 1960s, and currently uses the “FAT” technologies to inject 100 MGD of purified water, without dilution, into the groundwater basin for subsequent extraction for potable consumption. Figure 4 illustrates the advanced treatment processes described as FAT.

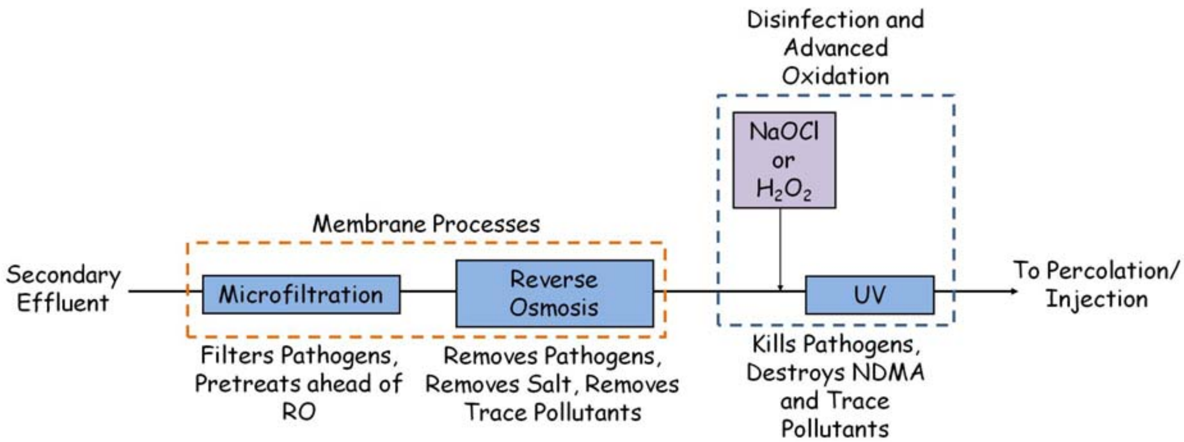

Figure 4 Conventional FAT (MF/RO/AOP) Potable Reuse Treatment Train

The Australian Guidelines for Water Recycling (NRMMC/EPHC/NHMRC, 2008) summarize the performance of various unit processes for removal of enteric pathogens and microbial indicator organisms, as referenced in Table 4. As shown, the results in Table 4 demonstrate that the MF/UF, RO, and UV AOP processes will achieve the recommended microbial removal guidelines (reproduced from Trussell et al., 2013, Table 1.28

Table 4 Log Reductions for Enteric Pathogens and Indicator Organisms (NRMMC/EPHC/NHMRC, 2008, Linden *et al*., 2012, Reardon *et al*., 2005)

Treatment Process	*Escherichia Coli*	Enteric Bacteria (e.g., *Campylobacter*)	Enteric Viruses	Phage	*Giardia*	*Cryptosporidium*
Secondary Wastewater Treatment	1.0 - 3.0	1.0 - 3.0	0.5 - 2.0	0.5 - 2.5	0.5 - 1.5	0.5 - 1.0
Microfiltration, Ultrafiltration	3.5 - >6.0	3.5 - >6.0	0.5 - >6.0	0.5 - >6.0	>6.0	>6.0
Reverse Osmosis	>6.0	>6.0	3-6.7	3-6.7	>6.0	>6.0
Advanced Oxidation	>6.0	>6.0	>6.0	>6.0	>6.0	>6.0

Snyder et al. (2012) examined the concentrations of a wide range of trace organic compounds in secondary effluent and in effluent from the FAT process. Table 5 (reproduced from Trussell et al., 2013, Tables 1.14 and 1.15) summarizes the results. Trussell et al. (2013) also compiled maximum concentration values from eight sources including the US EPA maximum contaminant levels, the Australian regulatory guidance values, the World Health Organization guidance values, the California Department of Public Health notification levels for potable reuse, other state notification levels, and peer-reviewed research publications. The minimum guideline value shown in Table 5 represents the most stringent limit of the eight sources examined.

The chemical compounds in Table 5 cover a wide range of biological and physiochemical treatability, use classes and toxicological relevance. Despite this wide range of variables, there were no compounds in the final effluent of the systems examined that exceeded their respective maximum recommend values. Additionally, the concentrations are one to five orders of magnitude lower than the maximum recommended values. CWS has done some similar, though not as extensive, historical analysis of trace organic compounds in the FGF effluent. As part of SB737, the FGF tested for atrazine (<39 ng/L), carbamazapine (147 ng/L), DEET (103 ng/L), ibuprofen (<2470 ng/L), musk ketone (<1000 ng/L), and Triclosan (<4940 ng/L). For the two detected chemicals (carbamazapine and DEET), the concentrations were similar to the values in Table 5. For all analyzed compounds, the concentrations were well below health standards.

Trussell et al (2013) also provides a summary of Typical NEWater Quality (Singapore) compared against US EPA and World Health Organization Guidelines (WHO). For perspective, the NEWater facility, which utilizes MF, RO, and UV (but no H_2O_2), provides less treatment than the CWS demonstration treatment system, as the CWS provides UF in place of MF and does a very high dose UV system with H_2O_2 for advanced oxidation. The

NEWater process utilizes UV for disinfection only. Table 6 is reproduced from Trussell et al (2013) and summarizes the NEWater quality from March 2003 through May 2007, showing that Singapore's NEWater system consistently exceeds US EPA and WHO guidelines.

2.1 Demonstration Scale Ultrafiltration

MF and UF remove particulates using polymeric, pressure-driven membranes with nominal pore sizes of 0.1 um for MF and 0.01 um for UF. The CWS process uses 0.04 um ultrafiltration membranes from Evoqua. The turbidity of the filtered water will be reduced to approximately 0.1 NTU with this membrane. Through size exclusion, the UF membranes remove bacteria, protozoan, and viral pathogens (Cheryan, 1998, USEPA, 2005, WERF, 2005). The membranes also pretreat the water prior to RO. CDPH grants virus removal credit for UF on the basis of smaller pore size than MF. UF is noted for constant product quality regardless of the source water, providing a significant advantage over traditional water treatment methods.

Table 5 Effluent Concentration of Indicator Trace Organic Compounds in Secondary Wastewater Effluent and in the Effluent from the FAT Process

Target Compound	Use of Target Compound	Secondary Wastewater Treatment[(1)] (ng/L)	MF-RO-UV/H_2O_2[(2)] (ng/L)	Maximum Recommended Value[(3)] (ng/L)
Atenolol	pharmaceutical, beta blocker	710	<25	70,000
Atrazine	Herbicide	28	<10	1,000
Bisphenol A	plastics additive	<50	<50	200,000
Carbamazepine	pharmaceutical, anti-convulsant	140	<10	1,000
DEET	insect repellant	54	<25	2,500,000
Diclofenac	pharmaceutical, nonsteroidal anti-inflammatory drug	62	<25	1,800
Gemfibrozil	pharmaceutical, lipid regulating agent	31	<10	45,000
Ibuprofen	pharmaceutical, pain reliever	<25	<25	400,000
Meprobamate	pharmaceutical, anti-anxiety medication	41	<10	260,000
Musk Ketone	fragrance additive	<100	<100	350,000
Naproxen	pharmaceutical, pain reliever	<25	<25	220,000
Phenytoin	pharmaceutical, anti-convulsant	110	<10	6,800
Primidone	pharmaceutical, anti-convulsant	67	<10	10,000
Sulfamethoxazole	pharmaceutical, antibiotic	570	<25	35,000
Triclosan	biocide	26	<25	350
Trimethoprim	pharmaceutical, antibiotic	280	<10	70,000
TCEP	fire retardant	540	<200	1,000

Notes:
(1) Data reproduced from Trussell et al (2013) Table 1.14 (page 41).
(2) Data reproduced from Trussel et al (2013) Table 1.15 (page 42).
(3) Recommended regulatory contaminant level by Trussell et al (2013).

Table 6 Typical NEWater Characteristics

Compound	Unit	NEWater	EPA/WHO Guideline Value[(2)]
Color	Hazen Units	< 5	15
pH	pH units	7.3 – 7.6	6.5 – 8.5
Conductivity	S/cm	59 – 75	-
Alkalinity	mg/L as $CaCO_3$	9 – 30	-
Total Dissolved Solids	mg/L	36 – 49	500
Hardness	mg/L as $CaCO_3$	0.33 – 0.45	-
Fluoride	mg/L	0.13 – 0.20	1.5
Nitrite	mg/L as N	0.02 – 0.07	0.06 – 0.91
Nitrate	mg/L as N	1.1 – 1.6	10
Ammonia	mg/L as N	0.14 – 0.35	1.2 (aesthetic)
Chloride	mg/L	1.5 – 7.6	250
Turbidity	NTU	< 0.1	< 0.3 for 95% of samples
Aluminum	mg/L	< 0.02	0.05 – 0.2
Iron	mg/L	< 0.003	0.3
Manganese	mg/L	< 0.003	0.05
Sulfate	mg/L as SO_4	0.14 – 0.19	250
Zinc	mg/L	< 0.004	3
Silica	mg/L	0.68 – 1.6	-
Phosphate	mg/L as P	0.05 – 0.07	-
Sodium	mg/L	11.5 – 17	200
Total organic carbon	mg/L	0.05 – 0.07	-
Total coliforms	number/100 mL	ND	-
Fecal coliforms	number/100 mL	ND	-
C. perfringens	CFU/100 mL	ND	-
Male-specific coliphage	PFU/100 mL	ND	-
Enterovirus	present/absent	ND	-

Notes:
(1) Data reproduced from Trussell et al (2013) Table 1.35 (page 86).
(2) Lowest published limit of either US EPS or WHO.
(3) CFU = colony forming unit; PFU = plaque forming unit; ND = non-detect.

2.2 Demonstration Scale Reverse Osmosis

RO uses a semi-permeable polymeric membrane to remove dissolved substances from water that passes through the RO membrane by diffusion facilitated by high pressure. Dissolved substances are separated from the water because they diffuse through the membrane material much – in many cases several orders of magnitude – more slowly than the water. RO is commonly used to remove salt from ocean water to create drinking water and also will remove salts from the wastewater. RO removes common chemical constituents as well as the majority of trace pollutants found at the ng/L level (Brown, 2010), a significant portion of the dissolved organic matter and trace chemical substances of human health concern (Trussell *et al.*, 2013), and pathogens remaining after UF. CDPH grants pathogen log removal credits based upon the accuracy of RO online performance monitoring. Conventional RO online monitoring is for either total organic carbon (TOC) or electrical conductivity (EC), both of which can demonstrate about 1.5 to 2-log reduction of TOC/EC. RO has been shown to provide 4+ log removal of pathogens (up to 6-log).

2.3 Demonstration Scale UV Advanced Oxidation

Advanced oxidation can be performed with various treatment processes. This demonstration project uses the standard high dose UV system (approximately 800 mJ/cm^2, provided by Trojan) and a hydrogen peroxide (H_2O_2) dose of 10 mg/L (dosed ahead of the UV). The UV AOP provides destruction of small, non-charged dissolved substances that may pass through the RO membrane, particularly nitrosamines including NDMA (*N*-nitrosodimethylamine) and 1,4-dioxane. Because NDMA and 1,4-dioxane are prevalent in wastewater at trace but measureable concentrations, the NWRI (2013) suggests using them as tracers to demonstrate removal of a wider range of pollutants that may pass through RO at trace concentrations. NDMA and other nitrosamines are removed effectively through photolysis with ultraviolet (UV) light, whereas 1,4-dioxane and other organic compounds are removed effectively through hydroxyl radical chemistry by adding H_2O_2 ahead of the UV system. The UV AOP also provides substantial disinfection due to the high UV dose.

3.0 TREATMENT RESULTS

The results of testing are examined first in a process-by-process fashion, detailing the performance of each treatment system in isolation. Following that discussion is a summary of final product water quality, which is a demonstration of the combined treatment performance.

3.1 Primary and Secondary Treatment (Full-Scale)

No new data have been collected for the removal of virus or protozoa through the Clean Water Services FGF primary and secondary processes. The literature provides guidance on conservative removal estimates for pathogens, as reviewed here.

Table 2-3 of USEPA (1986) lists 10 to 35 percent removal of bacteria and less than 10 percent removal of virus through primary treatment. Protozoa removal through primary treatment is not listed. The same table (2-3) includes bacteria and virus removal percentages for secondary treatment, showing 90 to 99 percent removal of bacteria and 76 to 99 percent removal of virus.

Table 2 of Francy *et al.* (2012) demonstrated 99 percent to 99.98 percent removal of bacteria and 88 percent to 99.9995 percent removal of various virus and coliphage through primary and secondary treatment. The single data set with any data below 90 percent removal, which was for adenovirus, showed removal ranging from 88 percent to 99.93 percent with a median removal of 99.8 percent.

The most recent CDPH approval of pathogen removal credits for combined primary and secondary treatment was obtained by the Water Replenishment District of Southern California (WRD, 2013). That document relied upon risk analysis data presented by Olivieri *et al.* (2007) which was developed based upon research by Rose *et al.* (2004). Rose *et al.* (2004) defined the range of bacteria, enterovirus, *Cryptosporidium*, and *Giardia* removal through six different full scale wastewater treatment plants. The raw data from that work is reported by Olivieri *et al.* (2007). At WRD (2013), the secondary process pathogen removal credits were based upon the data from two of the six tested secondary process configurations. Specifically, two of the secondary process trains (Facilities C and D, with solids retention times (SRTs) of 1.6 to 2.7 days and 3 to 5 days, respectively) had SRT values less than the secondary process feeding the WRD advanced treatment system (>9 days), and thus are presumed to be conservative estimates of performance. Per CDPH request, WRD (2013) used the lower 10th percentile values calculated for each pathogen, resulting in 1.9 log reduction of enterovirus, 1.2 log reduction of *Cryptosporidium*, and 0.8 log reduction of *Giardia*. Note that our analysis of the same data set found one data translation error, but the overall impact on the log reduction credits is minimal.

Thus, through full-scale primary treatment and secondary treatment, the combined pathogen reduction is shown below. As we add on multiple treatment barriers, this same graphic will be expanded to show the total combined treatment.

	Virus	***Giardia***	***Crypto***
Primary/Secondary	**1.9**	**0.8**	**1.2**
Total	**1.9**	**0.8**	**1.2**

Table 7 Pathogen Reduction Values Through Primary and Secondary Treatment (from Rose et. al., 2004)

Lower 10th percentile values		**Log Reduction**		
SRT	**Facility**	**Enterovirus**	**Giardia**	**Crypto**
1.6-2.7	C	1.8	2.6	1.25
3-5	D	2.05	1.35	1.4
3.5-6	B	1.95	2.45	1.6
6-8	A	1.65	0.8	0.7
8.7-13.3	E	1.75	2.6	1.9
8-16	F	2.6	0.9	0.25
1.6-16	**ALL**	**1.85**	**0.8**	**1.2**
50th percentile values		**Log Reduction**		
SRT	**Facility**	**Enterovirus**	**Giardia**	**Crypto**
1.6-2.7	C	2.05	3.05	1.65
3-5	D	2.5	1.9	2.6
3.5-6	B	2.25	2.6	1.9
6-8	A	2.1	1.6	1.1
8.7-13.3	E	2.2	2.8	2.1
8-16	F	2.75	1.1	0.95
1.6-16	**ALL**	**2.3**	**2.6**	**1.6**

3.2 UV Disinfection (Full-Scale)

The advanced treatment demonstration system is downstream of the existing full-scale UV disinfection system (Figure 5), which is a Trojan UV4000, designed to keep fecal coliform counts below the permit level of 126 *E. coli* MPN/100mL. The FGF has a long track record of meeting this permit goal, with effluent *E. coli* counts typically at or below 20 MPN/100mL. As shown in Figure 6, undisinfected concentrations of *E. coli* range from 4,000 to 40,000 MPN/100mL. To routinely achieve 20 MPN/100mL requires 2.3 to 3.3 log reduction. On 5/5/14, a series of samples were collected from the UV influent and UV effluent for total coliform. The set of 10 paired samples indicated 3.6 to 4.7 log reduction of total coliform by UV.

This performance data can be readily translated to UV dose, which can then be used to estimate virus and protozoa disinfection. Figure 6 includes three bench-top collimated beam UV studies performed on FGF undisinfected secondary effluent. As shown in Figure 5, attaining an *E. coli* count of 20 MPN/100mL correlates to a UV dose of at least 15 mJ/cm^2.

Figure 5 Full-Scale UV4000 at the FGF

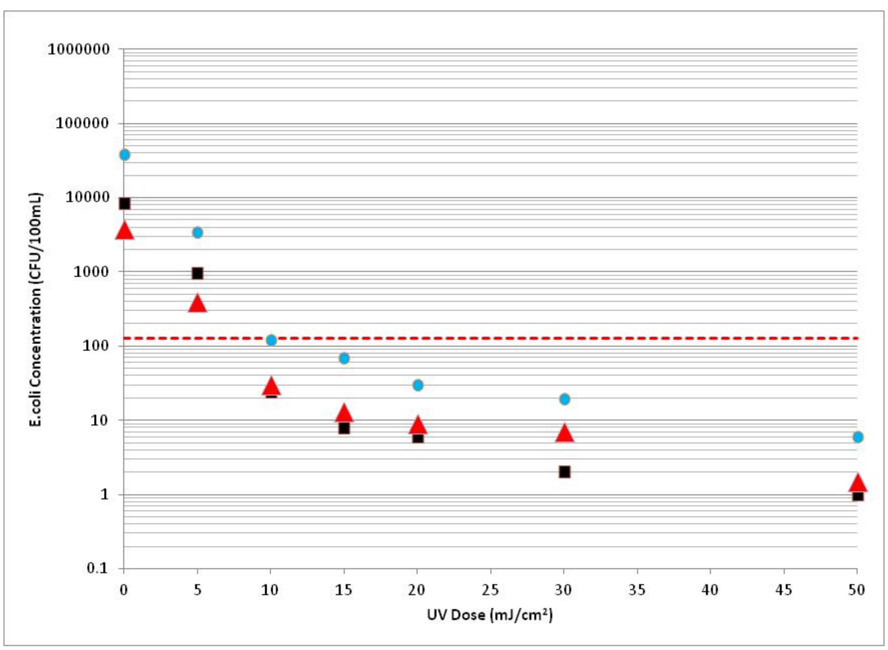

Figure 6 Bench-top Collimated Beam UV Test Results for the FGF

The final step in the data analysis is the correlation of dose to virus and protozoa reduction. Table 8 shows the UV dose targets for *Giardia*, *Cryptosporidium* (*Crypto*), and virus inactivation credits as defined by the LT2ESWTR (USEPA 2006a). For a UV system providing a dose of 15 mJ/cm^2, it is reasonable to expect 3.5-log reduction of *Cryptosporidium* and *Giardia*. The dose is insufficient to provide a similar level of inactivation of adenovirus. Note that adenovirus is the most resistant virus to UV disinfection; hence it's inclusion in USEPA (2006a). Subsequent processes, including UF, RO, and the very high UV dose processes all provide for robust virus (including adenovirus) kill/reduction.

Table 8 UV Dose Targets for Log Inactivation Credit, mJ/cm^2 (USEPA, 2006a)

Target	0.5-log	1.0-log	1.5-log	2.0-log	2.5-log	3.0-log	3.5-log	4.0-log
Crypto	1.6	2.5	3.9	5.8	8.5	12	15	22
Giardia	1.5	2.1	3	5.2	7.7	11	15	22
Adenovirus	39	58	79	100	121	143	163	186

Thus, through full-scale primary treatment, secondary treatment, and UV disinfection, the combined pathogen reduction is:

	Virus	*Giardia*	*Crypto*
Primary/Secondary	**1.9**	**0.8**	**1.2**
Full-Scale UV	**0**	**3.5**	**3.5**
Total	**1.9**	**4.3**	**4.7**

3.3 Ultrafiltration (Demonstration Scale)

For this demonstration project, UF was chosen instead of MF, as UF has a smaller pore size compared to MF, resulting in greater rejection of all pathogens of concern. UF provides substantially more removal of virus compared to MF based upon this pore size differential (Table 9). The UF pilot unit, capable of producing up to 4 gpm, was supplied by Evoqua (Figure 7).

Table 9	Pathogen Sizes (Brock et al., 1997, Strauss and Sinsheimer, 1963, McCuin and Clancy, 2006, Meyer and Jarroll, 1980, Singleton, 1999) High Purity Water Project Clean Water Services
	Size Range, *u*m
Protozoa	2 to 200 (*Giardia* - 6 to 14 *u*m) (*Cryptosporidium* – 3 to 8 *u*m)
Bacteria	0.1 to 15 (*E. coli* 0.25 *u*m dia X 2 *u*m long) (Salmonella 0.7-1.5 *u*m dia X 2-5 *u*m long)
Enteric Virus	0.01 *u*m to 0.1 *u*m
MS-2	0.027 *u*m
UF	0.01 *u*m nominal pore size for FGF UF Demo

Figure 7 Demonstration Scale Evoqua UF at the FGF

3.3.1 Pressure Decay Tests

Pressure decay testing, also called membrane integrity testing (MIT), was repeated multiple times prior to the start of treatment system analysis. The goal of the initial MIT was to ensure system performance and provide a baseline membrane integrity with the new membranes. During all subsequent test events, the MIT was measured both at the start and at the end of the day of testing. For future batch production, MITs will again be run before and after batching of purified water as a measure of quality control (further detailed at the end of this document).

Some explanation of the MIT test is needed. The integrity of the membrane is determined based upon an air pressure test in which the membranes are pressurized with air, then put in a “hold” mode in which the air slowly leaks from the membranes. Too fast a leak means that the membrane has been compromised. For this Evoqua UF membrane, as is the case with many MF and UF systems, the manufacturer recommended that MIT values remain at or below 0.3 psi/min.

During equipment startup, the MIT was repeatedly run, and initial results were outside of the recommended 0.3 psi/min (or less) tolerance. Coinciding with the higher MIT results were measurements of increased turbidity in the UF effluent (Figures 8 and 9). Working with the manufacturer, CWS staff adjusted the fittings on the membrane cartridge, resulting in MITs meeting the optimum performance criteria, well below 0.3 psi/min, as shown in Figures 10 and 11. These results confirm system performance and demonstrate how the MIT and turbidity readings can be used to track and ensure continued UF performance.

