Stormwater Reuse Research

MAWD July 2018

Research Question

Should there be water quality criteria for stormwater reuse, and if so, what should they be?

Clean Water Fund Study

- **Clean Water Fund: Contaminants of Emerging Concern (CEC)**
  - Water Reuse and Quantitative Microbial Risk Assessment
- Dr. Tim LaPara, Cheryl Haines
  - Civil, Environmental, and Geo-engineering
  - Two stormwater reuse systems
    - Residence hall – toilet flushing
    - Irrigation system

Clean Water Fund Study Objectives

- Determine if common microbes that can make people sick (human pathogens, also known as “germs”) were in the water of these reuse systems.
- If human pathogens were found:
    - Estimate the concentration of the human pathogens in the water (i.e., how many pathogens per liter of water).
    - Estimate the risk to human health posed by the pathogens.
- Use the findings of the study to help inform possible recommendations for regulatory and/or non-regulatory approaches to water reuse in Minnesota

Risk-based Framework for the Development of Public Health Guidance

Goal: Prepare recommendations on the following:

- Water quality pathogen reduction targets for multiple types of alternate water sources
- Monitoring regimes for water quality
- Management considerations for systems
- Strategies for permitting projects
- Applications and end uses of treated alternate water sources

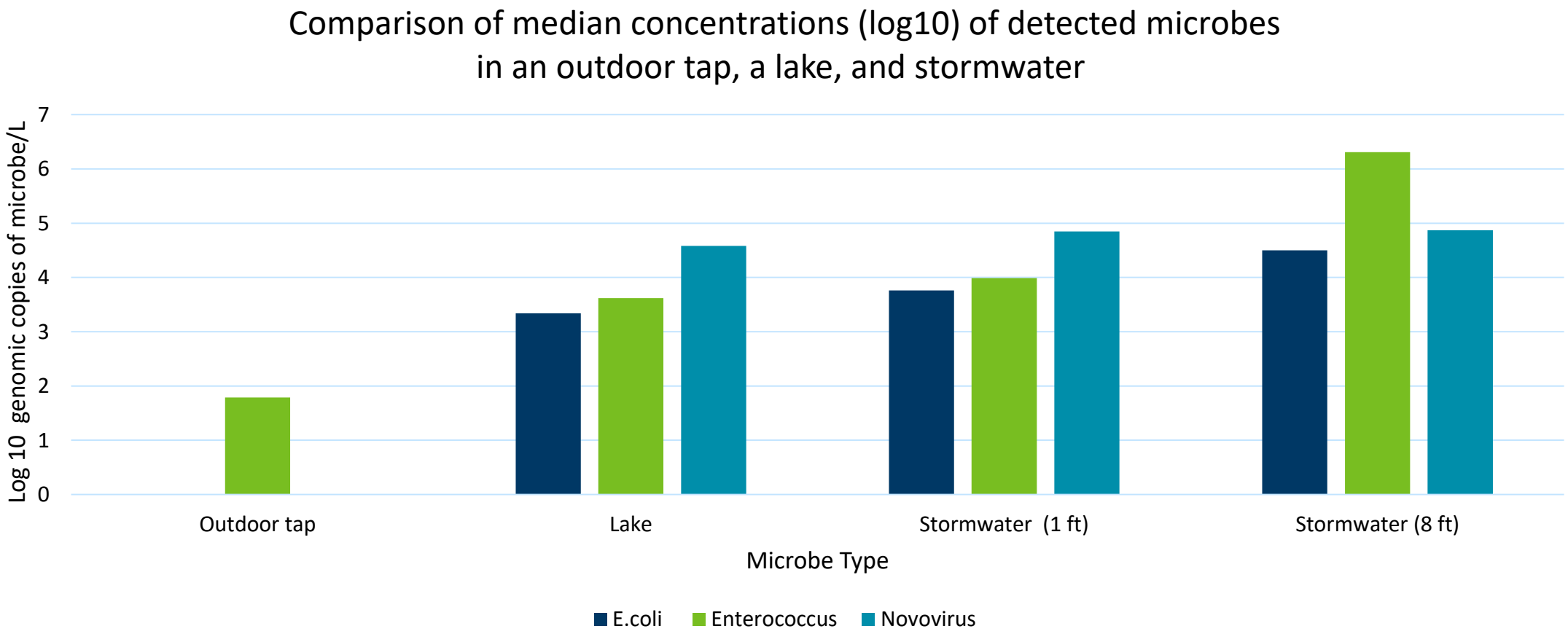
Released March 15, 2017

WE&RF Pathogen Reduction Targets

Water Use Scenario	Log_{10} Reduction Targets for 10^{-4} (10^{-2}) / person•y Benchmarks		
	Enteric Virus	Parasitic Protozoa	Enteric Bacteria
Domestic Wastewater or Blackwater			
Unrestricted irrigation	8.0 (6.0)	7.0 (5.0)	6.0 (4.0)
Indoor use	8.5 (6.5)	7.0 (5.0)	6.0 (4.0)
Graywater			
Unrestricted irrigation	5.5 (3.5)	4.5 (2.5)	3.5 (1.5)
Indoor use	6.0 (4.0)	4.5 (2.5)	3.5 (1.5)
Stormwater (10^{-1} Dilution)			
Unrestricted irrigation	5.0 (3.0)	4.5 (2.5)	4.0 (2.0)
Indoor use	5.5 (3.5)	5.5 (3.5)	5.0 (3.0)
Stormwater (10^{-3} Dilution)			
Unrestricted irrigation	3.0 (1.0)	2.5 (0.5)	2.0 (0.0)
Indoor use	3.5 (1.5)	3.5 (1.5)	3.0 (1.0)
Roof Runoff Water			
Unrestricted irrigation	Not applicable	No data	3.5 (1.5)
Indoor use	Not applicable	No data	3.5 (1.5)

