



Future Beach Water Quality and the Potential Use of Viral Indicators

Bill Kramer
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Ambient Water Quality Criteria

- The 2012 RWQC for primary contact recreation are associated with **bacterial** indicators of fecal contamination.
 - Enterococci and *E. coli*.
 - A new, rapid analytical method, quantitative polymerase chain reaction (qPCR) is available on a site-specific basis for the purposes of beach monitoring.
 - Section 303(i)(1)(B) of the Clean Water Act (as amended by the BEACH Act of 2000) directs each state with coastal recreational waters to adopt and submit to EPA new or revised water quality standards for those waters for all pathogens and pathogen indicators to which the new or revised water quality criteria are applicable three years from EPA publication of new recommended criteria (i.e., December 2015). "State" includes the 5 territories and 3 eligible tribes receiving BEACH Act grants.

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Ambient Water Quality Criteria - Viruses

- Microbial, QMRA, and epidemiological studies over the past 30 years show that **viruses** are the microorganism group predominately driving the **illnesses** associated with primary contact in recreational waters impacted by human sources.
- Traditional fecal indicator bacteria:
 - do not persist in the environment or through disinfection treatments as long as viruses,
 - do not show consistent correlations with viruses, and
 - do not contribute to the majority of illnesses associated with primary contact recreation.
- **Bacteriophage** – (a virus that infects a bacterium) as a viral indicator - can provide improvement in water quality monitoring!

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Ambient Water Quality Criteria - Viruses

- Bacteriophage (what makes them good viral indicators)
 - Viral indicator of fecal origin/highly concentrated in sewage.
 - Physically similar to enteric viruses of concern.
 - Similar persistence patterns to enteric viruses of concern.
 - No re-growth in the environment.
 - Significantly correlated to viral pathogens (Wu et al. 2011).
 - Non-pathogenic.
 - EPA approved 136 methods, with rapid methods under evaluation.
 - Methods are simple relatively quick (~24-36hr)
 - More resistant to sewage treatment than bacterial indicators.
 - Particularly useful for end-of-pipe measurements.
 - **FDA** is also moving towards use of bacteriophage as a viral indicator of wastewater treatment in shellfish waters.

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Ambient Water Quality Criteria - Viruses

Why are bacteriophage particularly useful for end-of-pipe purposes?

- In waters impacted by WWTP (human), the illness is viral driven.
- Viruses are inactivated at a slower rate than bacteria (especially in systems using a chlorine disinfectant).
- Phage are good surrogates for human enteric viruses in WWTP.
- Phage criteria will greatly improve knowledge of risk leaving the WWTP.
 - Force improvements in WWTP.
- Phage methods already 136 approved, offer incremental improvement over current bacteria indicators that qPCR was not able to provide.
 - Methods will be able to illustrate the removal of live viruses.

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Ambient Water Quality Criteria - Viruses

Phage for other CWA purposes

- Collaborating with EPA and non-EPA epidemiologists to evaluate associations between phage and health while swimming.
 - In general, fewer epidemiological studies have evaluated phage.
- When monitor anywhere except for end of pipe or associated plume, unsure if phage is associated with human sewage.
 - Phage is also measureable, although to a lesser degree, in animal waste.
- Need to develop an approach for using for 305b, 303d listing, etc.

Overall, AWQC for Viruses will:

- Improve knowledge of risk leaving the WWTP.
- Allow States to employ the most up-to-date science.
- Provide more accurate permits limits for wastewater treatment plants. ⁶



Ambient Water Quality Criteria - Viruses

- **EPA Near-Term Goals (1-2 yrs): AWQC for Viruses**
 - Use QMRA and/or epidemiology studies to develop criteria.
 - Determine how criteria will fit in other EPA Office of Water programs.
 - Collaborate with epidemiologists to evaluate bacteriophage analysis from epidemiological studies.
- **EPA Long-Term Goals (5-7 yrs):**
 - Improved detection methods, collaboration ongoing with EPA research microbiologists.
 - Updated Phage Criteria: with newer methods
 - Phage methods – flow cytometry, qPCR, and human specific phages (GB124)
 - Virus Criteria: Norovirus, Adenovirus, Enterovirus
 - Human virus methods under development by EPA's Office of Research and Development.

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Ambient Water Quality Criteria - Viruses

- **Near-term: Next Steps (1-2 yrs):**
 - Three Literature reviews: bacteriophage, norovirus, adenovirus
 - Letter Peer Reviews (spring-summer 2014)
 - EPA Publications (fall 2014)
 - Peer Review Publications (winter 2014/2015)
 - Criteria Derivation (spring-summer 2014): evaluation of multiple approaches
 - QMRA – (spring-summer 2014)
 - SCCWRP epidemiology studies (Doheny) -- (spring-summer 2014)
 - AWQC for Viruses (Bacteriophage Criteria) Draft:
 - with Peer-review/Public Comment (spring 2015)
 - Publish criteria (fall 2015)
- **Long-term: Next Steps (5-7 yrs):**
 - Method development: bacteriophage and enteric viruses of concern.
 - Improved Virus/Bacteriophage Criteria.

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Ambient Water Quality Criteria - Viruses

Broader Implications

- Research and literature reviews used to develop the AWQC for Viruses have direct application for:
 - Potable Drinking Water
 - Water Reuse Applications – defacto, direct potable, etc.
 - Biosolids
 - Shellfish Waters

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Thank you

Bill Kramer
Kramer.bill@epa.gov
(202)566-0385

Sharon Nappier
Nappier.sharon@epa.gov
(202)566-0740

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