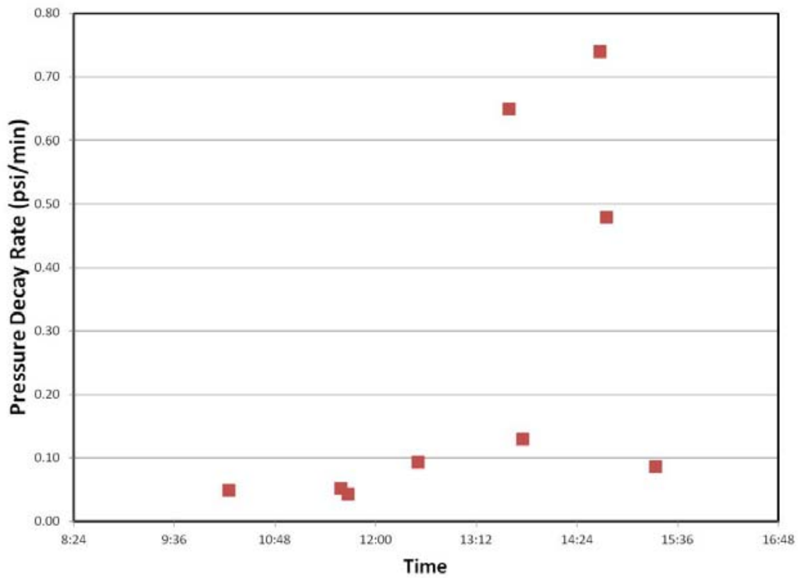

Figure 8 MIT Failure During UF Startup

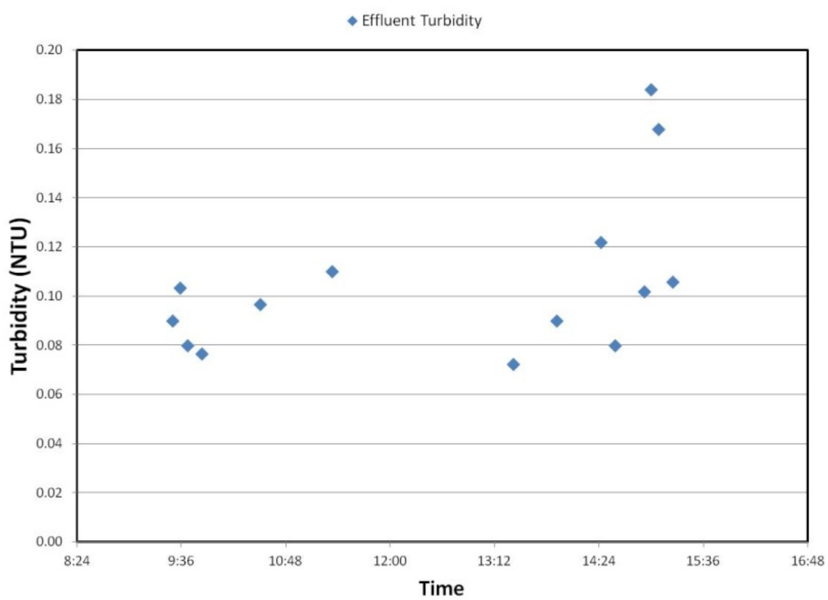

Figure 9 UF Effluent Turbidity Values During MIT Failure Event

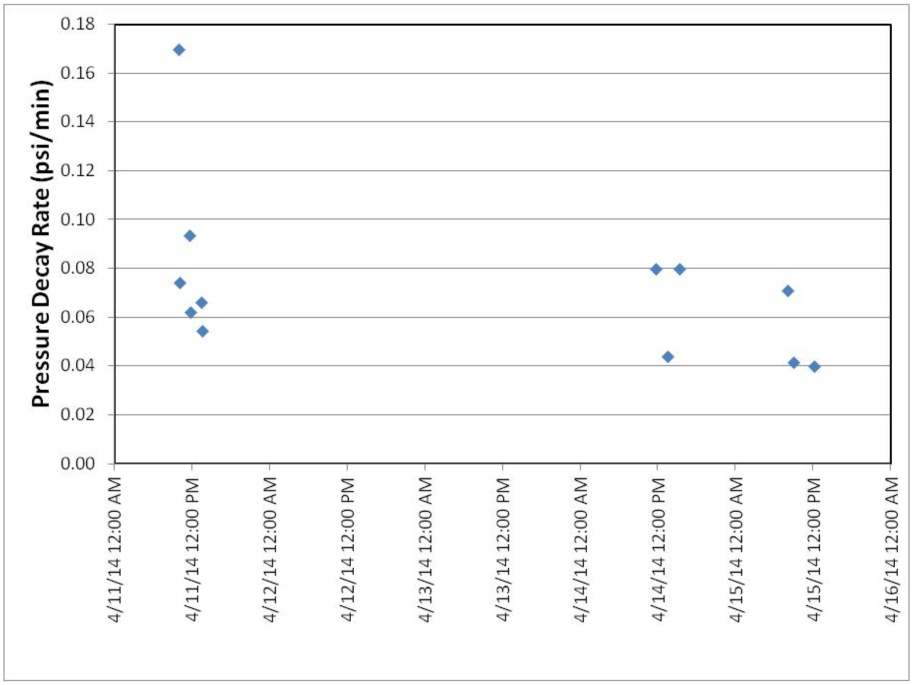

Figure 10 UF MIT Results at Startup

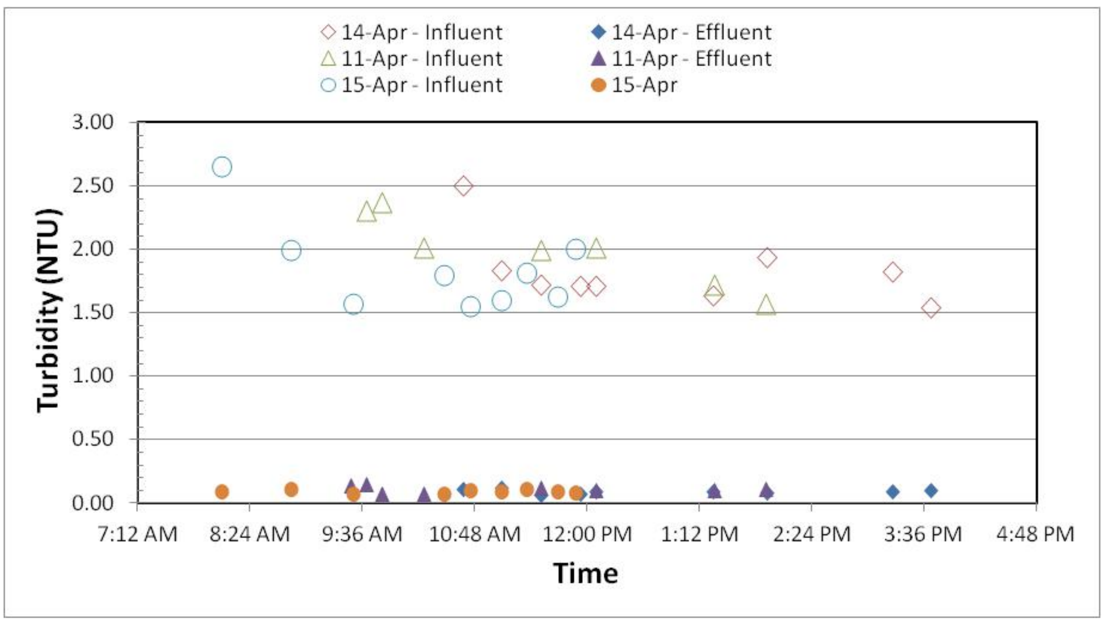

Figure 11 UF Influent and Effluent Turbidity During Startup

For the two days of intensive demonstration testing, 4/28/14 and 4/29/14, MIT was done twice per day (morning and evening). Those results were, in chronological order, 0.103, 0.044, 0.042, and 0.146 psi/min.

3.3.2 <u>Turbidity</u>

The turbidity data during startup are shown in the prior section. The UF effluent turbidity values, prior to the two-day demonstration testing, ranged from 0.07 to 0.15, with an average value of 0.10 NTU. For the two days of intensive demonstration testing, 4/28/14 and 4/29/14, UF filtrate (effluent) turbidity was sampled 5 times per day. For 4/28/14, the filtrate turbidity average values (based upon triplicate analysis) were 0.11, 0.08, 0.08, 0.07, and 0.07 NTU. For 4/29/14, the filtrate turbidity average values (based upon triplicate analysis) were 0.07, 0.08, 0.08, 0.09, and 0.08 NTU.

3.3.3 Particle Removal

On the days of demonstration testing (4/28/14 and 4/29/14), UF influent and effluent samples were taken for particle size distribution (PSD) analysis. The analysis was done with Carollo's optical particle sizer/counter (PSS AccuSizer 780/SIS), with a sensitivity down to approximately 1 micron. UF influent and UF effluent samples were taken (10 data sets), and the log reduction results for particles in the size range of bacteria and protozoa are presented in Figure 12. The data suggest a greater than 2 log reduction of protozoa and a greater than 1.5 log reduction of bacteria. As subsequent testing of virus removal indicates, performance of the UF exceeded these estimations made by particle reduction, suggesting that the PSD analysis method is insufficiently sensitive and conservative to estimate removal of protozoa and bacteria. The PSD analysis is not able to detect particle removal in the size range of virus.

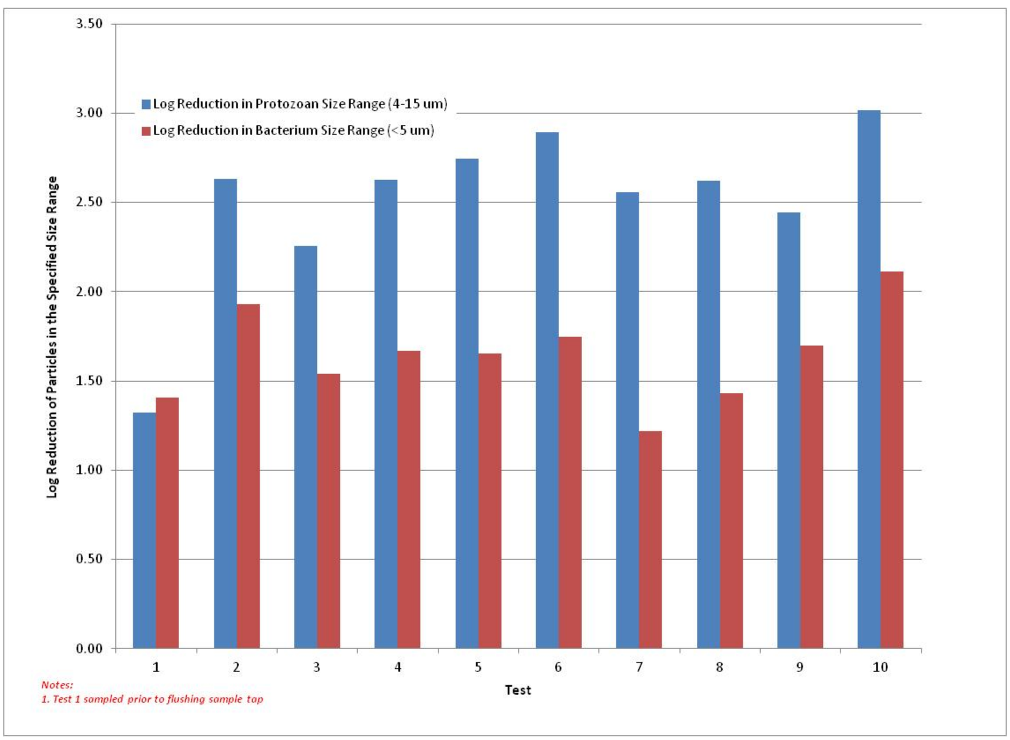

Figure 12 Log Reduction of Particles in the Size Range of Protozoa and Bacteria

3.3.4 Total Coliform Removal

Total coliform removal across the UF membrane was done as part of the demonstration testing. Figure 13 illustrates the results, with between 0.5 and 1.4 log reduction.

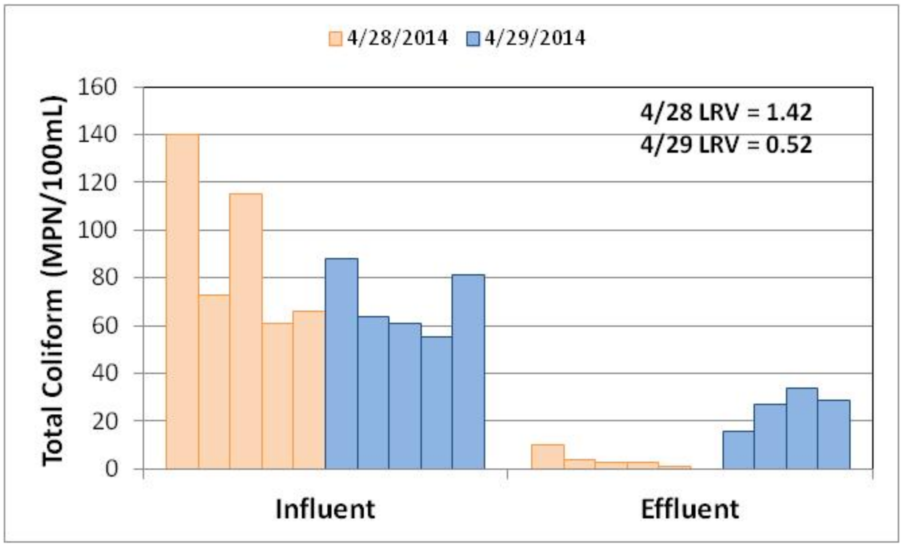

Figure 13 Log Reduction of Total Coliform Across UF

3.3.5 Virus Removal

The bacteriophage MS2 was used as a surrogate for enteric virus that may be present in the secondary effluent. MS2 is similar in size to virus, and smaller than protozoa and bacteria. Hence, it represents a conservative surrogate for removal by filtration.

The log removal of virus across the UF system was demonstrated by continuously seeding (as opposed to a pulsed spike) the UF influent with a high concentration of MS2 and measuring the removal of MS2 virus in the UF effluent. The MS2 injection location is located upstream of the UF process. The influent sampling port is downstream of the injection location after a few pipe bends, and the effluent sampling port is downstream of the UF.

Prior to MS2 testing, a tracer test was run to document the time for a seeded compound (or MS2) to move from the dosing location through the reactor to the effluent sampling location. The tracer that was used for the UF testing was a UV transmittance modifier, which allows the project team to sample for and measure UVT at the influent and effluent sampling ports. Following the tracer study, the MS2 was injected ahead of the UF and the appropriate time interval was allowed to pass between the start of seeding and sampling of UF influent and UF effluent. The virus rejection is shown in Figure 14, consistently 4.7 log reduction (99.998%) for all tests. These values are within the reported values in the literature referenced previously.

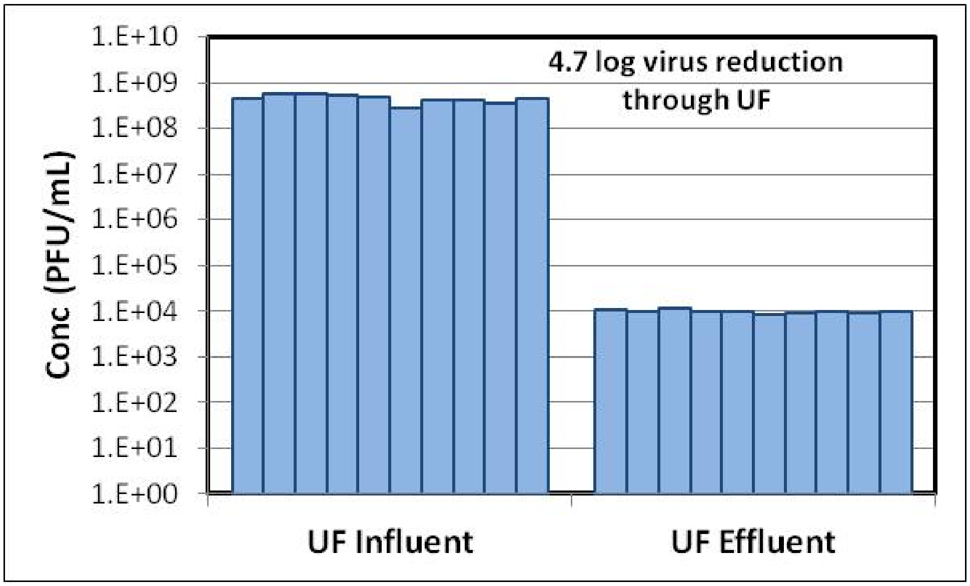

Figure 14 Reduction of Seeded MS2 (Virus) Through UF

3.3.6 Summary of UF Performance for Pathogen Reduction

The overall performance of the UF is best illustrated by the rejection of seeded MS2, with ~4.7 log reduction. Because protozoa are larger than MS2, 4.7 log reduction of protozoa can also be assumed based upon these results. The MIT results indicate that the UF integrity was and is not compromised. Turbidity results provide a quality check on the MIT results. Particle counts are helpful, but not sensitive enough to measure the true log reduction of pathogens.

To this point, the multiple barriers of treatment are providing a robust level of pathogen removal, as shown below.

	Virus	*Giardia*	*Crypto*
Primary/Secondary	**1.9**	**0.8**	**1.2**
Full-Scale UV	**0**	**3.5**	**3.5**
Pilot-Scale UF	**4.7**	**4.7**	**4.7**
Total	**6.6**	**9.0**	**9.4**

3.4 Reverse Osmosis (Demonstration Scale)

While RO is technically a “semi-permeable membrane”, constituents smaller 0.1 to 1 nm can pass through RO (Khulbe et. al., 2008, Kogutid and Kunst, 2002). A visual presentation of membrane pore size, and the constituents that can be removed by different membranes, can be found at http://www.sswm.info/sites/default/files/toolbox/RADCLIFF%202004%20Filtration%20Spectrum.png.

The RO process provides four critical roles in the purification of reclaimed water, all driven by the ability to remove extremely small compounds, chemicals, and pathogens. First, RO removes salts. Second, RO removes bulk organic matter (measured as Total Organic Carbon, TOC). Third, it removes pathogens. Fourth, RO removes trace pollutants. Each of these is reviewed below. The pilot unit, capable of producing ~1.1 gpm of RO permeate, was supplied by Evoqua (Figure 15).

Figure 15 Demonstration Scale RO (with CWS Staff)

3.4.1 Electrical Conductivity

The demonstration scale RO system was equipped with online electrical conductivity (EC) meters on the influent and the effluent of the RO system. EC has a linear relationship with the total dissolved solids (TDS) in water, but that ratio is site specific. For one utility, the Santa Clara Valley Water District (SCVWD, California), TDS in mg/L is 57 percent of the EC value. For this demonstration project, the influent and effluent EC is plotted in Figure 16. EC removal is best examined from the standpoint of log reduction, and for CWS the log reduction ranged from 1.59 to 1.66. Typical EC log reduction witnessed as part of IPR projects in California have shown a range from 1.5 to 2.0 log reduction. Specific examples include the SCVWD (1.65 log) and the City of Los Angeles (1.5 log), both from unpublished data sets. From a long-term monitoring standpoint, the CWS team will be watching the log reduction of EC for a downward trend, which would suggest a compromised RO membrane.

Within California, the CDPH has determined that because of the small size of salts, that the log reduction of EC provides a conservative measure of pathogen reduction performance from RO. Said another way, for the CWS RO system, ***at least*** 1.6 log reduction of all pathogens can be assumed through RO.

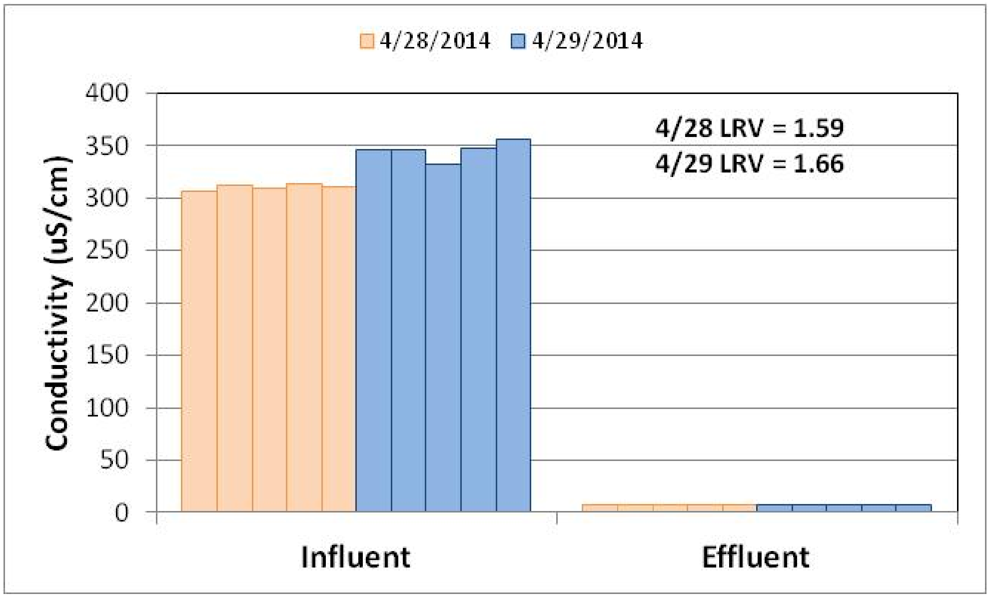

Figure 16 Log Reduction of EC by RO

3.4.2 Total Organic Carbon

The RO process will reject the majority of total organic carbon present in the UF filtration. Similar to EC, the CDPH allows for TOC log reduction to be used as a surrogate for pathogen reduction by RO. As shown in Figure 17, the reduction in TOC shows a similar pattern to the reduction of EC, with 1.74 to 1.61 log reduction. The TOC reduction from this demonstration is consistent with other research. For example, WateReuse Research Foundation Project 11-02 (Gerringer et. al., 2014) showed TOC reduced from 5 mg/L to 0.1 mg/L, a log reduction of 1.7.

