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Water Reuse- Indirect IPR or Direct DPR

Utilities and water purveyors in the Western US have learned that climate change is real. Periods of drought have stretched to become the normal phenomenon of weather, negatively impacting water supplies, business activities, regional population growth and agricultures. Water reuse is becoming increasingly necessary for maintaining adequate water supplies, the California Division of Drinking Water (DDW) has released draft regulations for using recycled (reclaimed) wastewater as a source of potable water (1). Potable water reuse comes in many forms, but primarily follows two models: 1) the broadly used Indirect Potable Reuse (IPR), which involves tertiary or advanced treatment of wastewater and the use of an environmental buffer such as a groundwater basin or a surface water reservoir; and 2) Direct Potable Reuse (DPR) which directly purifies wastewater for potable use. In addition to the state of California's regulation for IPR projects, several research organizations are developing guidance efforts for both IPR and DPR to determine pathogen concentrations throughout the treatment process and in the finished water. These standards require pathogen reduction of at least 12-log for enteric viruses and 10-log each for the parasites Giardia and Cryptosporidium [Section 60320.108-Pathogenic Microorganism Control from DDW regulations (1)] prior to potable water consumption (referred to as the "12-10-10 Rule"). These IPR regulations in California highlight specific and necessary focus on pathogen removal for potable water reuse. The new proposed draft regulations for DPR is most stringent with the sum of the treatment process validated log reductions for the treatment train must be at least 20 log for enteric virus, 14 log for Giardia cysts, and 15 log for Cryptosporidium oocysts."

State-of-Knowledge Supporting Reuse Projects –
Combined wastewater treatment trains including the activated sludge process, sedimentation ponds, coagulation, filtration, and disinfection have been shown to reduce viral load by 50 to 90 percent in a tertiary effluent, but a non-trivial level of virus can escape treatment. As a result, enteric viruses are common pollutants of environmental waters and can pose a risk to human health through exposure to contaminated water sources. The importance of testing water sources for enteric viruses is clear, but until recently the difficulty and cost associated with enteric virus detection methods limited the extent of testing. Because of its relative ease and low cost, bacteriophage (F^+- or male-specific Coliphage) was widely used as a surrogate organism for enteric viruses. Bacteriophage is not relevant to human health, however, and new improvements in the detection methodology for enteric viruses have spurred recent interest in direct detection of enteric viruses.

In 2013 **Cel Analytical** was selected as one of the 5 laboratories nation-wide to participate in US EPA Unregulated Monitoring Rule 3 Pres-screening survey for pathogens in ground water sources of drinking water using the newly developed EPA method 1615.

UCMR3 provided a large scale 'proof of concept' for using RT-qPCR to detect enteric viruses in water in addition to Total culturable Virus assay (TCVA), and provides particular utility for the detection of Norovirus, which cannot be detected in cell culture systems. This survey also confirmed that RT-qPCR is more sensitive than the TCVA method and has a wider detection range, suggesting the possibility of using RT-qPCR to establish 12-log reduction on smaller, more manageable sample sizes for IPR projects. The 20-log reduction of enteric viruses proposed for the Draft DPR can ONLY be determined using molecular methods.

The large ~1,800 L sample volume collected for the UCMR3 survey limits the applicability of EPA Method 1615, and many treatment system managers are hesitant to collect such large sample volumes. It became evident that for water reuse, in reclamation projects, understanding the virus concentration in raw wastewater was an essential step.

In 2019-2020 **Cel Analytical** served as the lead laboratory for the Water Research Federation (WRF) Direct Potable Reuse Phase 2 (DPR-2) pathogen monitoring in raw wastewater campaign (including SARS-CoV-2 analysis). This monitoring campaign was funded by the California State Water Resources Control Board (SWB) to gain better understanding of the level of potentially harmful waterborne pathogens in raw wastewater so that the proper levels of treatment can be determined and reliably applied. In addition to analysing DPR-2 raw wastewater samples, **Cel Analytical** was responsible for participating in development of methods for the raw wastewater matrix; developing the study QAPP (2); reviewing the data from the other labs for quality control; organizing sampling protocols and shipping; and, supplying surrogate target microorganisms.

Cel Analytical uses surrogates such as male specific bacteriophage. In the laboratory, these viruses are detected by the formation of plaques on "lawns" of susceptible E. coli. This procedure is easier and less costly method than the use of tissue culture as employed with animal viruses. Results are usually available within 5 days. Bacteriophages appear to be particularly useful in evaluating the ability of water and wastewater treatment processes. **Cel Analytical** can provide high titer Bacteriophage that can be used in studies as indicators of the presence enteroviruses in water and wastewater. Contact the laboratory for more information.

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Resources

1) A Proposed Framework of Regulating Direct Potable Reuse in California Addendum version 3-22-2021 DPR Framework 2nd edition Addendum – Early Draft of Anticipated Criteria for Direct Potable Reuse- *64990.45.a.The sum of the treatment process validated log reductions for the treatment train must be at least 20 log for enteric virus, 14 log for Giardia cysts, and 15 log for Cryptosporidium oocysts."*

2) DPR-2 Project Team (2020) Quality Assurance Project Plan: Analytical Microbiological Services. https://www.waterrf.org/resource/quality-assurance-project-plan-analytical-microbiology-services. Access date July 26, 2021.