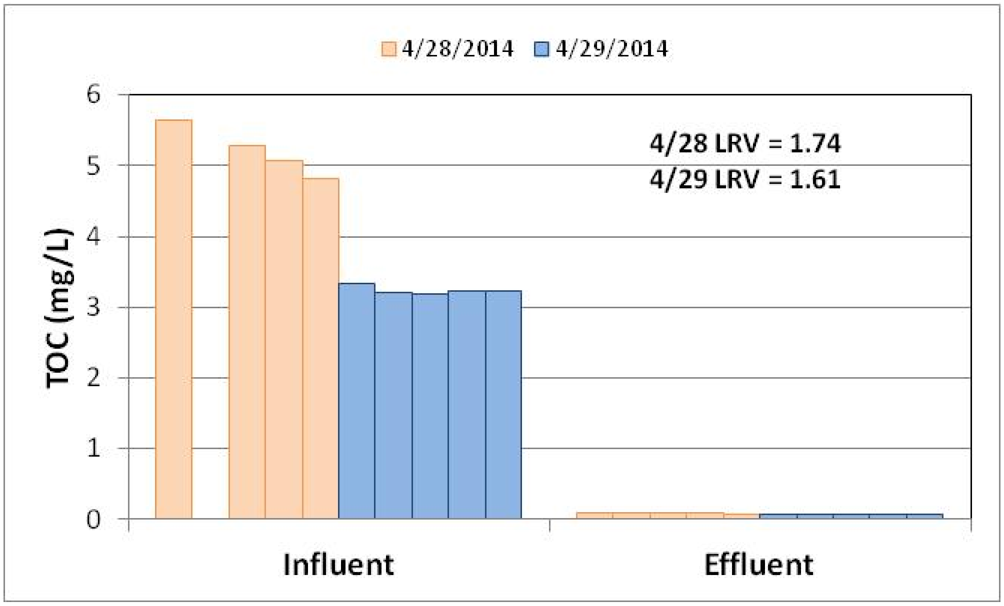

Figure 17 Log Reduction of TOC by RO

3.4.3 Virus Reduction

Similar to the UF analysis, MS2 was seeded ahead of the RO system, subjected to mixing, then sampled at the RO influent and RO effluent. The necessary time between the start of seeding (again, a continuous seed instead of a pulsed spike) was also determined, but this time using a salt tracer and monitoring the time for RO influent and effluent EC to change. The RO system provided robust removal of MS2, with 4.3 log reduction as shown in Figure 18. These values are within the reported values in the literature referenced previously. .

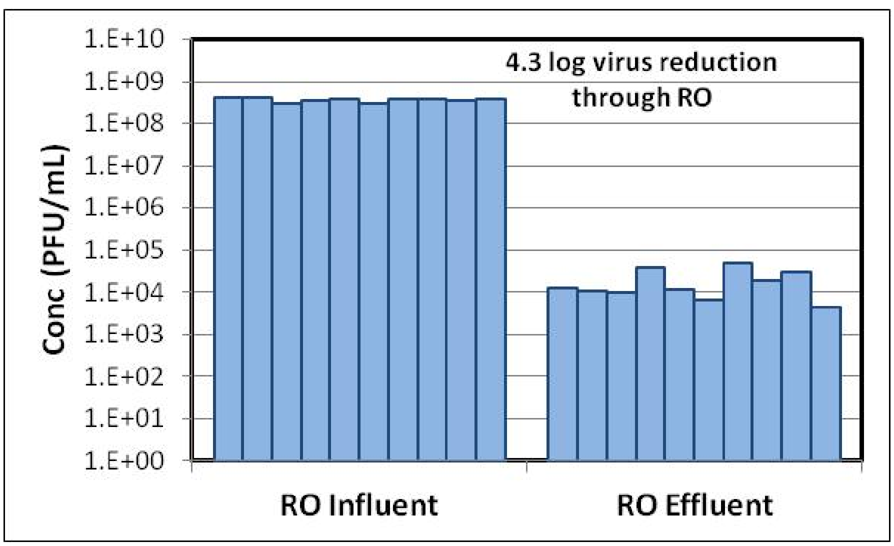

Figure 18 Log Reduction of Virus by RO

3.4.4 Summary of RO Performance for Pathogen Reduction

Both the TOC and EC data support a well-functioning RO membrane. The log removal of seeded MS2 was consistently 4.3 log (99.995). Because protozoa are larger than the MS2, a minimum of 4.3 log reduction of protozoa through RO can also be assumed.

The addition of RO to the already robust upstream treatment provides for even further reduction of pathogens..

	Virus	*Giardia*	*Crypto*
Primary/Secondary	**1.9**	**0.8**	**1.2**
Full-Scale UV	**0**	**3.5**	**3.5**
Pilot-Scale UF	**4.7**	**4.7**	**4.7**
Pilot-Scale RO	**4.3**	**4.3**	**4.3**
Total	**10.9**	**13.3**	**13.7**

3.5 UV Advanced Oxidation (Demonstration Scale)

The UV AOP has three main purposes in polishing the purified water. First, a few very small non-polar chemicals can pass through RO membranes. Some of these small pollutants are best destroyed by UV photolysis, NDMA being one example. High dose UV is very effective at NDMA destruction, with a dose of 1000 mJ/cm^2 resulting in 1-log reduction (Sharpless and Linden, 2003[1]). The second value of UV AOP is the advanced oxidation process, as some of the small trace level pollutants are resistant to UV photolysis, but can be destroyed through advanced oxidation. The addition of an oxidant, such as H_2O_2, turns the high dose UV reactor into such an advanced oxidation process (AOP), with the UV light cleaving the H_2O_2 molecule resulting in the formation of hydroxyl radicals. The hydroxyl radical is very effective for the oxidation of trace pollutants, and the reactivity of the hydroxyl radical for a range of pollutants is well documented (Figure 19, Hokanson *et. al.,* 2011). Third and finally, UV is a robust disinfectant, as defined by USEPA (2006a). The high dose UV demonstration unit, provided by Trojan Technologies, is shown in Figure 20. The H_2O_2 dosing (tank and pump) are not shown in this photo.

3.5.1 NDMA Destruction

NDMA is one of a few constituents that can pass through RO. Over the two days of intensive testing, RO permeate concentrations of NDMA ranged from 41-57 ng/L (Day 1, 4/28/14) to 540-640 ng/L (Day 2, 4/29/14). For both of these days, the high dose UV

[1] Work by Sharpless and Linden (2003) is widely used incorrectly in the industry. The incorrect interpretation is that a UV dose of ~400 mJ/cm^2 provides 1-log reduction of NDMA. As a point of fact, that work demonstrated that $\ln(NDMA/NDMA_0) = -1$ for a UV dose of ~400 mJ/cm^2, which is very different than 1-log removal [(log $NDMA_0$)-log (NDMA)] of NDMA at that same dose.

system, running with two reactors in series, reduced the NDMA concentration to below detection (<2 ng/L), as shown in Table 10. The log reduction of NDMA ranged from >1.31 to >2.51, noting that the performance is greater than the listed values due to the non-detect of NDMA in all High Dose UV effluent samples. The delivered dose for the High Dose UV system can be estimated based upon the NDMA destruction, as the correlation between NDMA destruction and UV dose is well defined (Sharpless and Linden (2003)). The demonstration unit UV dose is > 2500 mJ/cm^2, well in excess of the dose employed for IPR projects in California, which range from 500 to 1000 mJ/cm^2.

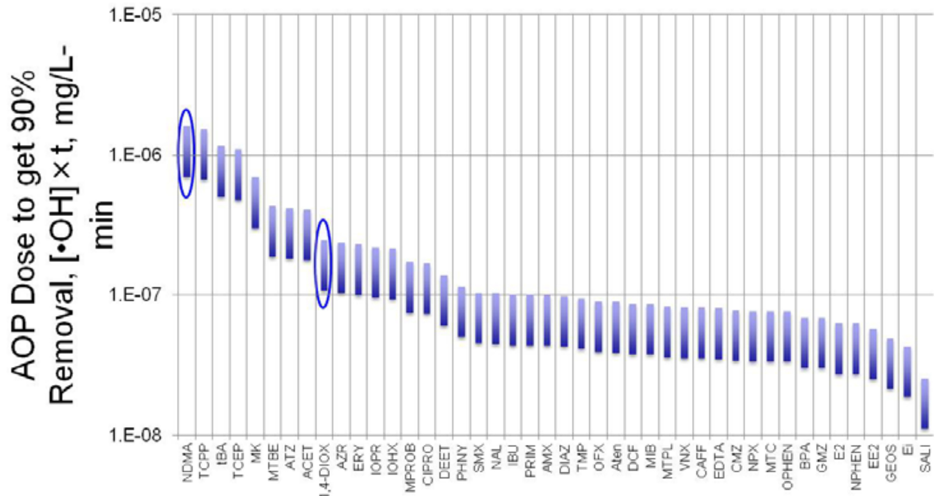

Figure 19 Hydroxyl Radical Reaction Rates for Various Trace Pollutants (Hokanson *et. al.,* 2011, figure courtesy of Trussell Technologies)

Figure 20 High Dose UV Reactors (two in series) from Trojan Technologies

Table 10 NDMA Destruction by High Dose UV

RO Permeate Concentration, ng/L	High Dose UV Effluent Concentration, ng/L
57 (Day 1)	<2
40 (Day 1)	<2
41 (Day 1)	<2
48 (Day 1)	<2
43 (Day 1)	<2
Not sampled (Day 2)	<2
540 (Day 2)	<2
640 (Day 2)	<2
600 (Day 2)	<2
540 (Day 2)	<2

3.5.2 Trace Pollutant Destruction with UV AOP

For this demonstration system, the H_2O_2 dose was set to 10 mg/L, far in excess of the industry standard of 3 mg/L (as used by the Orange County Water District). This high dose of H_2O_2 coupled with the high dose of UV >2500 mJ/cm^2, will result in substantial hydroxyl radical formation and would be expected to destroy the oxidizable constituents in the RO permeate to below detection at the ng/L level. For this demonstration project, the removal of trace pollutants was not specifically measured across the High Dose UV system, but it was measured in the finished water, as reviewed in a subsequent section. As expected, the high H_2O_2 and high UV dose resulted in a finished water with no detectable trace pollutants.

3.5.3 UV for Pathogen Reduction

The finished water was consistently non-detect for total coliform, as would be expected for a UF/RO/UV AOP treatment train. Measurement of a lack of total coliform does demonstrate effective disinfection. Because the results are not detectable it is not possible to calculate the log removal rate. However, the very high log removal of NDMA >2.51 correlates to a UV dose of >2500 mJ/cm^2 (Sharpless and Linden (2003)). Such a high dose results in a large amount of pathogen kill, as shown previously in Table 9. The USEPA table, created for drinking water UV disinfection, only extends to 4-log removal, with a UV dose of 22 mJ/cm^2 required for 4-log of *Cryptosporidium* and *Giardia*, and a UV dose of 186 mJ/cm^2 required for 4-log of adenovirus. For a dose of 2500 mJ/cm^2, the log reduction of all pathogens would be an order or magnitude higher. However, CDPH (2013) has determined that no single process should receive more than 6-log credit, directing utilities and projects to employ multiple barriers for pathogen control. Following that conservative logic, we conservatively identified that the High Dose UV system part of this demonstration project as 6-log removal credit for all pathogens.

The addition of the final disinfection step, high dose UV, results in a dramatically high level of disinfection.

	Virus	*Giardia*	*Crypto*
Primary/Secondary	**1.9**	**0.8**	**1.2**
Full-Scale UV	**0.0**	**3.5**	**3.5**
Pilot-Scale UF	**4.7**	**4.7**	**4.7**
Pilot-Scale RO	**4.3**	**4.3**	**4.3**
Pilot-Scale UV	**6.0**	**6.0**	**6.0**
Total	**16.9**	**19.3**	**19.7**

3.6 Summary of Total Pathogen Removal

The total reduction of pathogens through the full-scale FGF and the demonstration-scale advanced treatment systems is summarized in Table 11. The target log reduction of virus, *Giardia*, and *Cryptosporidium* of 12, 10, and 10, respectively has been met and exceeded as part of this demonstration testing. A comparison of performance can be made based upon Texas standards for DPR, as also shown in Table 11. As with the comparison with California standards, the results of this project demonstrate protection of public health.

Table 11 Log Disinfection Performance for the FGF and Advanced Treatment System Compared to CA IPR and Texas DPR Standards

Standard		Primary and Secondary Treatment	Full-Scale UV	Demo UF	Demo RO	Demo UV/H_2O_2	Total Credits
California IPR Standards (CDPH, 2013)							
log viruses - California	12	1.9	0	4.7	4.3	6	**16.9**
log *Giardia* cysts - California	10	1.2	3.5	4.7	4.3	6	**19.7**
log *Cryptosporidium* oocysts - California	10	0.8	3.5	4.7	4.3	6	**19.3**
Texas DPR Standards (Berg, 2014)							
log viruses - Texas	8	No credit	No credit	4.7	4.3	6	**15.0**
log *Giardia* cysts - Texas	6	No credit	No credit	4.7	4.3	6	**15.0**
log *Cryptosporidium* oocysts - Texas	5.5	No credit	No credit	4.7	4.3	6	**15.0**

3.7 Finished Water Quality

3.7.1 Trace Chemicals

The finished water quality was sampled for an extensive list of chemicals, as shown in Tables 12 through 18. Note the specific units used in the table, as some are measured in mg/L, others in *u*g/L, and still others in ng/L. These results, when compared back to Table 3 (effective treatment) and the drinking water requirements defined in OAR 333-061 (OAR, 2008), demonstrate that the finished water quality meets the treatment goals and public health standards.

3.7.2 Microbiology

Similar to the trace chemicals, all finished water microbiological analysis resulted in non-detect (Table 19), including tests for total coliform, heterotrophic plate counts, *Legionella*, *Giardia*, and *Cryptosporidium*.

Table 12 Inorganic Chemicals (as listed in Table 1 of OAR 333-061-0030)

Constituent	Unit	FW#1 (April 28)	FW #2 (April 28)	FW#3 (April 29)	FW#4 (April 29)	MCL/Action Level, mg/l	MRL, mg/L
Antimony	mg/L	ND	ND	ND	ND	0.006	0.001
Arsenic	mg/L	ND	ND	ND	ND	0.01	0.001
Asbestos	MFL	ND	ND	ND	ND	7 MFL	0.2
Barium	mg/L	ND	ND	ND	ND	2	0.002
Beryllium	mg/L	ND	ND	ND	ND	0.004	0.001
Cadmium	mg/L	ND	ND	ND	ND	0.005	0.0005
Chromium	mg/L	<0.0004	<0.0004	<0.0004	<0.0004	0.1	0.0004
Copper	mg/L	ND	ND	ND	ND	1.3 *(Action Level)*	0.002
Cyanide	mg/L	ND	ND	ND	ND	0.2	0.025
Fluoride	mg/L	ND	ND	ND	ND	4	0.05
Lead	mg/L	ND	ND	ND	ND	0.015 *(Action Level)*	0.0005
Mercury	mg/L	ND	ND	ND	ND	0.002	0.0002
Nickel	mg/L	ND	ND	ND	ND	*MCL being re-evaluated by EPA*	0.005
Nitrate (as N)	mg/L	0.227	0.222	0.139	0.123	10	0.005
Nitrite (as N)	mg/L	<0.005	<0.005	<0.005	<0.005	1	0.005
Total Nitrate + Nitrite (as N)	mg/L	0.227	0.223	0.139	0.123	10	0.01
Selenium	mg/L	ND	ND	ND	ND	0.05	0.005
Thallium	mg/L	ND	ND	ND	ND	0.002	0.001

Note:
1. MFL = million fibers per liter longer than 10 *u*m.

Table 13 Synthetic Organic Chemicals (as listed in Table 2 of OAR 333-061-0030)

Constituent	Unit	FW#1 (April 28)	FW #2 (April 28)	FW#3 (April 29)	FW#4 (April 29)	MCL/Action Level, mg/l	MRL, mg/L
Alachlor	mg/L	ND	ND	ND	ND	0.002	0.00005
Atrazine	mg/L	ND	ND	ND	ND	0.003	0.00005
Benzo(a)pyrene	mg/L	ND	ND	ND	ND	0.0002	0.00002
Carbofuran	mg/L	Not Sampled	ND	ND	ND	0.04	0.0005
Chlordane	mg/L	ND	ND	ND	ND	0.002	0.0001
Dalapon	mg/L	ND	ND	ND	ND	0.2	0.001
Dibromochloropropane	mg/L	ND	ND	ND	ND	0.0002	0.00001
Dinoseb	mg/L		ND	ND	ND	0.007	0.0002
Dioxin(2,3,7,8-TCDD)	mg/L	ND	ND	ND	ND	3.00E-08	5.00E-09
Diquat	mg/L	ND	ND	ND	Not Sampled	0.02	0.0004
Di(2-ethylhexyl) adipate	mg/L	ND	ND	ND	ND	0.4	0.0006
Di(2-ethylhexyl) phthalate	mg/L	ND	ND	ND	ND	0.006	0.0006
Endothall	mg/L	ND	ND	ND	ND	0.1	0.005
Endrin	mg/L	ND	ND	ND	ND	0.002	0.00001
Ethylene Dibromide	mg/L	ND	ND	ND	ND	0.00005	0.00001
Glyphosate	mg/L	ND	ND	ND	ND	0.7	0.006
Heptachlor	mg/L	ND	ND	ND	ND	0.0004	0.00001
Heptachlor epoxide	mg/L	ND	ND	ND	ND	0.0002	0.00001
Hexachlorobenzene	mg/L	ND	ND	ND	ND	0.001	0.00005
Hexachlorocyclopentadiene	mg/L	ND	ND	ND	ND	0.05	0.00005
Lindane	mg/L	ND	ND	ND	ND	0.0002	0.00001
Methoxychlor	mg/L	ND	ND	ND	ND	0.04	0.00005
Oxamyl(Vydate)	mg/L	Not Sampled	ND	ND	ND	0.2	0.0005
Picloram	mg/L	ND	ND	ND	ND	0.5	0.0001
Polychlorinated Biphenyls (TOTAL)	mg/L	ND	ND	ND	ND	0.0005	0.0001
Pentachlorophenol	mg/L	ND	ND	ND	ND	0.001	0.00004
Simazine	mg/L	ND	ND	ND	ND	0.004	0.00005
Toxaphene	mg/L	ND	ND	ND	ND	0.003	0.0005
2,4-D	mg/L	ND	ND	ND	ND	0.07	0.0001
2,4,5-TP Silvex	mg/L	ND	ND	ND	ND	0.05	0.0002

Table 14 Disinfection Byproducts (as listed in Table 3 of OAR 333-061-0030)

Disinfection Byproduct	Unit	FW#1 (April 28)	FW #2 (April 28)	FW#3 (April 29)	FW#4 (April 29)	MCL/Action Level, mg/L	MRL, mg/L
Total Trihalomethanes (TTHM)	mg/L	ND	ND	ND	ND	0.08	0.0005
Haloacetic acids (five)(HAA5)	mg/L	ND	ND	ND	ND	0.06	0.002
Bromate	mg/L	ND	ND	ND	Not Sampled	0.01	0.001
Chlorite	mg/L	ND	ND	ND	Not Sampled	1.0	0.01
Chlorate[1]	mg/L	ND	ND	ND	Not Sampled	0.8*	0.01

Note:
1. Chlorate not listed in Table 3 of OAR 3330-61-0030.

Table 15 VOCs (as listed in Table 5 of OAR 333-061-0030)

Constituent	Unit	FW#1 (April 28)	FW #2 (April 28)	FW#3 (April 29)	FW#4 (April 29)	MCL/Action Level, mg/L	MRL, mg/L
Benzene	mg/L	ND	ND	ND	ND	0.005	0.0005
Carbon tetrachloride	mg/L	ND	ND	ND	ND	0.005	0.0005
cis-1,2-Dichloroethylene	mg/L	ND	ND	ND	ND	0.07	0.0005
Dichloromethane	mg/L	ND	ND	ND	ND	0.005	0.0005
Ethylbenzene	mg/L	ND	ND	ND	ND	0.7	0.0005
Monochlorobenzene (Chlorobenzene)	mg/L	ND	ND	ND	ND	0.1	0.0005
o-Dichlorobenzene	mg/L	ND	ND	ND	ND	0.6	0.0005
p-Dichlorobenzene	mg/L	ND	ND	ND	ND	0.075	0.0005
Styrene	mg/L	ND	ND	ND	ND	0.1	0.0005
Tetrachloroethylene(PCE)	mg/L	ND	ND	ND	ND	0.005	0.0005
Toluene	mg/L	ND	ND	ND	ND	1	0.0005
trans-1,2-Dichloroethylene	mg/L	ND	ND	ND	ND	0.1	0.0005
Trichloroethylene (TCE)	mg/L	ND	ND	ND	ND	0.005	0.0005
Vinyl chloride	mg/L	ND	ND	ND	ND	0.002	0.0003
Xylenes(total)	mg/L	ND	ND	ND	ND	10	0.0005
1,1-Dichloroethylene	mg/L	ND	ND	ND	ND	0.007	0.0005
1,1,1-Trichloroethane	mg/L	ND	ND	ND	ND	0.2	0.0005
1,1,2-Trichloroethane	mg/L	ND	ND	ND	ND	0.005	0.0005
1,2-Dichloroethane	mg/L	ND	ND	ND	ND	0.005	0.0005
1,2-Dichloropropane	mg/L	ND	ND	ND	ND	0.005	0.0005
1,2,4-Trichlorobenzene	mg/L	ND	ND	ND	ND	0.07	0.0005

Table 16	Radionuclides (as listed in Table 6 of OAR 333-061-0030)						
Constituent	**Unit**	**FW#1 (April 28)**	**FW #2 (April 28)**	**FW#3 (April 29)**	**FW#4 (April 29)**	**MCL**	**MRL (units shown at far left)**
Gross Alpha (including Radium-226 but not Radon and Uranium)	pCi/L	<2	<2.5	<2.3	Not Sampled	15 pCi/L	2.0 - 2.5
Radium-226	pCi/L	<0.38	< 0.5	<0.31	<0.65	-	0.31 - 0.65
Radium-228	pCi/L	<0.69	< 0.56	<0.78	<0.59	-	0.56 - 0.78
Combined Radium-226 and Radium-228 *(226 + 228)*	pCi/L	<1.07	<1.06	<1.09	<1.24	5 pCi/L	-
Uranium	ug/L	ND	ND	ND	ND	30ug/L	1
Beta/Photon emitters (gross beta tested)	pCi/L	<1.6	<1.7	<1.71	Not Sampled	4 mrem/yr*	1.6, 1.7

*Note: Since no emitters were detected, the samples comply with the MCL. Compliance with the 4 mrem/yr MCL is determined by calculating the sum of fractions in pCi/L for each emitter detected, then converting to mrem/yr .

Table 17	Secondary Constituents (as listed in Table 7 of OAR 333-061-0030)						
Secondary Constituent:	**Unit**	**FW#1 (April 28)**	**FW #2 (April 28)**	**FW#3 (April 29)**	**FW#4 (April 29)**	**MCL/Action Level (units shown at far left)**	**MRL (units shown at far left)**
Color	ACU	ND	ND	ND (H3)	ND	15 color units	3
Corrosivity (below)*						Non-corrosive	
Langelier Index - 25 degrees C	-	-5.7	-5.6	-5.5	-5.6	Non-corrosive	-
Langelier Index at 60 degrees C	-	-5.2	-5.1	-5.1	-5.1	Non-corrosive	-
Agressiveness Index-Calculated	-	6.2	6.4	6.4	6.4	Non-corrosive	0.1
pH of CaCO3 saturation(25C)	units	11	11	11	11	Non-corrosive	0.1
pH of CaCO3 saturation(60C)	units	11	11	11	11	Non-corrosive	0.1
Bicarb. Alkalinity as HCO3,calc	mg/L	2.6	3.1	2.5	2.5	Non-corrosive	2
Foaming agents (Surfactants)	mg/L	ND	ND	ND	ND	0.5	0.05
pH	SU	4.86	4.72	not measured	not measured	6.5-8.5	
Hardness (as CaCO3)	mg/L	~0.556	~0.556	~0.556	~0.556	250	0.05
Odor (SM 2150B - Odor at 60 C (TON))	TON	ND	ND	ND (H3)	ND	3 (Threshold Odor Number)	1
Total dissolved solids(TDS)	mg/L	<5	<5	<5	<5	500	5
Aluminum	mg/L	ND	ND	ND	ND	0.05-0.2	0.02
Chloride	mg/L	0.14	0.14	0.14	0.14	250	0.02
Copper	mg/L	ND	ND	ND	ND	1	0.002
Fluoride	mg/L	ND	ND	ND	ND	2	0.05
Iron	mg/L	ND	ND	ND	ND	0.3	0.02
Manganese	mg/L	ND	ND	ND	ND	0.05	0.002
Silver	mg/L	ND	ND	ND	ND	0.1	0.001
Sulfate	mg/L	ND	ND	ND	ND	250	0.5
Zinc	mg/L	ND	ND	ND	ND	5	0.02

Table 18 Trace Compounds Specified by NWRI (2013)							
Contaminant	**Unit**	**FW#1 (April 28)**	**FW #2 (April 28)**	**FW#3 (April 29)**	**FW#4 (April 29)**	**Criteria (units shown at far left)**	**MRL (units shown at far left)**
N-Nitrosodimethylamine (NDMA)	ng/L	ND	Not Sampled	ND	ND	1 ng/L*	2
1,4- dioxane	ug/L	ND	ND	ND	ND	0.1 ug/L	0.07
Perfluoro-octanoic acid (PFOA)	ug/L	ND	ND	ND	Not Sampled	0.4 ug/L	0.0025
Perfluoro-octane sulfonate (PFOS)	ug/L	ND	ND	ND	Not Sampled	0.2 ug/L	0.0025
Perchlorate	ug/L	ND	ND	ND	ND	6 ug/L	4
Ethinyl Estradiol	ug/L	ND	ND	ND	ND	-	0.005
17-b-estradiol (reported as Estradiol)	ug/L	ND	ND	ND	ND	-	0.005
Cotinine	ug/L	ND	ND	ND	ND	1 ug/L	0.001
Dilantin	ug/L	ND	ND	ND	ND	1 ug/L	0.02
Primidone	ug/L	ND	ND	ND	ND	1 ug/L	0.005
Atenolol	ug/L	ND	ND	ND	ND	4 ug/L	0.005
Meprobamate	ug/L	ND	ND	ND	ND	4 ug/L	0.005
Carbamazepine	ug/L	ND	ND	ND	ND	10 ug/L	0.005
Estrone	ug/L	ND	ND	ND	ND	0.32 ug/L	0.005
Sucralose	ug/L	ND	ND	ND	ND	150,000 ug/L	0.1
Tris[2-chloroethyl]phosphate (TCEP)	ug/L	ND	ND	ND	ND	5 ug/L	0.01
N,N-diethyl-meta-toluamide (DEET)	ug/L	ND	ND	ND	ND	200 ug/L	0.01
Triclosan	ug/L	ND	ND	ND	ND	21,000 ug/L	0.01

*Note: There is no EPA criteria for NDMA. California Dept. of Public Health lists a 10-6 Risk Level of 3 ng/L, a notification level of 10 ng/L, and a response level of 300 ng/L.

Table 19 Microbiological Constituents					
Constituent	**Unit**	**FW#1 (April 28)**	**FW #2 (April 28)**	**FW#3 (April 29)**	**FW#4 (April 29)**
Heterotrophic plate count (HPC)	MPN/100 mL	not measured	<1	<1	<1
Total Coliform	MPN/100 mL	not measured	<1	<1	<1
Legionella[4]	organisms/mL	<3	Not Sampled	Not Sampled	<3
Cryptosporidium	oocysts/L	<0.09	Not Sampled	Not Sampled	<0.1
Giardia lamblia	cysts/L	<0.09	Not Sampled	Not Sampled	<0.1

4.0 BATCH PRODUCTION QUALITY CONTROL

Once this demonstration project is approved, CWS will use the demonstration facility to produce batches of purified water. This water will be used by local breweries for limited production of beer. The current plan is to produce a total of 500 gallons of purified water, which will later become 5 to 10 barrels of beer (130-260 gallons). The purified water will be produced in two days and placed into four individual totes. The brewers will be given the water the day after production for them to begin the brewing process. If any of the individual treatment processes do not meet the standards documented here, or if the finished water quality does not meet the standards documented here, the batch of water will be rejected and discarded.

As listed in Section 3, the treatment processes provided robust removal of all microbiological and chemical constituents. While the system is expected to continue to provide the same level of treatment during batch production, confidence in the continued performance of each process is established by performance testing.

4.1.1 Trace Chemicals

At the beginning of the first production day and the end of the second production day, the finished water quality will be sampled for all the constituents listed in Tables 12 through 19. The finished water quality will be compared with the regulated levels and the data within this report.

In addition to the chemical testing above, NDMA will be measured before and after the demonstration scale UV reactors. This allows for a determination of safe NDMA levels in the water and also allows for demonstration of a high UV dose from the UV system.

4.1.2 Pathogens

As discussed in this report, the online monitoring methods for the demonstration system are not sufficiently sensitive to justify the full pathogen reduction credit for each process. As an example, RO was shown to remove 4.3-log of virus, but the online measurement of EC only shows ~1.6 log removal. Table 20 reviews the pathogen credits that can be continuously verified online compared to the pathogen credits that can be verified through online monitoring coupled with grab sampling. As the table indicates, grab sampling (and analysis) is critical to demonstrating performance of the treatment system during batch production.

Table 20 Monitoring Confidence and Pathogen Credits
High Purity Water Project
Clean Water Services

Credits shown for Virus/*Giardia*/*Cryptosporidium*

Process	Potential Credits Based Upon Demonstration Testing and Literature	Online Monitoring	Online Credits	Grab Sampling	Combined Online and Grab Sample Credits	Notes
Primary and Secondary Process	1.9/1.2/0.8	None	0/0/0	*Enteric virus and protozoa analysis*	No sampling proposed for Batch Production	
Full-Scale UV	0/3.5/3.5	None	0/0/0	*E. coli*	0/3.5/3.5	
Demo UF	4.7/4.7/4.7	Effluent Turbidity	0/0/0	MIT, Influent and Effluent Total Coliform, PSD	4.7/4.7/4.7	Demonstration testing suggests a correlation of Turbidity with MIT results, but is not sufficiently quantified to demonstrate pathogen removal credit.
Demo RO	4.3/4.3/4.3	EC	1.6/1.6/1.6	TOC, MS2 Seeding and Sampling	1.6/1.6/1.6	Seeding of MS2 for batch production will not be done. TOC monitoring provides same level of credits as EC monitoring.
Demo UV	6/6/6	None	0/0/0	Influent and Effluent NDMA	6/6/6	NDMA destruction demonstrates UV dose delivery
Totals	**17.9/19.7/19.3**		**1.6/1.6/1.6**		**12.3/15.8/15.8**	

Table 21 summarizes the recommended testing standards for each day of batch production of purified water.

**Table 21 Batch Production Testing
High Purity Water Project
Clean Water Services**

Process	Test	Target Concentration	Tested Before or After the Batching Process
Full-Scale UV	*E. coli* in the UV effluent	<20 MPN/100mL	Both
Demo UF	PSD	>2 LRV (protozoa range) >1.5 LRV (bacteria range)	Both
	Total Coliform in UF effluent	<40 MPN/100mL	Both
	Turbidity in UF effluent	<0.1	Both
	MIT	<0.2	Both
Demo RO	EC	LRV >1.5	Both
	TOC	LRV >1.5	Both
Demo UV	NDMA	ND	Both
Finished Water	All constituents listed in Tables 12 through 19	Similar results to those demonstrated here	Both

5.0 SUMMARY

In summary, this report demonstrates:

- The FGF effluent, when treated with UF, RO, and UV AOP, provides a very high quality water that is absent of trace pollutants and pathogens.
- The combined treatment processes provide for a higher level of public health protection than required in California for IPR projects and in Texas for DPR projects.
- The coupling of online monitoring and grab sampling for future batch production of purified water provides confidence in water quality and public health protection.

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APPENDIX A - RESPONSE TO DEQ LETTER DATED 5/2/14

APPENDIX A - RESPONSE TO DEQ LETTER DATED 5/2/14

Text from DEQ and within Section 2.2.2 of DEQs recycled Water IMD (http://www.deq.state.or.us/wq/pubs/imds/RecycledWater.pdf) is shown here in **bold and red**.

If CWS would like to pursue a project involving human consumption of high-purity recycled water from a permitted wastewater treatment facility, OHA and DEQ request that CWS submit a written proposal for review and comment. In the proposal, please include the following:

1. **Information contained in section 2.2.2 Authorizing Other Beneficial Purpose**

The District has constructed and tested a pilot project that will help raise awareness and gather information on the re-use of high purity water, which will include making potable water for use in making a craft beer. DEQ may approve other beneficial purposes currently not identified in rule [OAR 340-055- 0016(6)].

If a request is made to use recycled water for a beneficial purpose not identified in rule, DEQ requests the permittee or applicant to provide the information necessary to evaluate the proposal.

The types of information requested may include, but is not limited to:

- **Recycled water quality data;**

The quality of the purified water is described in Section 3 of this report. The combination of treatment processes met and exceeded all pathogen reduction targets set for Indirect Potable Reuse (IPR) and Direct Potable Reuse (DPR) in California, Texas, New Mexico, and nationally. The finished water quality met all drinking water quality standards, with the far majority of measurements resulting in non-detect.

- **Recycled water quantity data;**

The pilot process is capable of producing 1 gallon per minute, in practice operations will provide less than 1000 gallons per day**.**

- **Data on the quantity and quality of water necessary for the proposed beneficial purpose;**

- A memo from Brian King, which immediately follows this question and answer discussion within this Appendix, describes the Districts understanding of the current regulatory requirements consistent with the proposed pilot demonstration project. In general the water used to produce and transport specialty craft beer must meet the currently identified potable drinking water standards. For a batch of beer to be produced will need approximately 500-1000 gallons of water. Approximately half the influent water is lost as RO brine which is returned to the FGF, while the other half of the water is passed through the RO membrane and through the UV AOP process, resulting in a purified finished water. Water will provided in individual totes of up to 250 gallons. Totes will be labeled describing the source of the water and noting that any water not used will be disposed of in an sanitary sewer system. The ratio of beer produced to the volume of water provided is about 1:3. **Description of the recycled water's resource value for the use;**

Drought throughout the Southwestern United States, from California, Nevada, Arizona, New Mexico, and Texas have forced these states to quickly set regulations for Direct Potable Reuse (DPR) as a near term water supply. Utilities in Texas, as one example, have moved from small non-potable water reuse projects to DPR in a matter of several years. California is mandated by state law to examine how to safely implement DPR. As documented in Section 2 (literature review) and Section 3 (demonstration testing results), the treatment barriers employed for DPR are robust and effective. The key items limiting potable water reuse in general, and DPR in particular, is public and regulatory perception.

This project by CWS is intended to proactively engage the public and the regulatory community on the high quality water and value of DPR. While Oregon in general does not face the dramatic drought conditions of the Southwestern US, this project and this discussion will allow for CWS and other communities to better plan for a long term sustainable water supply.

- **Technical and scientific facts that support the proposed use**

This report includes detailed information supporting potable water reuse, as follows:

Section 1

- Summarizes IPR and DPR applications nationally;
- Reviews the literature related to public health and IPR and DPR;
- Regulations for IPR and DPR in Oregon, California, New Mexico, Texas, and Nationally.

Section 2

- Review of potable reuse treatment technologies, with literature references for performance;
- Details on the CWS potable reuse demonstration treatment system.

Section 3

- Treatment performance results, including full-scale and demonstration scale facilities, with references and comparisons to industry data.

- **Pilot studies**

This report summarizes the detailed CWS demonstration project (pilot study).

- **Epidemiological data.**

Epidemiological studies are summarized in Section 1 of this report, with information taken directly from NRC (2012).

- **Possible adverse effects to public health or the environment;**

Regarding the environment, the only concern related to potable reuse is the discharge of brine to the environment. That topic, while important, is not part of this demonstration project. Regarding human health, the literature referenced within this report and the regulatory framework set forth by the State of California (and others), demonstrates that potable reuse (IPR or DPR) is protective of public health. The California Medical Association has met and resolved that potable reuse is protective of public health (CMA, 2012).

- **Exposure pathways;**

The high purity water will be produced from the pilot scale treatment system on site by professional staff. Once a batch is produced and tested to demonstrate quality the water will be stored in individual totes. Each tote will then be transported to select craft beer manufactures who use the water to make a craft beer. A spill response plan will be provided for each batch of beer transported. Each tote will be labeled specifying origin of the water and requirement to dispose of excess water not used in the beer process to a sanitary system. Processed beer will be made available as “tasting” for non—profit non-commercial use at specific events such as professional conferences or internal events.

- **Potential for offsite migration;**

See above, during the processing any water released will be drained into the sanitary sewer system. Spill response plans and requirements for returning any excess water not used in the beer making process will limit offsite migration.

- **Adjacent land uses;**

Not applicable for potable water reuse.

- **And examples of other jurisdictions (e.g., states, countries, etc.) or facilities using recycled water in the proposed manner.**

Section 1 of this report provides examples of other potable reuse projects, and provides references to larger databases of information. To our knowledge, there are no other projects intending on using potable reuse technology as a pilot to produce purified water for specialty brewing applications.

2. A detailed description of the proposed treatment system

The demonstration treatment system is reviewed in Section 2 of this report.

3. Data demonstrating that all current requirements under the Safe Drinking Water Act will be met or exceeded at the point of reuse.

The high quality water produced from the demonstration facility is described in Section 3 of this report.

4. Data on the treatment, removal, and final concentrations of unregulated contaminates (e.g., personal care products, pharmaceuticals, etc) likely present in wastewater effluent prior to advance treatment

The high quality water produced from the demonstration facility is described in Section 3 of this report.

5.Information on any additional requirements from the Oregon Department of Agriculture or the US Food and Drug Administration or Both

This Appendix (A) and this report explains why compliance with the Oregon Drinking Water Quality Act and the accompany criteria would meet the water quality requirements fo the federal Alcohol and Tobacco Tax and Trade Bureau and the Food and Drug Administration.

SCHWABE, WILLIAMSON & WYATT®
ATTORNEYS AT LAW

Memorandum

ATTORNEY-CLIENT PRIVILEGED AND ATTORNEY WORK PRODUCT

To: Bob Baumgartner, Clean Water Services

From: Jeffrey D. Hern

Date: June 19, 2014

Subject: Pure Water Project: Additional Requirements from U.S. Food & Drug Administration and Oregon Department of Agriculture

File No.: 091418-194292

I. INTRODUCTION

With the Pure Water Project (the "Project"), Clean Water Services ("CWS") will demonstrate how municipal wastewater may be treated with advanced water purification and disinfection technology to the point where it meets safe drinking water standards and is suitable for human consumption. In particular, CWS hopes to supply such water to a local Oregon craft brewer which could make beer using the high-purity water.

CWS contacted the Oregon Department of Environmental Quality ("ODEQ") and Oregon Health Authority ("OHA") about the Project because those agencies must approve any use of recycled water for direct human consumption under Oregon law.[1] In response, by a joint letter dated May 2, 2014, ODEQ and OHA asked for more information about the Project including any "additional requirements" of the federal Food & Drug Administration ("FDA") and the Oregon Department of Agriculture ("ODOA"). This memorandum responds to that particular request.

II. THE FEDERAL FOOD & DRUG ADMINISTRATION AND THE OREGON DEPARTMENT OF AGRICULTURE

The FDA and ODOA fix and establish standards for the manufacture and processing of food and beverages, including beer.[2] The FDA and ODOA rules set forth similar requirements because ODOA largely adopts the federal agency's rules and standards on matters pertinent to the Project.[3] Broadly, the FDA and ODOA both require food and beverages, including their

[1] *See* OAR 340-055-0017(5) ("The use of recycled water for direct human consumption … is prohibited unless approved in writing by [OHA], and after public hearing, and it is so authorized by the Environment Quality Commission.")
[2] *See* 21 U.S.C. 301 *et seq.*; *see also* 21 U.S.C. 321(f) (defining "food" to include beverages and thus beer); 21 U.S.C. 341 (authorizing the FDA to set "a reasonable standard of quality" for any food or beverage product).
[3] *See* ORS 616.230; OAR 603-025-0190.

ingredients (such as water), to be "suitable for human consumption."[4]

Further, the FDA and ODOA rules similarly require water to be used in the food manufacturing process to come from an "adequate source."[5] This generally means that the water to be used, which may be treated or processed prior to such use, should meet state and local drinking water standards and otherwise be suitable for human consumption.

In the context of bottled drinking water,[6] the FDA sets forth some rules that may be instructive here. Those rules define an "approved source" of water as:

> … [A] source of water and the water therefrom, whether it be from a spring, artesian well, drilled well, municipal water supply, or <u>any other source</u>, that has been inspected and the water sampled, analyzed, and found to be of a <u>safe and sanitary quality according to applicable laws and regulations of State and local government agencies having jurisdiction</u>.[7]

Those rules on bottled drinking water also set forth standards for the treatment of such "product water," as follows:

> All treatment of product water by distillation, ion-exchanging, filtration, ultra-violet treatment, reverse osmosis, carbonation, mineral addition, or any other process shall be done in a manner so as to be effective in accomplishing its intended purpose and in accordance with [21 U.S.C. 348]. … Product water samples shall be taken after processing and prior to bottling by the plant and analyzed as often as necessary to assure uniformity and effectiveness of the processes performed by the plant. The methods of analysis shall be those <u>approved by the government agency or agencies having jurisdiction</u>.[8]

While addressing a slightly different context, these regulations show that water to be used as an ingredient in food (including beer) should meet the state and local drinking water standards, such as those in the Oregon Drinking Water Quality Act.

Moreover, the FDA generally must conform the water quality standards (or explain why conforming is not necessary) to those set forth in the federal Safe Drinking Water Act ("SDWA") and the related Environmental Protection Agency ("EPA") rules, including the National Primary Drinking Water Regulations ("NPDWRs").[9] Oregon adopts similar water

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[4] *See, e.g.,* 21 C.F.R. 110.80 (providing food, including ingredients, shall be "suitable for human consumption"); OAR 603-025-0150(2)(e)(A) (same). The federal rules also recognize that food may be treated or processed to eliminate possible contamination. *See* 21 C.F.R. 110.80.
[5] 21 C.F.R. 110.37; OAR 603-025-0020(8); *see also* 21 C.F.R. 110.38.
[6] Under the FDA rules on bottled drinking water, there are distinctions among the terms "operations water" (water used for clean-up or sanitary purposes), "product water" (processed water used by plant), and "bottled drinking water" (final product for human consumption). 21 C.F.R. 129.3(a).
[7] 21 C.F.R. 129.3(a) (emphasis added).
[8] 21 C.F.R. 129.80(a) (emphasis added).
[9] 21 U.S.C. 349(a)-(b).

quality standards in its Drinking Water Quality Act in that the standards generally must conform to or be "no less stringent" than the NPDWRs of the EPA.[10] Accordingly, if water complies with the Oregon Drinking Water Quality Act, it should meet the requirements of NPDWRs and thereby water quality requirements adopted by the FDA and ODOA.

III. THE FEDERAL ALCOHOL & TOBACCO TAX & TRADE BUREAU AND THE OREGON LIQUOR CONTROL COMMISSION

The federal Alcohol & Tobacco Tax & Trade Bureau ("TTB") is worth mentioning because it regulates the manufacturing of beer.[11] TTB rules lack specific requirements as to the quality of water to be used in the brewing process. The regulations, however, set forth some general standards for water quality. In particular, the term "malt beverage" as defined references such standards.

> *Malt beverage*. A beverage made by the alcoholic fermentation of an infusion or decoction, or combination of both, in potable brewing water, of malted barley with hops, or their parts, or their products, and with or without malted cereals, and with or without the addition of unmalted or prepared cereal, other carbohydrates or products prepared therefrom, and with or without the addition of carbon dioxide, and with or without other wholesome products suitable for human consumption.[12]

Based on this definition, the water used to make beer must be "potable" and "suitable for human consumption." This is consistent with the standards set forth by the FDA and ODOA.

Finally, the Oregon Liquor Control Commission ("OLCC") largely does not regulate the manufacturing of beer, or at least not the ingredients to be used in beer. The OLCC focuses on the licensing, control and service of alcohol within the state and leaves regulation of the manufacturing to the TTB as well as the FDA and ODOA.

IV. CONCLUSION

In sum, the FDA, ODOA and TTB similarly require that water to be used as an ingredient in food (including beer) should meet safe drinking water standards and otherwise be "suitable for human consumption." With the Project, the water will be treated with advanced water purification and disinfection technology to the point where it meets these standards.

cc: Gerald P. Linder, Esq.
Brian J. King

[10] ORS 448.273(4).
[11] *See generally* 27 C.F.R. Parts 1, 7, 25.
[12] 27 C.F.R. 7.10 (emphasis added.)

APPENDIX B - CDPH REGULATED CHEMICALS

Appendix B

Regulated Chemicals

Contaminant	USEPA (shown for reference only)		CDPH	
	MCL (mg/L)	Date[1]	MCL (mg/L)	Effective Date
Inorganics (Table 64431-A)				
Aluminum	0.05 to 2[2]	1/91	1 0.2[2]	2/25/89 9/8/94
Antimony	0.006	7/92	0.006	9/8/94
Arsenic	0.05 0.01	eff: 6/24/77 2001	0.05	77
Asbestos	7 MFL[3]	1/91	7 MFL[3]	9/8/94
Barium	1 2	eff: 6/24/77 1/91	1	77
Beryllium	0.004	7/92	0.004	9/8/94
Cadmium	0.010 0.005	eff: 6/24/77 1/91	0.010 0.005	77 9/8/94
Chromium	0.05 0.1	eff: 6/24/77 1/91	0.05	77
Copper	1.3[4]	6/91	1[2] 1.3[4]	77 12/11/95
Cyanide	0.2	7/92	0.2 0.15	9/8/94 6/12/03
Fluoride	4 2[2]	4/86 4/86	2	4/98
Lead	0.05[5] 0.015[4]	eff: 6/24/77 6/91	0.05[5] 0.015d	77 12/11/95
Mercury	0.002	eff: 6/24/77	0.002	77
Nickel	Remanded		0.1	9/8/94
Nitrate	(as N) 10	eff: 6/24/77	(as NO_3) 45	77
Nitrite (as N)	1	1/91	1	9/8/94
Total Nitrate/Nitrite (as N)	10	1/91	10	9/8/94
Selenium	0.01 0.05	eff: 6/24/77 1/91	0.01 0.05	77 9/8/94
Thallium	0.002	7/92	0.002	9/8/94

Contaminant	USEPA (shown for reference only) MCL (mg/L)	Date[(1)]	CDPH MCL (mg/L)	Effective Date
Radionuclides (Tables 64442 and 64443)				
Uranium	30 µg/L	12/7/00	20 pCi/L	1/1/89
Combined radium-226 & 228	5 pCi/L	eff: 6/24/77	5 pCi/L	77
Gross Alpha particle activity	15 pCi/L	eff: 6/24/77	15 pCi/L	77
Gross Beta particle activity	dose of 4 millirem/yr	eff: 6/24/77	50 pCi/L[(6)]	77
Strontium-90	8 pCi/L	eff: 6/24/77 now covered by Gross Beta	8 pCi/L[(6)]	77
Tritium	20,000 pCi/L	eff: 6/24/77 now covered by Gross Beta	20,000 pCi/L[(6)]	77
Organic Chemicals (Table 64444-A)				
VOCs				
Benzene	0.005	6/87	0.001	2/25/89
Carbon Tetrachloride	0.005	6/87	0.0005	4/4/89
1,2-Dichlorobenzene	0.6	1/91	0.6	9/8/94
1,4-Dichlorobenzene	0.075	6/87	0.005	4/4/89
1,1-Dichloroethane	-	-	0.005	6/24/90
1,2-Dichloroethane	0.005	6/87	0.0005	4/4/89
1,1-Dichloroethylene	0.007	6/87	0.006	2/25/89
cis-1,2-Dichloroethylene	0.07	1/91	0.006	9/8/94
trans-1,2-Dichloroethylene	0.1	1/91	0.01	9/8/94
Dichloromethane	0.005	7/92	0.005	9/8/94
1,3-Dichloropropene	-	-	0.0005	2/25/89
1,2-Dichloropropane	0.005	1/91	0.005	6/24/90
Ethylbenzene	0.7	1/91	0.68 0.7 0.3	2/25/89 9/8/94 6/12/03
Methyl-tert-butyl ether (MTBE)	-	-	0.005[(2)] 0.013	1/7/99 5/17/00
Monochlorobenzene	0.1	1/91	0.03 0.07	2/25/89 9/8/94
Styrene	0.1	1/91	0.1	9/8/94
1,1,2,2-Tetrachloroethane	-	-	0.001	2/25/89

Contaminant	USEPA (shown for reference only)		CDPH	
	MCL (mg/L)	Date[1]	MCL (mg/L)	Effective Date
Tetrachloroethylene	0.005	1/91	0.005	5/89
Toluene	1	1/91	0.15	9/8/94
1,2,4 Trichlorobenzene	0.07	7/92	0.07 0.005	9/8/94 6/12/03
1,1,1-Trichloroethane	0.200	6/87	0.200	2/25/89
1,1,2-Trichloroethane	0.005	7/92	0.032 0.005	4/4/89 9/8/94
Trichloroethylene	0.005	6/87	0.005	2/25/89
Trichlorofluoromethane	-	-	0.15	6/24/90
1,1,2-Trichloro-1,2,2-Trifluoroethane	-	-	1.2	6/24/90
Vinyl chloride	0.002	6/87	0.0005	4/4/89
Xylenes	10	1/91	1.750	2/25/89
SVOCs				
Alachlor	0.002	1/91	0.002	9/8/94
Atrazine	0.003	1/91	0.003 0.001	4/5/89 6/12/03
Bentazon	-	-	0.018	4/4/89
Benzo(a) Pyrene	0.0002	7/92	0.0002	9/8/94
Carbofuran	0.04	1/91	0.018	6/24/90
Chlordane	0.002	1/91	0.0001	6/24/90
Dalapon	0.2	7/92	0.2	9/8/94
Dibromochloropropane	0.0002	1/91	0.0001 0.0002	7/26/89 5/3/91
Di(2-ethylhexyl)adipate	0.4	7/92	0.4	9/8/94
Di(2-ethylhexyl)phthalate	0.006	7/92	0.004	6/24/90
2,4-D	0.1 0.07	eff: 6/24/77 1/91	0.1 0.07	77 9/8/94
Dinoseb	0.007	7/92	0.007	9/8/94
Diquat	0.02	7/92	0.02	9/8/94
Endothall	0.1	7/92	0.1	9/8/94
Endrin	0.0002 0.002	eff: 6/24/77 7/92	0.0002 0.002	77 9/8/94
Ethylene Dibromide	0.00005	1/91	0.00002 0.00005	2/25/89 9/8/94
Glyphosate	0.7	7/92	0.7	6/24/90

Contaminant	USEPA (shown for reference only) MCL (mg/L)	Date[(1)]	CDPH MCL (mg/L)	Effective Date
Heptachlor	0.0004	1/91	0.00001	6/24/90
Heptachlor Epoxide	0.0002	1/91	0.00001	6/24/90
Hexachlorobenzene	0.001	7/92	0.001	9/8/94
Hexachlorocyclopentadiene	0.05	7/92	0.05	9/8/94
Lindane	0.004 0.0002	eff: 6/24/77 1/91	0.004 0.0002	77 9/8/94
Methoxychlor	0.1 0.04	eff: 6/24/77 1/91	0.1 0.04 0.03	77 9/8/94 6/12/03
Molinate	-	-	0.02	4/4/89
Oxamyl	0.2	7/92	0.2 0.05	9/8/94 6/12/03
Pentachlorophenol	0.001	1/91	0.001	9/8/94
Picloram	0.5	7/92	0.5	9/8/94
Polychlorinated Biphenyls	0.0005	1/91	0.0005	9/8/94
Simazine	0.004	7/92	0.010 0.004	4/4/89 9/8/94
Thiobencarb	-	-	0.07 0.001[(2)]	4/4/89 4/4/89
Toxaphene	0.005 0.003	eff: 6/24/77 1/91	0.005 0.003	77 9/8/94
2,3,7,8-TCDD (Dioxin)	$3x10^{-8}$	7/92	$3x10^{-8}$	9/8/94
2,4,5-TP (Silvex)	0.01 0.05	eff: 6/24/77 1/91	0.01 0.05	77 9/8/94
Disinfection Byproducts (Table 64533-A)				
Total trihalomethanes	0.100 0.080	11/29/79 eff: 11/29/83 eff: 1/1/02[(7)]	0.100	3/14/83
Total haloacetic acids	0.060	eff: 1/1/02[(7)]		
Bromate	0.010	eff: 1/1/02[(7)]		
Chlorite	1.0	eff: 1/1/02[(7)]		

	USEPA (shown for reference only)		CDPH	
Contaminant	**MCL (mg/L)**	**Date[1]**	**MCL (mg/L)**	**Effective Date**

Notes:
(1) "eff." indicates the date the MCL took effect; any other date provided indicates when USEPA established (i.e., published) the MCL.
(2) Secondary MCL.
(3) MFL = million fibers per liter, with fiber length > 10 microns.
(4) Regulatory Action Level; if system exceeds, it must take certain actions such as additional monitoring, corrosion control studies and treatment, and for lead, a public education program; replaces MCL.
(5) The MCL for lead was rescinded with the adoption of the regulatory action level described in footnote d.
(6) MCLs are intended to ensure that exposure above 4 millirem/yr does not occur.
(7) Effective for surface water systems serving more than 10,000 people; effective for all others 1/1/04.

APPENDIX C - CDPH DRINKING WATER NOTIFICATION LEVELS

Table 1. CDPH Drinking Water Notification Levels		
Notes*	**Chemical**	**Notification Level (milligrams per liter)**
1	Boron	1
2	n-Butylbenzene	0.26
3	sec-Butylbenzene	0.26
4	tert-Butylbenzene	0.26
5	Carbon disulfide	0.16
6	Chlorate	0.8
7	2-Chlorotoluene	0.14
8	4-Chlorotoluene	0.14
9	Diazinon	0.0012
10	Dichlorodifluoromethane (Freon 12)	1
11	1,4-Dioxane	0.001
12	Ethylene glycol	14
13	Formaldehyde	0.1
14	HMX	0.35
15	Isopropylbenzene	0.77
16	Manganese	0.5
17	Methyl isobutyl ketone (MIBK)	0.12
18	Naphthalene	0.017
19	N-Nitrosodiethylamine (NDEA)	0.00001
20	N-Nitrosodimethylamine (NDMA)	0.00001
21	N-Nitrosodi-n-propylamine (NDPA)	0.00001
22	Propachlor**	0.09
23	n-Propylbenzene	0.26
24	RDX	0.0003
25	Tertiary butyl alcohol (TBA)	0.012
26	1,2,3-Trichloropropane (1,2,3-TCP)	0.000005
27	1,2,4-Trimethylbenzene	0.33
28	1,3,5-Trimethylbenzene	0.33
29	2,4,6-Trinitrotoluene (TNT)	0.001
30	Vanadium	0.05
* Notes include toxicological endpoint, references, history, and other information (see page 6)		

APPENDIX D - CALIFORNIA CODE OF REGULATIONS SECONDARY WATER STANDARDS

California Code of Regulation
Title 22. Division 4. Environmental Health
Chapter 15. Domestic Water Quality and Monitoring Regulations

Article 16. Secondary Water Standards

(1) Amend Section 64449 as follows:

64449. Secondary Maximum Contaminant Levels and Compliance.

(a) The secondary MCLs shown in Tables 64449-A and 64449-B shall not be exceeded in the water supplied to the public by community water systems. ~~, because these constituents may adversely affect the taste, odor or appearance of drinking water.~~

Table 64449-A

Secondary Maximum Contaminant Levels

"Consumer Acceptance ~~Limits~~ Contaminant Levels"

Constituents	*Maximum Contaminant Levels/Units*
Aluminum	0.2 mg/L
Color	15 Units
Copper	1.0 mg/L
~~Corrosivity~~	~~Non-corrosive~~
Foaming Agents (MBAS)	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Methyl-*tert*-butyl ether (MTBE)	0.005 mg/L
Odor—Threshold	3 Units
Silver	0.1 mg/L
Thiobencarb	0.001 mg/L
Turbidity	5 Units
Zinc	5.0 mg/L

Table 64449-B

Secondary Maximum Contaminant Levels –

"Consumer Acceptance Contaminant Level Ranges"

Constituent, Units	*Maximum Contaminant Level Ranges* Recommended	Upper	Short Term
Total Dissolved Solids, mg/L or	500	1,000	1,500
Specific Conductance, ~~micromhos~~ μS/cm	900	1,600	2,200
Chloride, mg/L	250	500	600
Sulfate, mg/L	250	500	600

~~(b) The secondary MCLs listed in Table 64449-A shall not be exceeded in:~~

~~(1) New community water systems.~~

~~(2) New sources developed for existing community water systems.~~

~~(3) Existing community water systems.~~

~~(c) Community groundwater systems~~

(b) Each community water system shall monitor its groundwater sources or distribution system entry points representative of the effluent of source treatment every three years and its approved surface water ~~systems shall monitor~~ sources or distribution system entry points representative of the effluent of source treatment annually for the following:

(1) Secondary MCLs listed in Tables 64449-A and 64449-B; and

(2) Bicarbonate, carbonate, and hydroxide alkalinity, calcium, magnesium, sodium, pH, and total hardness.

(c) If the level of any constituent in Table 64449-A exceeds an MCL, the

Table 1: Recommended Regulatory Criteria for Maximum Concentration Levels of Chemicals in Effluent from Potable Reuse Treatment Trains (NWRI 2013)

Chemical Group	Criterion	Rationale	Sources Used for Criteria
Disinfection byproducts that should be measured to evaluate treatment trains			
Trihalomethanes (THMs)	80 µg/L	Prominent chlorination byproducts	MCL OAR 333-061-0030, Table 3
Halogenated acetic acids (HAA5)	60 µg /L	Polar group of chlorination byproducts	Maximum Contaminant Level OAR 333-061-0030, Table 3
N-nitrosodimethylamine (NDMA)	10 ng/L	Byproduct of chloramination	California Department of Public Health notification level
Bromate	10 µg/L	Byproduct of ozonation	Maximum Contaminant Level OAR 333-061-0030, Table 3
Chlorate	800 µg /L	Reflective of hypochlorite use	California Department of Public Health notification level
Non-regulated chemicals of interest from a public health stand point (if present in wastewater source)			
Perfluoro-octanoic acid (PFOA)	0.4 µg/L	Known to occur, frequency unknown	Provisional short-term US EPA Health Advisory
Perfluoro-octane sulfonate (PFOS)	0.2 µg/L	Known to occur, frequency unknown	Provisional short-term US EPA Health Advisory
Perchlorate	15 µg/L 6 µg/L	Of interest, same analysis as chlorate and bromate	US EPA Health Advisory California Maximum Contaminant Level
1,4-Dioxane	1 µg/L	Occurs at low frequency in wastewater, but likely to penetrate RO membranes	California Department of Public Health notification level
Ethinyl Estradiol	None, close to detection limit if established	Steroid hormone, should evaluate presence in source water.	Bull et al. (2011)
17-ß-estradiol	None, close	Steroid hormone, should	Bull et al. (2011)

Chemical Group	Criterion	Rationale	Sources Used for Criteria
	to detection limit if established	evaluate presence in source water	
Pharmaceuticals of potential health concern that should be useful to evaluate the effectiveness of organic chemical removal by treatment trains.			
Cotinine/Primidone/ Dilantin	1/10/2 µg/L	Surrogate for low molecular weight, partially charged cyclics	Bruce et al. (2010); Bull et al. (2011)
Meprobamate/ Atenolol	200/4 µg/L	Occur frequently at the ng/L level	Bull et al. (2011)
Carbamazepine	10 µg/L	Unique structure	Bruce et al. (2010)
Estrone	320 ng/L	Surrogate for steroids	Based on an increased risk of stroke in women taking the lowest dose of conjugated estrogens
Other chemicals of potential health concern that should be useful to evaluate the effectiveness of organic chemical removal by treatment trains.			
Sucralose	150 mg/L	Surrogate for water soluble, uncharged chemicals of moderate molecular weight	Code of Federal Regulations Title 12, revised 4/1/12
Tris[2-chloroethyl]phosphate (TCEP)	5 µg/L	Chemical of interest	Minnesota Department of Health (2011) guidance value
N,N-diethyl-meta-toluamide (DEET)	200 µg/L	Chemical of interest	Minnesota Department of Health (2011) guidance value
Triclosan	50 µg/L	Chemical of interest	Minnesota Department of Health (2011) guidance value

Response to Public Comment Regarding Approval for a Limited Drinkable Reuse for Recycled Water

DEQ held a public hearing to receive comments about Clean Water Services' proposal to produce potable recycled water on Feb. 12, 2015, at 3 p.m. in DEQ's Northwest Region Office. Twenty-one people attended the hearing, and three people provided oral comment. Concurrent with the public hearing, DEQ accepted written comment between January 16, and February 20, 2015. Written comments were received from 14 different parties (including two who provided both oral and written comment). Written comments are included an appendix to this document. Oregon Association of Clean Water Agencies, and the Tualatin Riverkeepers presented oral comment and also submitted written versions of their comments. Oral comments by Art Larrence are summarized below. Both oral and written comments have been organized into categories that reflect whether the commenters support the request with conditions, generally support, request denial for the proposal, or provide clarification about their stance.

Many of the comments provided support for the project, and encouraged approval of the draft proposal as presented. Other comments provided clarification about their relationship to Clean Water Services, but offered neither support for nor request for denial of the project. The remaining comments requested additional oversight or requested denial of the project. The major concerns of these commenters included: a request for monitoring of additional parameters; whether DEQ has a sufficient enforcement program; whether DEQ provided sufficient notification regarding the public comment period; and whether the water is sufficiently safe for human consumption. These concerns are addressed in the text below the table.

Table 1. Summary of Comments Received

Summary of Comment	Commenter	Where to find DEQ's Response
Comments Proposing Conditions		
Supportive of concepts; request sufficient monitoring to protect human health	Oregon Environmental Council	Monitoring requirements will be identified in Recycled Water Use Plan and enforced through waste water discharge permit
Comments in Support:		
Good Idea	Greg Chick; Elizabeth Siping	Comments Noted
Support idea to promote water reuse and conservation, and believe that treatment approach is sufficient	Metropolitan Wastewater Management Commission, Tualatin Riverkeepers, Oregon Association of Clean Water Agencies, Oregon Water resources Congress, Clean Water Services, Art Larrance (oral comment only)	Comments Noted
Comments Requesting Denial		
Product not appealing; might have disadvantages; natural treatment through groundwater is better; plenty of water available	Elizabeth Graser-Lindsey	Comments addressed below
Sewage sludge is toxic; DEQ lacks funds for enforcement; DEQ is a proponent not an independent agency; cleaning system not sufficient; CWS double dipping by selling water and being paid to discharge it; DHS letter identifies concerns but concludes product is safe;	Northwest Toxic Communities Coalition	Comments addressed below
DEQ Public Notice limited distribution; media articles misleading about beer production	Stan Geiger, Aquatic Resources, Portland	Comments addressed below

and availability; concern that potable reuse water objectionable and will harm craft brew business; treatment is sufficient; should find a different alternative to promote conversation		
Bad idea, water will be treated but fresh water is better; Questions about brewing contest; Scope of project (gallons, availability); water is safe but does it have taste and odor issues?;Peroxide added at last step, may be present in final product; OHA approved, but bad idea as it may cause illness	Dorothy Shoemaker	Comments addressed below
Neutral comment providing Clarification		
OHA letter relies on boiling and alcohol content of water to ensure safety, beer industry does not desire that responsibility; Craft brews unique flavor is related to water used, and craft guild members prefer natural sources of water over highly treated water.	Craft Brew Alliance	Comments addressed below
CWS working with individual members; Guild itself has no official relationship with CWS	Oregon Brewers Guild	Comments addressed below

Comments Proposing Conditions

Oregon Environmental Council (monitoring requirements): The Oregon Environmental Council voiced support for exploring ways to treat and reuse water, given the increasing scarcity of water as a resource. OEC acknowledged some success with the treatment technology and extensive monitoring completed during the pilot project, and encouraged DEQ to require the same level monitoring on an ongoing basis. OEC also voiced concern that potable reuses of domestic wastewater may have high concentrations of emerging contaminants that are not currently regulated through Oregon's drinking water criteria. OEC encourages ongoing review of the National Water Reuse Institute contaminant list, as well as referring to Oregon's Priority Persistent Pollutant list, EPA's drinking water contaminant candidate list, as well as monitoring lists used by other states that have potable reuse projects in place.

Response: Potable uses of recycled water are regulated through a wastewater permit issued by DEQ. Permits issued to permittees that have received permission for potable reuses of wastewater will include conditions that will detail the required product monitoring in the Recycled Water Use Plan. Both DEQ and the Oregon Health Authority must review and approve these plans. The monitoring requirements are fully enforceable as part of the permit. This proposal includes monitoring for the concentration levels of all Oregon drinking water criteria (OAR 333-061-0030) as well as additional criteria recommended by the National Water Research Institute for potable reuse of water (NWRI, 2013). The National Water Research Institute fully evaluated the chemicals of concern that are likely to occur in wastewater at concentrations greater than expected in natural waters, and the health risks posed by them. The National Water Research Institute proposed a list of analytes to include in a potable reuse project that as a whole, monitors for chemicals that are likely to occur in recycled water and have a potential health risk, as well as chemicals that will indicated the efficacy of the sequence of three treatment trains proposed here. At this time, CWS is seeking approval for a pilot study that includes limited production and consumption rates for potable reuse water. As interest in potable reuse increases both nationally and in Oregon, DEQ and the Oregon Health Authority will continue to review and adopt new criteria and recommendations regarding potable reuse water.

Comments in Support of Potable Reuse

Greg Chick and Elizabeth Siping: Both submitted comments generally supportive of potable reuse.

Metropolitan Wastewater Management Commission, Tualatin Riverkeepers, Oregon Association of Clean Water Agencies, Oregon Water Resources Congress, Clean Water services, Art Larrance: All of these comments support approval of Clean Water Services proposal for potable reuse, and cite confidence in the proposed treatment, the finding of low risk to human health of consuming beer made from potable reuse water, the importance of conserving water, and the need to start a public dialogue about potable reuse as reasons why they support the proposal.

Response: These comments are noted by DEQ.

Comments Requesting Denial of Potable Reuse

Elizabeth Graser-Lindsey: Potable reuse water is unappealing; approval of this use would violate consumer trust and may have measurable disadvantages; conservation is not an issue in Oregon; the ground is a good purifier of water.

Response: Commenter asserts that there may be disadvantages but does not identify them. DEQ disagrees with the commenter that water conservation may not be a large issue at this time, but is likely to be in the future, given both population increase and anticipated climate changes. The commenter is concerned that approval of potable reuse may violate public trust. OHA finds that this project will have minimal health risks, and the extent of the proposed project will do little in itself to impact water resources. DEQ will encourage CWS to provide voluntary information to individuals that will consume the final product.

Northwest Toxic Communities Coalition: Sewage sludge contains many toxins and pathogens and is not safe. Clean Water Services is not recycling potable water. Oregon agencies lack finances for enforcement actions. DEQ is a proponent and therefore not an independent agency. The public should be skeptical of the proposed cleaning system. OHA points out various problems but concludes that this project poses a low health risk. Others are allowed to apply for similar approval therefore this is not a pilot project. Clean Water Services is paid to haul effluent; by going into business with recycling they are double dipping. Beer will be limited to adults.

Response: The commenters refer to sewage sludge and the many potential toxins and pathogens that may be contained in sludge. In contrast, this project will provide additional treatment to wastewater treatment plant effluent, a liquid that has sufficiently low concentrations of toxins and pathogens that it may be discharged to surface water. Clean Water Services is not proposing to recycle potable water; they propose to reuse treated effluent by providing additional water treatment to produce potable water.

DEQ's enforcement program uses a combination of tools to ensure compliance, including technical assistance, compliance inspections, investigation of complaints, assessment of civil penalties and compliance orders. Evaluations of this enforcement program show that DEQ protects public health and the environment. DEQ's inspection and enforcement program is evaluated routinely by the USEPA through a process known as the "State Review Framework." EPA published a report of its most recent audit in 2011 (*see* "State Review Framework Oregon Round 2 Report for Federal Fiscal Year 2010" available at http://www2.epa.gov/compliance/oregon-state-review-framework). EPA found that DEQ had inspected 46% of National Pollutant Discharge Elimination System Permit program (NPDES) majors and 20% of traditional NPDES non-majors, which EPA concluded largely meets federal expectations of program performance. *See* page 46 of the report. EPA also found that DEQ had properly identified occasions of "significant noncompliance" (an EPA designation of the most important violations). Oregon's incidence of significant noncompliance was only 2.7% of active major facilities, well below the national average of 23.9%, indicating that DEQ's regulatory program is successful at stimulating compliance. *See* page 48 of the report. Furthermore EPA found that DEQ took timely and appropriate enforcement action with properly applied penalties when violations were discovered, and that the enforcement actions promoted return to compliance. *See* pages 48-52 of the Report.

Regarding whether DEQ is a proponent of potable reuse or an independent agency, DEQ is an independent state agency that has been given the authority to protect the environment of Oregon, and in this case, to implement the federal Clean Water Act. To do this, DEQ has adopted rules that govern recycled water. The recycled water program is one way that DEQ helps to protect the aquatic resources of Oregon. Under Oregon Administrative Rules Chapter

350 Division 55, DEQ encourages water reuse activities when protective of public health and the environment. OAR 340-055-0007 states:

> *It is the policy of the Environmental Quality Commission to encourage the use of recycled water for domestic, agricultural, industrial, recreational, and other beneficial purposes in a manner which protects public health and the environment of the state. The use of recycled water for beneficial purposes will improve water quality by reducing discharge of treated effluent to surface waters, reduce the demand on drinking water sources for uses not requiring potable water, and may conserve stream flows by reducing withdrawal for out-of-stream use.*

The Northwest Toxic Communities Coalition also suggests that because DEQ allows multiple applicants for water reuse, this project is not a pilot project. Under Oregon Administrative Rule any person may request approval for beneficial use of recycled water. The rules prohibit the use of recycled water for human consumption except if approved through a specific process. At this point in time, this is the only application that DEQ has received requesting approval for human consumption. Northwest Toxic Communities Coalition cautions that the high level of treatment proposed is not sufficient to produce potable water. The Oregon Health Authority completed an extensive review of the proposed treatment, and the analytical results provided that demonstrate the actual treatment achieved, and determined that the recycled water poses a low health risk. The Oregon Health Authority implements the Safe Drinking Water Act in Oregon. The few problems OHA identified in the proposal regard pieces of missing information about the treatment train (e.g., equipment model numbers) and additional testing of the treatment apparauts (e.g., challenge test for membrane and pre- and post-treatment testing to assess equipment efficiency). DEQ and OHA will ensure that the revised Recycled Water Use Plan contains this additional information needed for OHA to approve the treatment train itself. In the absence of that additional information, OHA has reviewed the analytical results from a trial run of the treatment process and determined that the treated water itself met all quality criteria to make it suitable for drinking. This proposal has described a limited production of potable water, in batches, each of which would be tested for all of the analytes set forth in the Oregon drinking water standards and by the National Recycled Water Association.

Northwest Toxic Communities Coalition charges Clean Water Services of 'double dipping' regarding sewerage rates. Oregon DEQ has no authority over Clean Water Services rates; as a public agency, those are overseen by the commission that oversees the Clean Water Services agency.

Northwest Toxic Communities Coalition commented that it is obvious that only adults will be consuming the beer. OHA mentioned the age restriction in their letter because age groups have different risk levels, and OHA typically assesses risk to children separately from adults to account for their unique vulnerabilities. In this case, OHA limited their risk analysis to the adult age class because the proposed use is limited to beer production, which in turn is limited to adult consumption

Stan Geiger: Circulation of DEQ's Public Notice was too limited. Media articles about beer production and availability were misleading. The limited distribution of DEQ's public notice impaired the ability of Oregon's craft brewers to provide comment to this proposal. The proposed treatment is indeed at a high level, but are all the contaminants of concern been removed? If desired by beer brewers, highly treated water could be produced from sources other than treated sewage discharge. The Environmental Quality Commission should not approve this proposal as it may bring harm to the craft brewery business.

Response: DEQ's public notices are available on our website, and are circulated to those who subscribe to our mailing list. DEQ also sent out a news release about the hearing on Jan. 21 to Portland area media. Clean Water Services also worked to make sure that the news of the public hearing and comment periods were widely distributed. According to Mark Jockers of Clean Water Services, there were 400 media stories about the hearing in local, national and international media. Since the proposed use of the recycled water is for home brewers, not commercial brewers, DEQ did not see a need to reach out directly to commercial brewers. When media provided incorrect information, DEQ requested corrections from media outlets seeking clarification about the public hearing or the proposed action. DEQ has no authority over who might make beer or where it might be served. Clean Water Service's proposal limits the use of high-purity recycled water to brewing beer in a way that includes boiling the water as part of its production.

Dorothy Shoemaker: This looks like a bad idea; fresh water is probably healthier. The peroxide added to the potable reuse water will make people sick. Is the scope of the project limited to 500 gallon batches? The water meets drinking water requirements, but does it smell and taste good? OHA assumed a consumption rate of one liter per adult per year, if the beer tastes good won't people drink more of it?

Response: OHA has reviewed the treatment process and the analytical results from a trial run of the treatment process and determined that there is a low health risk with consumption of this product. This proposal has described a limited production of potable water, in batches, each of which would be tested for all of the analytes set forth in the Oregon drinking water standards and by the National Recycled Water Association. Peroxide is added to water that has been both ultra-filtered and subject to reverse osmosis, before the water is exposed to ultraviolet light. Under the energy of ultra violet light, the peroxide (H_2O_2) degrades into water (H_2O) and oxygen (O_2). The oxygen released will assist in the destruction of any remaining contaminants. Neither water nor oxygen will cause illness. OHA's assumption of 1 liter per year is based on the fact that this beer will not be commercially available, but rather will only be available at specialized conferences. Because the water is so highly purified, consuming more than 1 liter of the beer per year would not pose any quantifiable additional risk.

Neutral Comment Providing Clarification

Craft Brew Alliance: Part of the approval relies on the alcohol content and boiling the water to produce beer. Brewers should not carry this responsibility. The Craft Brew Alliance is committed to sustainability and technical innovation that reduce environmental impact as well as the highest standards in quality. Thus Craft Brew Alliance will continue to use high quality water.

Response: The Oregon Health Authority approval of the project limited recycled water to uses involving the brewing of beer that includes alcoholic beer and that includes bringing the water to a boil.

The Oregon Brewers Guild: The Guild submitted a comment indicating that the Guild itself has no relationship with Clean Water Services. Clean Water Services approached the Guild to assist Clean Water Services in determining how and if licensed brewers could make beer to be provided at an out of state conference. While the Guild has no formal relationship with Clean Water Services, some of its members have worked with Clean Water Services.

Response: DEQ appreciates the clarification. As an agency, DEQ has no authority over the brewing or distribution of beer; those authorities lie with other state and federal agencies.

Oregon Environmental Council
It's Your Oregon

222 NW Davis Street
Suite 309
Portland, OR 97209-3900
503.222.1963
www.oeconline.org

February 20, 2015

Avis Newell
Tualatin Basin Coordinator
DEQ
2020 SW 4th Ave, Suite 400
Portland, OR 97201

Dear Ms. Newell:

I am writing regarding Clean Water Services' proposal to re-use treated wastewater for brewing beer. This is an innovative concept that deserves consideration, and I commend Clean Water Services for raising the bar on efficient use of our limited water resources and high quality water treatment. In Western Oregon many people take water for granted, but climate change and population growth are making this precious resource increasingly scarce. Turning treated wastewater into a valuable product, rather than discharging it as a waste, is an idea whose time has come. As we explore these innovations in how we use and treat water, it is also important to take precautions to protect public health by ensuring that the treated water is in fact safe for potable reuse.

Research demonstrates that wastewater contains many so-called "emerging contaminants" that are not regulated by the Safe Drinking Water Act or the Clean Water Act. Brewing beer directly from wastewater could potentially put consumers at greater risk from these contaminants than brewing beer using other water sources. DEQ should carefully analyze the proposed treatment technologies to ensure that they are effective at removing the wide array of contaminants that are typically found in wastewater. In addition, the project's monitoring plan should include such contaminants and an action plan should be created to ensure that if water doesn't meet the monitoring targets, it is not used for potable purposes.

I understand that Clean Water Services has tested their highly treated water for 21 trace compounds recommended by the National Water Research Institute, and found no detects in all cases. This is good news, and similar testing should be required on an ongoing basis. DEQ should compare the NWRI contaminant list with the state's Priority Persistent Pollutant list, EPA's Drinking Water Contaminant Candidate List and the monitoring lists used in other states that have potable reuse projects to develop a list of required monitoring parameters for Clean Water Services. This list will need to be updated periodically as new chemicals and pharmaceuticals are introduced to the marketplace.

It is prudent to establish monitoring requirements for potable reuse that include contaminants not regulated by federal drinking water requirements, since those contaminants are more likely to be found in treated wastewater than in other water sources. By establishing such requirements, Oregon can promote water reuse while also protecting public health.

Sincerely,

Teresa Huntsinger

Teresa Huntsinger
Water Program Director

PARKER Angela

From: Greg Chick [greg@ramonasplumber.com]
Sent: Sunday, January 25, 2015 9:53 PM
To: NEWELL Avis
Subject: Water Reuse

Newell,
Bill Gates drinks it, the entire world drinks it, to some degree in time anyway. Let US, pun intended get real and embrace reality and do less "Shocking" responses to it. I will drink to that.

Greg Chick, LEED AP. CWM, ARCSA AP
greg@ramonasplumber.com

ACCREDITED GreenPlumbers® TRAINING

From: Elizabeth
To: NEWELL Avis
Subject: Proposed approval of recycled water
Date: Friday, February 20, 2015 3:58:33 PM

I absolutely think this is a good idea and should be approved!!

Please include me on your mailing list.

Thanks,
Elizabeth Siping

Metropolitan Wastewater Management Commission

partners in wastewater management

January 22, 2015

Avis Newell
Tualatin Basin Coordinator
Department of Environment Quality (DEQ)
2020 SW 4th Ave, Suite 400
Portland, OR 97201
Email: Newell.Avis@deq.state.or.us

Subject: Public hearing on proposed approval for a limited drinkable reuse of recycled water

Dear Ms. Newell:

The Metropolitan Wastewater Management Commission (MWMC) is providing these comments in response to the DEQ's *Invitation to Comment: Public hearing on proposed approval for a limited drinkable reuse of recycled water* dated January 15, 2015. The MWMC supports the proposal by Clean Water Services (CWS) to produce beer from recycled water to demonstrate high-quality wastewater treatment processes, recycled water safety, and the value of the water cycle and our water resources. As producers and users of recycled water in the Eugene/Springfield community, the MWMC recognizes the importance of demonstrating safe recycled water use to the public.

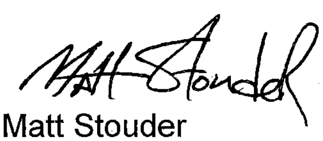
Our endorsement of CWS's proposed use is supported by the following statements presented in documents describing the proposal posted by the DEQ on its website.

- As described by CWS: *The District proposes a pilot project to create high purity water for potable re-use from advanced secondary treatment plant water available at our Forest Grove Facility to demonstrate the different uses for high purity water including products suitable for human consumption. The pilot will use well-established treatment technology including ultrafiltration, reverse osmosis, and advanced oxidation to provide water that far exceeds drinking water standards and make that water available to craft brewers to make limited edition craft beer.*

- As further noted by CWS: *By highlighting craft beer, a product Oregon is known for around the world, the project will seek to engage industry professionals, public leaders, and people everywhere in a conversation about water.*
- As described by DEQ: *In recent decades water has been treated to very high standards, used for a primary purpose, and then discharged to a river or stream as "wastewater." Although this water is typically of lower quality following a primary use, used water has resource value and can often be safely reused for additional purposes without adverse effects to public health or the environment. Reusing appropriately treated wastewater for irrigation, industrial, commercial and construction applications helps conserve drinking water supplies and improve water quality of surface waters.*
- According to the Oregon Health Authority (OHA): *Due to the high water quality of the treated water, the additional microbial reduction in the brewing process, and a low health risk overall, OHA Public Health Division approves the proposed use of recycled water in the limited case as described in [the] proposal.*
- According to DEQ: *There is very little, if any, health risk associated with drinking these beverages. The proposed treatment method has been demonstrated to produce water that meets and exceeds all water quality standards for public drinking water. The treatment method also removes additional contaminants of concern in wastewater such as traces of personal care products and pharmaceuticals. Therefore, the health risk of drinking beverages made from this water is no greater than drinking beverages made with public drinking water.*

The MWMC supports this creative proposal that would benefit many of Oregon's wastewater treatment facilities working to inform the public about recycled water.

Respectfully Submitted,



Matt Stouder
MWMC General Manager

TUALATIN RIVERKEEPERS®
11675 SW Hazelbrook Road • Tualatin, Oregon 97062
phone 503-218-2580 • fax 503-218-2583
www.tualatinriverkeepers.org

February 12, 2015

Avis Newell
Tualatin Basin Coordinator
DEQ
2020 SW 4th Ave, Suite 400
Portland, OR 97201

Re: Tualatin Riverkeepers Supports Clean Water Services' Water Reuse Pilot Project

Dear Ms. Newell:

The Tualatin Riverkeepers encourages DEQ to approve Clean Water Services request to pilot the limited reuse of recycled water to brew beer.

Demand for a reliable long-term supply to support our economy and our society is growing as the population of the Tualatin Basin grows. Climate uncertainty and seismic threats call into question the reliability of developed sources in our basin. The growing demand for reliable clean water sources could put our native fish and aquatic communities at risk if more water is extracted from our rivers and streams. **Recycling** of valuable water is necessary for a sustainable economic and ecological future.

We applaud Clean Water Services' highly effective efforts to raise awareness about the potential for recycled water to help meet Oregon's long-term water needs Increasingly severe droughts and population growth present challenges that cannot be solved by conservation alone. While beer is a good way to get people talking about precious water resources, the real point is that Clean Water Services has a dependable supply of water that can be cleaned to any desired level. Today's water treatment and monitoring technologies make recycled water a viable water supply that could meet demands for irrigation, manufacturing, and other uses.

We ask that DEQ approve Clean Water Services' request so that Oregon's regulations will allow access to a most valuable source of clean recycled water.

Sincerely,

Brian Wegener

Brian Wegener, Riverkeeper
Advocacy Manager

oregon association of CLEAN WATER agencies

Working with more than 90 community wastewater treatment and stormwater management agencies to protect Oregon's water

107 SE Washington, Suite 242
Portland, Oregon 97214
(503) 236-6722 www.oracwa.org Fax (503) 236-6719

18 February 2015

Avis Newell
Tualatin Basin Coordinator
DEQ – Northwest Region
2020 SW Fourth
Portland, OR 97201

Re: Clean Water Services Application for Drinkable Reuse of Recycled Water

Sent electronically to newell.avis@deq.state.or.us

Dear Avis:

The Oregon Association of Clean Water Agencies is a private, not-for-profit organization of Oregon's wastewater treatment and stormwater management agencies, along with associated professionals. Our 125+ statewide members are dedicated to protecting and enhancing Oregon's water quality.

As we know from junior high school science class and the study of the water cycle, all water - - water in the Tualatin Basin, water in Oregon, and water in the world - - is all recycled water.

ACWA supports the application of Clean Water Services to use Class A Recycled Water on a limited scale to produce beer, and recommends that the DEQ move the application to the Environmental Quality Commission for approval.

If Oregon is going to meet its increased water demands for use in agriculture, industrial and commercial uses, and potable water supplies, while faced with a growing population and climate change, the State will need to embrace development of innovative and improved water recycling programs.

Clean Water Services' leadership with its High Purity Water project:

- Demystifies the water purification process,
- Showcases the opportunities for water recycling in an urban water cycle, and

- Highlights innovative water management practices needed to meet Oregon's water needs.

While beer is a good way to get people talking about precious water resources, the real point is that wastewater treatment plants throughout Oregon and at the Clean Water Services wastewater treatment plants, are a dependable supply of water that can be cleaned to any desired level. Today's water treatment and monitoring technologies make recycled water a viable water supply that could bridge demands for irrigation, manufacturing, and other uses.

We urge the DEQ and the Environmental Quality Commission to continue to demonstrate its support for water recycling by approving the request from Clean Water Services. The approval of the Clean Water Services application is consistent with

- Governor's Executive Order 05 04 highlighting that "*Water Reuse as an Integral Component of Economic Development, Water Conservation, and Environmental Sustainability in Oregon*" (copy attached)
- The policy of the Environmental Quality Commission…
  "…encourage the use of recycled water for domestic, agricultural, industrial, recreational, and other beneficial uses in a manner which protects public health and the environment of the state. (see OAR 340, Division 55).

DEQ should be complimented for its leadership in moving this innovative and creative project forward.

ACWA looks forward to continuing to partner with Oregon DEQ to promote water recycling projects throughout the state.

Very Truly Yours,

Janet A. Gillaspie

Janet A. Gillaspie
Executive Director

Attachment – Governors Executive Order

Cc: Biosolids & Recycled Water Committee
ACWA Board
Bob Baumgartner, Clean Water Services

Office of the Governor
State of Oregon

EXECUTIVE ORDER NO. EO 05-04

WATER REUSE AS AN INTEGRAL COMPONENT OF ECONOMIC DEVELOPMENT, WATER CONSERVATION, AND ENVIRONMENTAL SUSTAINABILITY IN OREGON.

Pursuant to my authority as Governor of the State of Oregon, I find that:

WHEREAS the people of the State of Oregon have a long history of finding innovative solutions to challenging and complex problems;

WHEREAS the State of Oregon's strategic plan, Oregon Shines, reflects a balance of the community, environmental and economic values that we hold for our state;

WHEREAS analysis of current trends described by the Oregon Benchmarks and by the Oregon State of the Environment Report documents certain threats to our quality of life and the state's environmental and economic sustainability;

WHEREAS, for purposes of the Executive Order, water reuse is defined as the beneficial use of reclaimed water (treated wastewater) for such planned uses as landscape and golf course irrigation; agricultural irrigation; industrial and commercial uses; recreation; groundwater recharge; environmental enhancement; and other uses permitted under Oregon law;

WHEREAS water reuse provides an environmentally-sound method for managing wastewater, while conserving water and replenishing valuable water supplies;

WHEREAS water reuse can be a source of water to communities during drought conditions;

WHEREAS the Environmental Protection Agency, a federal agency, encourages water reuse as a means for managing wastewater under the provisions of the Clean Water Act, 33 USC §§ 1251 *et seq.*;

WHEREAS Oregon statutes and regulations protect public health and environmental quality, and require a specific level of water quality and treatment corresponding to each beneficial use of reclaimed water; and

WHEREAS the Oregon Environmental Quality Commission encourages water reuse for beneficial purposes using methods that assure that public health and environmental quality of the state are protected;

Office of the Governor
State of Oregon

NOW THEREFORE, IT IS HEREBY ORDERED AND DIRECTED:

1. The State of Oregon shall promote policies and programs to encourage and support water reuse, to work together to overcome institutional and regulatory barriers and funding constraints, to ensure protection of public health and environmental quality, to encourage public acceptance of water reuse, and to help this state meet its overall water needs.

2. The State of Oregon shall improve its policies and internal operations to encourage more water reuse by:

   a. State agencies that participated in the Urban Reuse Task Force that was created subsequent to the passage of Senate Bill 820 by the Seventy-second Oregon Legislative Assembly, Chapter 788, Oregon Laws 2003, shall review agency policies and rules, as they are revised, and make appropriate revisions to those policies to remove potential regulatory barriers and to encourage water reuse in Oregon Within one year of the effective date of this Executive Order, such agencies shall report in writing to the Governor's Office regarding their progress under this Executive Order. Within 18 months of the effective date of this Executive Order, the Governor's Office will coordinate with the relevant agencies to review their actions and to identify possible next steps.

   b. The Department of Environmental Quality is responsible for leading the coordination among state agencies, businesses, non-profit organizations, local governments and other citizens in the development of guidance describing the regulatory and permitting requirements for water reuse projects.

   c. The Office of Regulatory Streamlining is responsible for negotiating and executing a Memorandum of Understanding among the relevant state agencies that expressly sets forth each agency's responsibilities as they pertain to the approval of water reuse projects.

   d. The Water Resources Department, Department of Human Services, and Department of Environmental Quality shall coordinate outreach activities that encourage water reuse and shall meet annually to determine whether agency procedures and permitting activities are consistent with this Executive Order.

Office of the Governor
State of Oregon

e. The Department of Environmental Quality, Department of Human Services, Water Resources Department, and the Department of Consumer and Business Services shall collaborate, consistent with each agency's existing authority, to allow water reuse pilot projects that are protective of public health and the environment, and shall work to resolve issues with other relevant state agencies regarding water reuse.

Done at Salem, Oregon this 21st day of March, 2005.

GOVERNOR

ATTEST:

SECRETARY OF STATE

Oregon Water Resources Congress
437 Union St. NE | Salem, OR 97301 | Phone: 503-363-0121 | Fax: 503-371-4926 | www.owrc.org

February 11, 2015

Avis Newell
Tualatin Basin Coordinator
Department of Environmental Quality
2020 SW 4th Ave, Suite 400
Portland, OR 97201

Re: Letter of Support for Clean Water Services' Water Reuse Pilot Project

Dear Ms. Newell:

On behalf of the Oregon Water Resources Congress (OWRC), I am writing to express our support for the Clean Water Services' request to pilot the limited reuse of recycled water to brew beer and strongly encourage the Department of Environmental Quality (DEQ) to approve this innovative reuse.

As a nonprofit association representing irrigation districts, water control districts, improvement districts, drainage districts and other local government entities delivering agricultural water supplies, OWRC has a strong interest in water conservation, supply and innovation. The water stewards we represent operate complex water management systems, including water supply reservoirs, canals, and pipelines, delivering water to roughly 1/3 of all irrigated land in Oregon. These entities and the thousands of water users they supply embody the associations founding principles to promote the development, control, conservation, preservation and utilization of land and water resources of the State of Oregon.

We applaud Clean Water Services' highly effective efforts to raise awareness about the potential for recycled water to help meet Oregon's long-term water needs and OWRC is very supportive of innovative projects like the one Clean Water Services' has proposed here. Increasingly severe droughts and population growth present challenges that cannot be solved by conservation alone. While beer is a good way to get people talking about precious water resources, the real point is that Clean Water Services has a dependable supply of water that can be cleaned to any desired level. Today's water treatment and monitoring technologies make recycled water a viable water supply that could bridge demands for irrigation, manufacturing, and other uses; in fact, OWRC member districts are exploring projects that would use recycled water for irrigation. We ask that DEQ approve Clean Water Services' request for this pilot project so that Oregon's regulations will allow access to all of our water resources.

Sincerely,
April Snell
Executive Director

The mission of the Oregon Water Resources Congress is to promote the protection and use of water rights and the wise stewardship of water resources.

From: Elizabeth Graser-Lindsey
To: NEWELL Avis
Subject: 022015drinkable
Date: Tuesday, January 20, 2015 3:06:08 PM

It is important to consider what consumers want to keep their trust. Use of recycled water is likely to be unappealing to them. It might even have actual, measurable disadvantages. There is plenty of clean water in Oregon. Let's let the ground do the purifying as water sinks a hundred or more feet to the water table. DON'T use recycled water in alcoholic beverages.

northwest toxic communities coalition

PO Box 2664 Sequim WA 98382

16 February 2015

Avis Newell
Tualatin Basin Coordinator
DEQ
2020 SW 4th Avenue
Portland OR 97201

RE: Proposed approval for recycling drinking water

SEWAGE SLUDGE AKA BIOSLUDGE AKA BIOSOLID CLASS A and CLASS B CONTENTS. Sewage sludge of any class, including the effluent, is such a complex and unpredictable mixture of pathogens and chemical compounds that even if all the constituents were known, it would still be impossible to reliably assess the health risks. How will it be demonstrated that all the following will be eliminated by the processes suggested in the permit? This is especially, important, as an intended pilot project for using effluent as potable water statewide.

Federal and state regulations limit concentrations of only 9 heavy metals and one pathogen listed below out of the many that create the toxic soup of wastewater treatment plants.

Heavy Metals - Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Bromine, Cadmium, Cerium, Cesium, Chromium, Copper, Dysprosium, Erbium, Europium, Gadolinium, Germanium, Gold, Hafnium, Holmium, Iron, Lanthanum, Lutetium, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Niobium, Palladium, Praseodymium, Rhodium, Rubidium, Ruthenium, Samarium, Scandium, Selenium, Silver, Strontium, Tantalum, Tellurium, Terbium, Thallium, Thorium, Thulium, Tin, Titanium, Tungsteen, Uranium, Vanadium, Yttrium, Ytterbium, Zinc **Pathogens - Bacteria** - Fecal Coliform, Salmonella 2000 types, Shigella 4 spp., E. coli 0157:H7, Staphylococcus aureus, Enteropathogenic E. coli, Yersinia enterocolitica, Campylobacter jejuni, Vibrio cholera, Leptospira, Listeria, Helicobacter, Mycobacteria, Aeromanonas, Legionella, Burkholderia, Endotoxins, antibiotic resistant bacteria**Viruses** - Adenovirus, Astrovirus, Calcivirus, Coronavirus, Enterovirus, Poliovirus, Coxsackie A, Coxackie B, Echovirus, Enterovirus 68 - 72, Hepatitis A virus, Hepatitis E virus, Norwalk Virus, Reovirus, Rotavirus, **Protozoa** - Cryptosporidium, Entamoeba histolytica, Giardia lamblia, Balantidium coli, Toxoplasma gondii **Helminths (Parasites)** - Ascaris lumbicaides (roundworm), Ancylostoma duodenale (hookworm), Necator americanus (hookworm), Tainia saginata (tapeworm), Trichuris (whipworm), Toxocara (roundworm) Strongyloides (threadworm), Ascaris suum, Toxocara canis, Taenia solium, Hymenolepis nanaFungi - Aspergillus fumigatus, Candida albicans, Cryptococcus neoformans, Epidermophyton spp., Trichophyton spp., Trichosporon spp., Phialophora spp.,**Prions** (spongiform encephalopathy)
Synthetic Chemicals - Dioxins & Furans Octachlorodibenzo-P-Dioxin, 1,2,3,4,6,7, 8-Heptachlorodibenzo-P-Dioxin, Octachlorodibenzo Furan, 1,2,3,4,6,7,8 Heptachlorodibenzo-Furan (71), 2,3,7,8-Tetrachlorodibenzo-Furan, 1,2,3,6,7,8 Hexachlorodibenzo-P-Dioxin, 1,2,3,4,7,8-Hexachlorodibenzo-Furan, 1,2,3,7,8,9-Hexachlorodibenzo-P-Dioxin, 1,2,3,6,7,8-Hexachlorodibenzo-Furan, 2,3,4,6,7,8-Hexachlorodibenzo-Furan, 1,2,3,4,7,8,9-Heptachlorodibenzo-Furan, 2,3,4,7,8-Pentachlorodibenzo-Furan, 1,2,3,4,7,8-Hexachlorodibenzo-P-Dioxin, 1,2,3,7,8-Pentachlorodibenzo-Furan, 1,2,3,7,8 Penta-chlorodibenzo-P-Dioxin, 1,2,3,7,8,9-Hexachlorodibenzo-Furan, 2,3,7,8-Tetrachlorodibenzo-P-Dioxin, Polychlorinated Dibenzodioxin/Polychlorinated Dibenzofuran (PCDD/PCDF), Tetrahydrofuran, 2,4-D, 2, 4,5-T, dioxin (TCDD) **Organics (carbon-based)** Acetones, Chloroform, Cyclohexanone, Bis(2-ethylhexyl) Phthalate, Bis(2-ethylhexyl), tetrabromophthalate, Di-n-undecyl phthalate, Alkyl

benzyl Phthalate, Di-(2-Ethylhexyl) Phthalate, (DEHP). Butyl Benzyl Phthalate, Toluene, 2-Propanone, Methylene 2 Chloride, Hexanoic Acid, 2-Butanone, Methyl Ethyl Ketone, Alcohol Ethoxylate, Alkylphenolethoxylates, Phenol, Nonylphenol, 2,2'-methylenebis{4-methyl-6-nonyl-Phenol, p-Nonylphenol, 4,4'-butylidenebis{2-(1,1-dimethylethyl)-5-methyl-,4-Methylphenol, Phenol, 4,4'-(1-methylethylidene) bis{2-(1,1-dimeth, Phenol, 4,4'-(1-methylethylidene) bis(2-(1,1-dimeth, 2,4-dicumylphenol, p-Dodecylphenol, 2,4,5-Trichlorophenol, N-Hexacosane, N-Tetracosane, N-Dodecane, N-Tetradecane, N-Triacontane, N-Eicosane, N-Hexadecane, N-Octacosane, Carbon Disulfide, N-Decane, N-Docosane, N-Octadecane, P-Cymene, Benzo(B)fluranthene, Fluoranthene, P-Chloroaniline, Pyrene, Tetrachloromethane, Trichlorofluoromethane, 2-Hexanone, 2-Methylnaphthalene, 4-Chloroaniline, Benzo(a)pyrene**Pesticides &Insecticides** Aldrin, Chlordane, Cyclohexane, Heptachlor, Endosulfan, Endosuflan-II, Lindane, Dieldrin, Endrin, DDT, DDD, DDE, 2,4,5-Trichlorophenoxyacetic Acid, Acetic Acid (2,4-Dichlorophenoxy), 2,4,5-Trichlorophenoxypropionic Acid, Pentachloronitrobenzene, Chlorobenzilate, Beta-BHC, Kepone, Mirex, Methoxycholor, **PCBs**- PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, PCB-1260,**PBDEs (PolyBrominated Diphenyl Ethers)** BDE-28, BDE-47, BDE-66, BDE-85, BDE-99, BDE-100, BDE-138, BDE-153, BDE-154, BDE-183, BDE-209 **Hydrocarbons, Petrochemicals, Organochlorines** PCBs, PCT, PBB, PBT, Anthracene, Pentachlorophenol, Benzo(g,h,i)perylene, Benzene, Benzene, C14-C24-branched,(1)

Your available documents were reviewed, prompting these comments:

• The Clean Water Services (CWS) is not recycling potable water, but rather hazardous and disease bearing wastes and pathogens.
• OR agencies, including the DEQ, as with so many states, lacks appropriate finances for enforcement actions. This will translate into minimal, if at all, review of the CWS processes for beer making and/or enforcement of infractions.

- Because DEQ is a proponent, it will "mitigate" *ad infinitum* if there are problems. And in that the DEQ is a proponent, the public should be entitled to having an independent entity not invested in this project or that of wastewater recycling review the data and the project and make recommendations.
- The public should be skeptical that the proposed cleaning systems will remove all harmful toxins and pathogens and that they won't have to be sampled and analyzed for the thousands of toxins in the water. Further public skepticism is called for because this is being permitted along with the NPDES permit which allows for much toxicity. If testing for what is really in the water, if testing is not necessary to test for everything, it cannot be deemed safe.

• The documents say that other entities can apply to DEQ for permission to do the same as the CWS. This turns this effort from a "pilot project" into "wholesale activity."
• The CWS is paid to haul off the effluent, and can now go into business recycling it, so is double dipping, "using beer as a way of promoting their ability to produce very high quality water from wastewater" and claim it as potable.
• The CWS "will limit the exposure of the beer to adults." Who else would they be selling beer to?!
• It is stated that the beer will be limited for use at functions like conventions and not sold. Will they tell drinkers what the beer water is from? (Right to know.) Since when are drinks at conventions not sold?
• The DOH letter of 9/8/2014 points out various problems, but concludes "due to the low health risk and limited use, DOH approves." Therefore, the drinking water regulations will not apply "because the proposal involves using the treated water to produce a **limited quantity** of beer." This, in effect, translates into public health regulations being lifted. DOH admits there are problems and that there are health risks. Even a small dose of contamination can have a large human health affect. And DOH may not be privy to the allowance of others to apply for a permit to do the same, taking it out of the realm of "limited use."

It is known that sewage treatment plants create antibiotic resistant bacteria.(2) It is known that sewage treatment plants contain triclosan and triclosan interfers with wastewater treatment.(3) It is known that microbeads/microfilaments/microplastics and flame retardants are in sewage effluent post treatment.(4,5) What is the analytical and treatment process for these? The same question is posed for new chemicals that could have been created from the mixing of all in the wastewater treatment plant?

There are current studies at the University of North Carolina at Chapel Hill Institute for Global Health and Infectious Diseases on antimicrobial fecal resistant bacteria in sewage "putting people at risk for exposure through contact with sewage or sewage-contaminated water.," as well as studies on how long Ebola could survive in sewage even post treatment. (6, 7) Though we don't have an Ebola case yet, or the death causing strain, but do have MRSA and antibiotic resistant bacteria in treatment plants, these underscore the point of what is in sewage and the effluent even post treatment.

As The Guardian just reported,

> The federal law, also known as TSCA, regulates chemicals that Americans encounter daily in electronics, furniture, clothing, toys, building materials, cleaning and personal care products, and much more. It was enacted in 1976, and – in spite of the introduction of thousands of new chemicals, as well as enormous progress in the understanding of chemicals' environmental and health impacts – hasn't been updated since then.
>
> …the 60,000-plus chemicals in production when the US's TSCA took effect 39 years ago continued to be used without any safety reviews.
>
> The US allows the use of many chemicals that are banned elsewhere, and its primary chemicals law has failed to keep up with thousands of chemicals currently in use, including the approximately 2,000 approximately 2000 new chemicals introduced each year.(8)

In summary, wastewater treatment plants were never designed for the purpose of cleaning most of the harmful sewage contaminants — which increase by thousands annually, nor were many of these even known at the time these plants were built. Neither the solids nor the effluent are safe for recycling and certainly not by the three methods CWS proposes.

Approval of this application to allow sewage effluent to be used for consumption can put people at risk of any number of health problems. We strongly disapprove and advise this proposal not be permitted.

The Northwest Toxic Communities Coalition is a non profit of organizations and individuals in USEPA Region 10.

REFERENCES

1) Compiled 12-27-10 by the Center of Sludge Information.
2) http://www.ncbi.nlm.nih.gov/pubmed/19321192?dopt=Abstract; http://www.deadlydeceit.com/antibiotic_resistance.html
3) http://www.alternet.org/environment/antibacterial-soaps-may-cause-wastewater-treatment-failures; http://envnewsbits.info/2014/06/24/triclosan-may-spoil-wastewater-treatment/
4) pubs.acs.org/est Flame Retardant Transfers from U.S. Households (Dust and Laundry Wastewater) to the Aquatic

Environment Erika D. Schreder and Mark J. La Guardia,
Environmental Science and Technology. 2014.

5) http://www.sfgate.com/science/article/Skin-cleansing-microbeads-harm-marine-life-5405452.phpSkin;

http://www.abc.net.au/news/2014-08-21/microplastics-found-in-sydney-harbour-floor/5686472

http://ottawacitizen.com/news/local-news/environmentalists-drawing-a-bead-on-microplastics

6) http://global.unc.edu/news/sobsey-awarded-unc-grant-to-study-antimicrobially-resistant-fecal-bacteria-in-sewage/ Sobsey Awarded UNC Grant to Study Antimicrobially Resistant Fecal Bacteria in Sewage - See more at: http://global.unc.edu/news/sobsey-awarded-unc-grant-to-study-antimicrobially-resistant-fecal-bacteria-in-sewage/#sthash.mdt1rHP5.dpufStudy to Examine Ebola's Survival Rate, Disinfection in Sewage

7) http://sph.unc.edu/sph-news/study-to-examine-ebolas-survival-rate-disinfection-in-sewage/ Study to examine Ebola's survival rate, disinfection in sewage

8) http://www.theguardian.com/lifeandstyle/2015/feb/13/us-senate-toxic-chemicals-law-health-safety

Darlene Schanfald, Ph.D., Chair, Northwest Toxic Communities Coalition

Barbara Miller, Silver Valley Community Resource Center

cc: Lillian Shirley, BSN, MPH, MPA, Director-Public Health Division

Tom Eversole, DVM, MS - Administrator, Center for Public Health Practice

February 19, 2015

Avis Newell

Tualatin Basin Coordinator

DEQ

(503)229-6018

Re: Request for comments on the Clean Water Services initiative to seek approval from the Environmental Quality Commission to use treated wastewater (potable reuse water) for brewing home brew beer, a supposedly limited scale project where the beer would be served at conferences and other private events.

- The article by Dana Tims in the *Oregonian/OregonLive* Feb 11 and 12th (which appeared at the same time as the hearing at ODEQ on this initiative) is the basis for these comments. Unfortunately, there was no notice by ODEQ in news sources that I review regularly to give me advance warning of the hearing. I did call and speak with Mark Jockers of Clean Water Services (CWS) about his initiative, however.
- The article by Tims which appeared on the front page of the February *Oregonian* was disturbing on a number of levels. After speaking with Mark Jockers, of Clean Water Services, who is mentioned in the article, I sensed that this initiative by Clean Water Services and others to reach out with what seemed like a popular and attractive idea of using treated wastewater to brew beer perhaps lacked the perspective of the entrepreneur and brewer and the craft beer industry marketing sensitivity. What first struck me from reading the article (and Dana picked up on this with his short note about toilets-to- beer connection), is why someone in this industry would even consider suggesting this connection. Apparently, from Mark, this "news" of a new initiative in Oregon has gone viral appearing in papers around the nation and world, which I confirmed with a web search. So, if I were an owner of Deschutes Brewing, or Widmer or Fort George, or Rogue, or ….I'd be all over developing a "counter message" and strategy that would counter (it's too late to eliminate or suppress) the idea that "craft brewers" (which is the term used to describe what is unique about home and commercial brewers in Oregon) are interested in this use of "potable reuse water" for making Oregon beer. **The lack of outreach to Oregon commercial brewers by the lack of adequate notice for the ODEQ hearing last Thursday will probably result in very little input from this segment of Oregon's commerce that stands to be affected the most.**

- The Tims' article, and the CWS initiative, conveys the impression that the Forest Grove wastewater treatment plant is producing water of such quality that it is suitable for drinking and that this quality of the treated water is further certified by the Oregon Health Authority. The reality here is that Clean Water Services has based this initiative on its demonstration project at Forest Grove wastewater treatment plant which uses a borrowed Siemens water treatment machine. One would assume that all treated wastewater at Forest Grove is what can be produced by the Siemens machine (which is not mentioned). Not so. One would also assume that the Oregon Health Authority (no reference to any department or person in OHA) approves the use of Forest Grove **treated wastewater** for "consumption". OHA may have made some determination about what comes out of the Siemen's machine, but it is highly unlikely that OHA has approved use of Forest Grove treated wastewater from its treatment facility to brew your beer, coffee or tea or any other kitchen food-prep related use. This main source of information to the public (Tims' article) has confused OHA's approval of a Forest Grove water treatment facility product which meets state and federal drinking water standards with standards related to required quality of wastewater treatment.
- For me, it is not a question of **whether the Siemens water treatment machine** can produce potable water out of treated wastewater that would meet state and federal drinking water standards. In the first place the CWS wastewater treatment facilities in Washington County are world class facilities, as good as any in the world in cleaning up wastewater. However, I do have an important caveat: There are numerous low-concentration contaminants that have been identified in drinking water sources across the United States not yet regulated by state and federal drinking water standards that originate from wastewater treatment plants and that are in the water we consume (e.g. Kolpin, D. W. et al. 2002 Environ. Sci. Technol. 36(6): 1202-1211; Salste L. et al. 2007 Sci. Total Environ. 378(3):343-351). USGS and USEPA are now beginning to release results of a study that began in 2007 of the effectiveness of water treatment plants across the United States removing these contaminants that originate in wastewater treatment plants from the human waste entering those plants. Are these contaminants addressed in the CWS information submitted to support their initiative? Probably not.
- In this initiative we are really talking about very small volumes of water, produced by CWS for this small demonstration project, for a use that is and has been far out of the purview of previous discussions in the state about reuse of treated wastewater. If home brewers want some water other than tap water for their brewing, and for some reason think even Portland Water Bureau water is inferior (that is what Widmer and Portland Brewing Company and others in the "craft brewing" industry are surely using) then there are companies in Portland who produce water of

comparable quality to what comes out of the borrowed Siemen's water purification machine for commercial and home use who would be glad to provide that water **without the stigma of its being treated wastewater. Why would home brewers even want to brew beer using even well treated wastewater when alternative high quality water is readily available? This is a puzzle.**

- If you like Oregon beer as much as I do, why would you want to use this boutique and misguided sideline of CWS to create dialog about reuse of treated wastewater that could cripple beer sales in and outside Oregon? The article by Tims did include a note (though small) of caution, about approving the use of treated wastewater to produce a "product whose birthplace was someone's household toilet" (which for those invested in the industry and marketing its product ought to be of prime importance).
- **The Environmental Quality Commission should not approve this CWS initiative, but send CWS back to the "drawing board" to find other and better alternatives to using its otherwise good quality treated wastewater. The risk of approval of this camel sticking its head in the brewer's tent is too great to a highly treasured Oregon industry. I suggest the EQC, out of respect for this industry, reach out and communicate with representatives of this very prominent industry before reaching a decision on something that may appear to be trivial. It would not be trivial.**

I did send an e-mail thanking Dana Tims for writing the article because much needs doing to inform people in our metro area about the important business of where our drinking water originates and what happens to it after we use it. Most of us are ignorant about these things. And at least the article, and his reporting on this CWS initiative, did provoke me.

Stan Geiger, Managing Ecologist, Aquatic Scientific Resources, Portland, OR 503-244-9966 (annsstang@frontier.com)

PARKER Angela

From: Dorothy Shoemaker [dorothyshoemaker@centurylink.net]
Sent: Tuesday, January 27, 2015 10:21 AM
To: NEWELL Avis
Subject: Recycled water for beer

Hello Avis,
I'm interested in Clean Water Services' request for a permit to reuse treated wastewater for making beer. I have the link to the public notice of a hearing, and I also saw KGW Channel 8's coverage last night about a contest. Keely Chalmers reported that Clean Water Services would like to hold a beer-making contest using this water.

Here's a link to the Invitation to Comment:

http://www.oregon.gov/deq/docs/022015drinkable.pdf

On the surface, this looks like a bad idea. The wastewater will be treated and boiled, but it still seems like using fresh water is healthier. I do see that the Oregon Health Authority has approved the initial comment period.

Would the beer making contest only involve Clean Water Services employees? The Question and Answer section, page 2, says that only Clean Water Services can make the beer. The Q & A section follows the Invitation to Comment.

Thanks,
Dorothy Shoemaker

PARKER Angela

From: Dorothy Shoemaker [dorothyshoemaker@centurylink.net]
Sent: Friday, February 20, 2015 9:53 AM
To: NEWELL Avis
Subject: Comments on treated wastewater for beer

Hello Avis Newell, DEQ, and OHA,
I am commenting on Clean Water Services' request to use treated wastewater to make beer in an experimental manner. I have already pointed out that the treatment process seems to end with the addition of peroxide, which would make people sick. I'd like to add some more points.

Here's a link to the public notice, with attachments:

http://www.oregon.gov/deq/docs/022015drinkable.pdf

In Ron Doughten's letter from the DEQ to Dave Leland of the Oregon Health Authority, dated July 14, 2014, he explains what Clean Water Services proposes. He says that water would be produced in batches
of less than 1000 gallons. Dave Leland of The Oregon Health
Authority responded on September 8, 2014. In that letter, they state that "The project proposal is to treat 500 gallons of water, to be exclusively used to brew beer for consumption at a technical conference." These are not contradictory, if the only batch is 500 gallons of water. Is 500 gallons to be served at a conference the entire scope of the project?

In the same letter, the Dave Leland of the OHA questions several parts of Clean Water Services' proposal, starting with "Our technical assessment of the treatment process is as follows:"

The next section, Monitoring, says that the treated wastewater meets Safe Drinking Water Act standards with respect to chemical contaminants, and other categories. However, it does not say if the water tastes good, smells good, or contains any peroxide.

OHA assumed that a person would drink 1 liter of this beer in a year. It seems likely that if the beer tastes good and does not cause illness, that many people would drink more of this beer.

Although Dave Leland approved the limited testing of this beer, I do not think that this is a good idea because it is likely to cause illness.

Thank you for taking comments,
Dorothy Shoemaker

PARKER Angela

From: Jenny McLean [Jenny.McLean@craftbrew.com]
Sent: Friday, February 20, 2015 6:16 PM
To: NEWELL Avis
Cc: Joe Casey
Subject: Widmer Brothers comments on using treated water to make beer

Hi Avis,
My name is Jenny McLean, and I am the Director of Communications at Craft Brew Alliance and Widmer Brothers. I have been working with Joe Casey, who has developed the following comments related to the CWS project and treated water. If you have any questions, feel free to reach out to either Joe or me. Many thanks.

Widmer Brothers Brewing on water and quality

- At Widmer Brothers Brewing, we proudly use PDX municipal water because it's high quality, great tasting and results in fantastic beers. Because Portland water is already very soft, clean, and pure, it isn't necessary to perform any special demineralization, filtration, or dechlorination processes. Straight from the Bull Run watershed, it makes great beers.

Our comments on the treated wastewater project

- According to the report, the regulators on this project are relying on the boiling during the brewing process and the ethanol formed in fermentation to function as safety backstops in the event that bacteria or viruses slip through the CWS treatment process. We don't believe the brewing industry should carry that responsibility.
- As part of our commitment to sustainability, we embrace and support the exploration of new technical innovations that reduce our environmental impact while allowing us to continue brewing the highest quality beers for our consumers. That said, we are committed to the highest standards in quality and safety, especially as it concerns beer's primary ingredient. Additionally, we recognize that Oregon-brewed craft beers are recognized for their exceptional quality and taste – which we attribute to the high quality of our water – and we are committed to doing everything we can to maintain that reputation.

Jenny McLean
Communications Director
jenny.mclean@craftbrew.com

Craft Brew Alliance
929 N. Russell Street, Portland, OR 97227
www.craftbrew.com
O 503.331.7248
M 503.887.8148

From: Joe Casey
Sent: Friday, February 20, 2015 5:40 PM

To: Jenny McLean
Subject: Fwd: comments on using treated water to make beer

Send to Avis.

Sent from mobile.

Begin forwarded message:

From: NEWELL Avis <NEWELL.Avis@deq.state.or.us>
Date: February 19, 2015 at 3:05:05 PM PST
To: 'Joe Casey' <Joe.Casey@craftbrew.com>
Subject: RE: comments on using treated water to make beer

Thanks Joe—
I think I answered your questions during our phone call. If not, I am around until about 5:00 or a little later today.

Avis Newell
Tualatin Basin Coordinator
DEQ
(503)229-6018

This spring, DEQ's Northwest Region Office will be moving to a new location - the 700 Lloyd Building at 700 NE Multnomah St., Suite #600, Portland, OR 97232. The target date for operating at the new location is May 26th, 2015.

From: Joe Casey [mailto:Joe.Casey@craftbrew.com]
Sent: Thursday, February 19, 2015 2:56 PM
To: NEWELL Avis
Cc: Jenny McLean
Subject: comments on using treated water to make beer

Hello Avis
I left you a voicemail earlier this afternoon. We are receiving consumer enquiries regarding the CWS project and proposal to supply treated sewer water to brewers to make beer. I know we missed a meeting last week, but, that written comments are being received through 5 PM tomorrow, Feb 20th. If we were to submit comments on the matter can you let me know where these comments live in the public domain, or if they're held confidential, and, what exactly we might be commenting on. Is you looking for feedback on the technology, the concept, the idea of using it to make beer, or other? Also, to where/who do we submit any such comments? Please give me a call when you have a moment. If you don't reach me at my desk please use my cell number as I'll be moving about this afternoon and the deadline expires tomorrow. I've copied my coworker Jenny who handles our communications so please use reply all if you send anything via email. Thanks much for any info you can share.

Joe Casey
Director of Brewing
joe.casey@craftbrew.com

Craft Brew Alliance
929 N. Russell Street, Portland, OR 97227
www.craftbrew.com

O: 503-331-7257
C: 971-207-6612

2000 NE 42nd Ave Ste D, PMB 278, Portland, OR 97213
(971) 270-0965
info@oregonbeer.org
www.OregonCraftBeer.org

02/20/2015

Avis Newell
Tualatin Basin Coordinator
DEQ
2020 SW 4th Ave, Suite 400
Portland, OR 97201

To Avis Newell:

I would like to comment on the proposed approval for a limited drinkable reuse of recycled water.

In reading through the comments on this proposal it might be inferred that we have a relationship with Clean Water Services. We were approached by them to figure out how to and if licensed brewers could use the water provided by Clean Water Services to make a beer to be served at a convention in Louisiana and the logistics and legalities of doing so made working with homebrewers for this issue an attainable solution.

We have no official relationship with Clean Water Services and no official position on this matter although I believe that some of our members do.

Sincerely,

Brian Butenschoen
Executive Director
Oregon Brewers Guild

Brewery Members

7 Devils Brewing
10 Barrel Brewing
13 Virtues Brewing
1188 Brewing Co.
Agrarian Ales
Alameda Brewing Co.
Ambacht Brewing Co.
Arch Rock Brewing
Astoria Brewing Co.
Baerlic Brewing Co.
Barley Browns Brewing
Base Camp Brewing
Beer Valley Brewing Co.
Below Grade Brewing
Bend Brewing Co.
Big Horse Brewery
Bill's Tavern & Brewhouse
Block 15 Restaurant & Brewery
Boneyard Brewing
Boring Brewing
Breakside Brewery
Brewers Union Local 180
BrickTowne Brewing
BridgePort Brewing
Burnside Brewing
Buoy Brewing Co.
Calapooia Brewing Co.
Caldera Brewing Co.
Cascade Brewing
Cascade Lakes Brewing Co.
Chehalem Valley Brewing Co.
Chetco Brewing Co.
Claim 52 Brewing
Climate City Brewing Co.
Coalition Brewing Co.
Columbia River Brewing
Crux Fermentation Project
Deluxe Brewing Co.
Deschutes Brewery
Double Mountain Brewery
Dragon's Gate Brewery
Ex Novo Brewing
Eliptic Brewing
Falling Sky Brewing
Fat Heads Brewery
Fire Cirkl Brewing
Fire Mountain Brewery
Flat Tail Brewing
Fort George Brewery
FOTM Brewing Co.
Full Sail Brewing Co.
Gigantic Brewing
Gilgamesh Brewing
Golden Valley Brewery
Good Life Brewing
Grain Station Brew Works
Griess Family Brews
Ground Breaker Brewing
Hair of The Dog Brewing
Heater Allen Brewing
Hop Valley Brewing
Hopworks Urban Brewery
Humble Brewing
Kells Brewpub
Klamath Basin Brewing Co.
Laurelwood Brewing Co.
Logsdon Farmhouse Ales
Lompoc Brewing Co.
Lucky Labrador Brewing Co.
Max's Fanno Creek Brewery
Mazama Brewing Co.
McMenamins
Mia & Pia's Brewhouse
Migration Brewing
Mt. Hood Brewing Co.
Mutiny Brewing
Natian Brewery
Ninkasi Brewing Co.
Oakshire Brewing
Occidental Brewing
Old Market Pub & Brewery
Old Mill Brew Werks
Old Town Brewing Company
Opposition Brewing
Oregon Trail Brewery
Pelican Pub & Brewery
pFriem Family Brewers
Pints Brewing
Plank Town Brewing Co.
Portland Brewing Co.
Portland U-Brew & Pub
Prodigal Son Brewery
Ram Restaurant+Brewery
Riverbend Brewing Co.
Rat Hole Brewing
Rock Bottom Brewery
Rogue Ales
Rusty Truck Brewing
Salem Ale Works
Sam Bonds Brewing
Santiam Brewing
Sasquatch Brewery
Seaside Brewing
Seven Brides Brewing
Silver Moon Brewing
Smith Rock Brewing
Solera Brewing
Standing Stone Brewing Co.
Stickmen Brewery & Skewery
StormBreaker Brewing
Sunriver Brewing Co.
The Commons Brewery
The Mash Tun
Three Creeks Brewing Co.
Three Mugs Brewing Co.
Thunder Island Brewing Co.
Two Kilts Brewing
Upright Brewing
Uptown Brewing
Vagabond Brewing
Vertigo Brewing
Walkabout Brewery
Widmer Brothers Brewing
Wild Ride Brewing
Wild River Brewing
Worthy Brewing Co.

Oregon

John A. Kitzhaber, MD, Governor

Department of Environmental Quality
Northwest Region
2020 SW 4th Ave, Suite 400
Portland, OR 97201
(503) 229-5263
FAX (503) 229-6945
TTY 711

July 14, 2014

Dave Leland
Interim Administrator, Center for Health Protection
Oregon Health Authority
800 NE Oregon Street, Suite 930
Portland, OR 97232

Dear Mr. Leland:

Clean Water Services, a special district in Washington County that treats wastewater, proposes to treat municipal waste effluent water to create very high quality water, such that it would be suitable for human consumption and high quality industrial uses. As DEQ understands the proposal, Clean Water Services has developed an advanced treatment system capable of producing such water. Clean Water Services proposes to supply this water to local brewers to brew beer that would be offered for consumption at conferences and other gatherings. The beer would not be commercially sold.

Oregon's Department of Environmental Quality (DEQ) regulates the use of treated wastewater through its National Pollution Discharge Elimination System Permit program. DEQ has adopted both rules and policy describing water re-use in its Recycled Water Program (Oregon Administrative Rule Chapter 340 Division 055). Clean Water Services proposes to use recycled water for a use that is not currently approved by Oregon Administrative Rules. OAR 340-055-0016(6) allows DEQ to authorize a beneficial purpose not specified by rule; however, DEQ's Recycled Water Rules prohibit use of recycled water for human consumption unless: the use is approved in writing by Oregon Health Authority; after a public hearing; and with authorization by the Environmental Quality Commission.

This letter comprises a formal request from the Oregon Department of Environmental Quality to the Oregon Health Authority to make a determination on the suitability of highly treated water for human consumption, as described in 'Clean Water Services High Purity Water Project: Direct Potable Water Reuse Demonstration, June 20, 2014.' Per Oregon Administrative Rule 340-055-0017(5), DEQ requests a written response from the Oregon Health Authority. Should the Oregon Health Authority provide approval of the use of this highly treated water for human consumption, DEQ would schedule and conduct a public hearing, respond to comments received, and seek approval from the Environmental Quality Commission. Should this use for recycled water be approved, DEQ would then work with Clean Water Services to amend their National Pollution Discharge Elimination System (NPDES) Permit. This permit is regulated by DEQ and issued to Clean Water Services for its waste water treatment plants. The permit amendment would include specific conditions regarding the use of recycled waste water effluent for human consumption.

Clean Water Services has submitted a detailed report that describes the proposed treatment for producing high purity water. This treatment includes ultrafiltration, reverse osmosis, and exposure to ultraviolet light enhanced with the addition of hydrogen peroxide. Clean Water Services further proposes to monitor each batch of treated water to ensure that the proposed treatment has met the water quality criteria that are specified in the report.

CWS's demonstration project is limited in scope, and DEQ seeks approval from the Oregon Health Authority for the proposed use of recycled water as described in the proposal. Based on the written proposal and conversations with CWS, DEQ understands the proposed demonstration project would operate under the following conditions:

- Water treated as described in the attached report entitled 'Clean Water Services High Purity Water Project: Direct Potable Water Reuse Demonstration, Draft, June 20, 2014,' produced by Clean Water Services, and Carollo, in association with National Water Research Institute.
- Water would be produced in batches of less than 1000 gallons.
- Each batch would be tested to ensure that the high purity water produced would meet the criteria set out in Tables12 through 19 and Table 21 included in the attached Clean Water report (pages 38-42 and page 45).
- Laboratory analysis for these tests would be completed by an independent laboratory that is certified by the Oregon Health Authority to test drinking water quality.
- The beverage product would be made available for adult consumption only.

DEQ has learned from informal conversations with both the Oregon Health Authority and the Food Safety Program at the Oregon Department of Agriculture that both the level of human exposure, and production monitoring are important factors for consideration. DEQ does not have the authority or expertise to establish limits for human consumption of recycled water or ingredients in food products. However, DEQ does have the authority to include permit conditions necessary to protect public health that could include requirements, for example, that limit the volume of water produced, and that dictate monitoring requirements for the high purity treatment in the NPDES permit. The NPDES permit is enforced under the guidance of Oregon Revised Statute Chapter 340, Division 12. Therefore, DEQ requests the Oregon Health Authority to suggest permit conditions, such as production limits or monitoring requirements as necessary to protect human health. DEQ will consider any specific permit conditions suggested by OHA regarding this particular use of recycled water.

DEQ understands that OHA may require some time to review the proposal and provide a decision to DEQ. In order for DEQ to efficiently manage workloads on this and other projects, DEQ requests the Oregon Health Authority provide an estimated schedule for review and receipt of a written response on the proposal. This response will assist DEQ in planning for potential future work on this project, and balancing that work with other DEQ responsibilities.

Please feel free to contact me with questions concerning this project. For the remainder of the month of July, I will be out of the office. During that time, Avis Newell or Anita Yap will be available to answer any questions you have. Avis Newell can be reached at (503)229-6018 or Newell.Avis@deq.state.or.us. Anita Yap can be reached at (503)229-6896 or Yap.Anita@deq.state.or.us.

Thank you very much for your attention to this request.

Sincerely,

for RD

Ron Doughten

Water Quality Manager
Department of Environmental Quality, Northwest Region

Electronic CC:

Nina DeConcini, DEQ
Anita Yap, DEQ
Avis Newell, DEQ
Bob Baumgartner, Clean Water Services

Public Health Division
Drinking Water Services
John A. Kitzhaber, MD, Governor

Oregon Health Authority

800 NE Oregon St, Ste 640
Portland, OR 97232
Ph. (971) 673-0405
Fax (971) 673-0694
http://healthoregon.org/dwp

September 8, 2014

Ron Doughton
Water Quality Manager, Northwest Region
Department of Environmental Quality
2020 SW 4th Avenue, Suite 400
Portland, OR 97201

Dear Mr. Doughton:

This letter responds to your July 14, 2014 request to the Oregon Health Authority (OHA) to determine the suitability of the Clean Water Services proposal to use wastewater treatment plant effluent, apply additional treatment, and use the resulting water to produce a limited quantity of beer for non-commercial purposes.

Background

The Department of Environmental Quality rules govern the use of treated wastewater. Direct potable reuse of such water is not allowed under current rules, unless approved by OHA, a public process, and the Environmental Quality Commission. Clean Water Services has proposed, in the document entitled "High Purity Water Project, Direct Potable Water Reuse Demonstration, June 20, 2014" to take effluent from Clean Water Service's Forest Grove wastewater treatment plant, pipe it directly to a water treatment system, and brew the water produced into beer. The additional treatment system includes ultrafiltration, reverse osmosis, and advanced oxidation with hydrogen peroxide and ultraviolet light. The project proposal is to treat 500 gallons of water, to be exclusively used to brew beer for consumption at a technical conference.

The Oregon Health Authority has implementation and enforcement authority of the Safe Drinking Water Act (SDWA) in the Oregon Drinking Water Quality Act. This act is governed by Oregon Administrative Rules (OAR) 333-061, which apply to water systems with piped water for human consumption. However, because the proposal involves using the treated water to produce a limited quantity of beer, rather than drinking water, drinking water regulations do not *directly* apply.

Treatment Evaluation

The proposed treatment incorporates commonly used technologies in the treatment of recycled wastewater. The water quality produced by the demonstration-scale post-treatment effluent meets maximum contaminant levels for regulated drinking water contaminants and appears appropriate for the intended use.

For public water systems, OHA requires that treatment meet specific treatment technique requirements established in OAR 333-061. These include pathogen reduction requirements of OAR 333-061-0032, membrane filtration challenge study requirements in -0050(4) (c), ultraviolet light validation study requirements in -0050(5) (k), and material compatibility requirements of -0087. No other basis for a technical review currently exists for direct potable reuse in Oregon.

Our technical assessment of the treatment process is as follows:

- Ultrafiltration (UF): UF is a membrane filtration process which has been shown to substantially remove microbial organisms. No challenge study on the ultrafiltration unit was provided. This study would provide a third party review of the membrane filter's ability to remove pathogens and set metrics to verify the integrity of the membrane during operation. Empirical data from the demonstration study indicates substantial reductions of these common microbial contaminants. It is noted that the pore size for the UF is listed as two different values in the documentation. The upper control limit of the pressure decay of the direct integrity test seems high, yet the limit established was not met in several instances during pilot testing.
- Reverse Osmosis (RO): This process is used to remove salts, organic matter, microbial pathogens, and trace pollutants. No model number for the RO unit is provided. Information provided in the proposal is not sufficient to comprehensively verify RO performance, but RO is widely used for treatment of recycled wastewater and generic theoretical performance data is widely available.
- Advanced Oxidation Process (AOP): The proposed treatment uses ultraviolet light (UV) preceded by hydrogen peroxide addition for microbial and organic compound reduction. Two Trojan brand UV reactors are proposed in series, but no model numbers are given, nor is a standardized validation study provided. The proposal describes in general terms how the efficacy of AOP can be estimated by measuring

reduction of two indicator compounds: NDMA and 1,4-dioxane. The proposal claims the extent of the elimination of NDMA supports a UV dose of 2,500 $^{mJ}/_{cm^2}$, though the limited data appears to support a dosage range of 1,250 to 2,500 $^{mJ}/_{cm^2}$. Reduction of 1,4-dioxane was not measured to determine oxidant efficacy. Overall, the documentation provided of the AOP limits quantification of the proposed treatment. AOP has been shown to substantially reduce microbes and trace organics and is used by others for treatment of recycled wastewater.

- General: No influent data (water leaving the wastewater treatment facility) is provided, so the removal efficiency of contaminants cannot be determined. The proposal does not include verification of NSF certification of water treatment components, materials, and chemicals used. After water treatment, the proposal is to store and transport the treated water in totes for beer processing. NSF certification of the totes is not discussed, nor is adherence to the water hauling guidelines established by OHA.

Monitoring

Test results from the treated water samples indicate that this water met all Safe Drinking Water Act (SDWA) standards for public drinking water with respect to chemical contaminants (Tables 12-17 of proposal). In addition, other analytes consisting of indicator chemicals for a wide range of chemical classes and chemicals of special concern for municipal wastewater (e.g., pharmaceuticals, personal care products, hormones, and industrial and household chemicals) were screened in treated water. All results for additional analytes were below detection limits, which were below proposed public health risk criteria (Table 18 in proposal).

Water quality monitoring at the beginning and end of the batch treatment is proposed as follows, from Table 21 of the proposal. OHA has determined this monitoring to be adequate, though continuous monitoring of turbidity, flow, and UV intensity is preferred but was not specifically mentioned.

Process	Test	Target Concentration
Wastewater UV	E. Coli in the UV effluent	<20 MPN/100ml
Demo UF	Particle Size Distribution Analysis	>2 LRV (protozoa range) >1.5 LRV (bacteria range)

	Total Coliform in UF effluent	<40 MPN/100ml
	Turbidity in UF Effluent	<0.1 NTU
	Membrane Integrity Test	<0.2
Demo RO	Electrical Conductivity	LRV>1.5
	TOC	LRV>1.5
Demo UV	NMDA	ND
Finished Water	IOC,SOC,DBPs,VOC, Radionuclides,Secondary Contaminants,Trace Compounds, Microbials	Below MCLs for SDWA-regulated contaminants and below proposed criteria for trace compounds with corrections mentioned below

Note that the criterion for 1,4-dioxane should be the California Department of Health's notification level of 1 μg/L (Table 18 in the proposal lists it as 0.1 μg/L). OHA also recommends using the Minnesota Department of Health's Short-term Non-Cancer Health Based Value (nHBVshort-term) of 50 μg/L for triclosan rather than the NRC-recommended value. It is more protective of health and was derived in a more transparent scientific process (http://www.health.state.mn.us/divs/eh/risk/guidance/gw/triclosan.pdf).

Public Health Risk Analysis

OHA assumed an upper-bound estimate for consumption of the specialty beer made from the proposed batch treated water to be 1 liter per adult person per year. In developing safe drinking water standards, the Environmental Protection Agency (EPA) assumes consumption of 2 liters per day every day of the year (730 liters per year).

Tests for pathogenic microorganisms in the batch treated water did not detect any microorganisms. If there were undetected pathogenic microorganisms in the batch treated water, any public health risk would be eliminated by the process of beer production. As described in the protocol, batch treated water will be boiled prior to use. In addition, the fermentation process produces ethanol, which is toxic to most pathogenic microorganisms. The concentration of ethanol in beer is not high enough to truly disinfect or sanitize, but it could prevent growth of many types of pathogenic organisms. Risk is reduced even further because the ethanol is a permanent component of the product itself, so any additional storage time would result in increased contact time between the ethanol and any residual microorganisms. Thus, the proposed use of treated water to make beer poses virtually no risk of infectious disease.

Conclusion

Due to the high water quality of the treated water, the additional microbial reduction in the brewing process, and a low health risk overall, **OHA Public Health Division approves the proposed use of recycled water in the limited case as described in this proposal.** The water from the proposed treatment system must achieve equal or higher quality to those presented at the demonstration-scale (i.e. below MCLs for regulated contaminants and below proposed criteria for additional analytes).

Please let me know if you have any questions. I can be reached at 971-673-0403.

Sincerely,

Dave Leland
Interim Administrator-Center for Health Protection
Public Health Division
Oregon Health Authority

C: Lillian Shirley, Director-Public Health Division
Sarah Schwab, Department of Agriculture