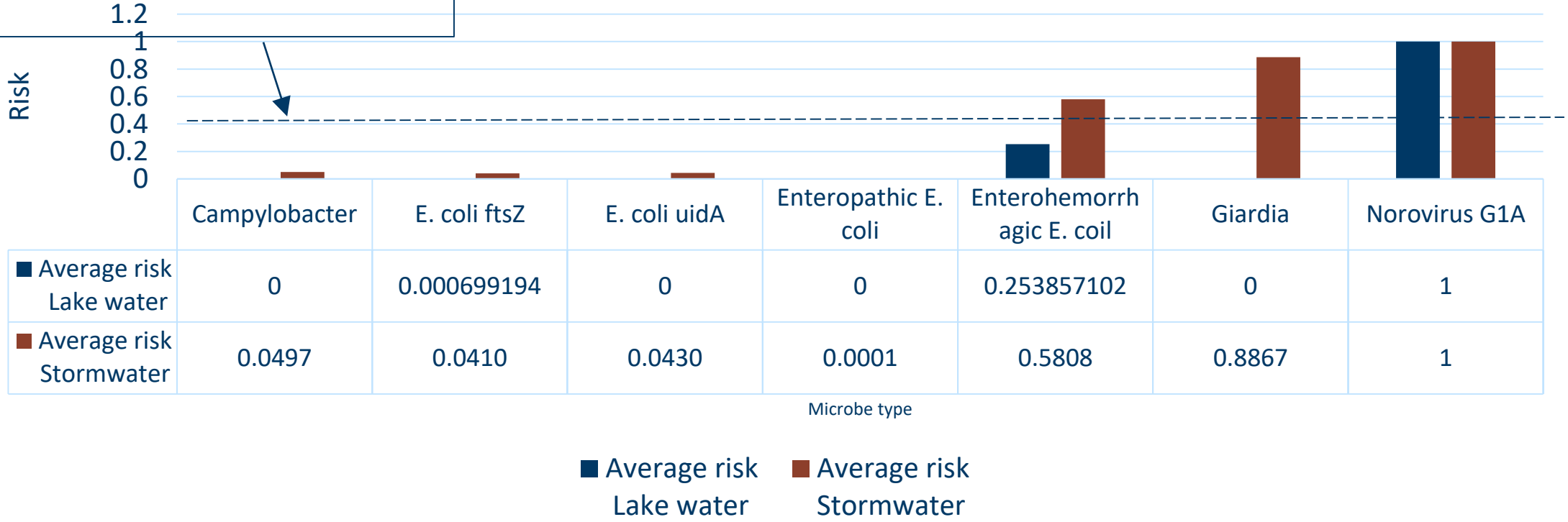
WATEREUSE

Microbe concentrations



Risk of Infection, per Year

Approximate EPA acceptable risk level for recreational activities, 50 exposures per year.



	Campylobacter	E. coli ftsZ	E. coli uidA	Enteropathic E. coli	Enterohemorrhagic E. coil	Giardia	Norovirus G1A
Average risk Lake water	0	0.000699194	0	0	0.253857102	0	1
Average risk Stormwater	0.0497	0.0410	0.0430	0.0001	0.5808	0.8867	1

Next steps

- Sample more systems
- Ideally try to model pathogens, and then verify the model
- Start to look at how system design affects water quality
- Develop practical tools

Maximizing the Benefits of Water Reuse

- In progress, completed June 30, 2019
- Dr. Satoshi Ishii
  - University of Minnesota; Soil Water and Climate, Biotechnology Institute
- Val Dooling
  - MS Student, University of Minnesota; Environmental Engineering

Maximizing the Benefits of Water Reuse: **Goals**

❖Eliminate barriers to reuse implementation

- Determine quality of reclaimed water for reuse purposes
  - Treated wastewater / greywater / stormwater
- Determine water quality standards for reuse purposes
  - Toilet flushing, vehicle washing, irrigation, final produce rinse

❖Improve stormwater management and reduce demands on groundwater aquifers

❖Reduce cost of water reuse systems that treat to higher quality

Maximizing the Benefits of Water Reuse: **Sampling Sites**

Water Samples from 24 Water Reuse systems

- Metro Area, Duluth
- Privately and publically owned
- Used for toilet flushing, vehicle washing, irrigation
- Treatment through Ozone, UV, Chlorination, Membrane Filtration
- Various weather conditions and seasons (Spring/Autumn)
- Sampling at Source, Post-treatment, End of distribution system
- Collect design components of source water, storage, treatment devices

Sampling Procedure

Throughflow Ultrafilter

Target Volume: 800L/200gal
at 2-5 L/min for 3 hours

- BackFlush
- Flocculation
- Concentration
- Storage

Minneapolis Convention Center

Rainwater roof collection
Irrigation

Woodbury, MN

14 Reuse Sites
Approved

Health East Sports Center

Stormwater
Irrigation

CHS Field- St Paul Saints Field

Rainwater from roof of Metro Transit
UV filtration
Toilet flushing and irrigation

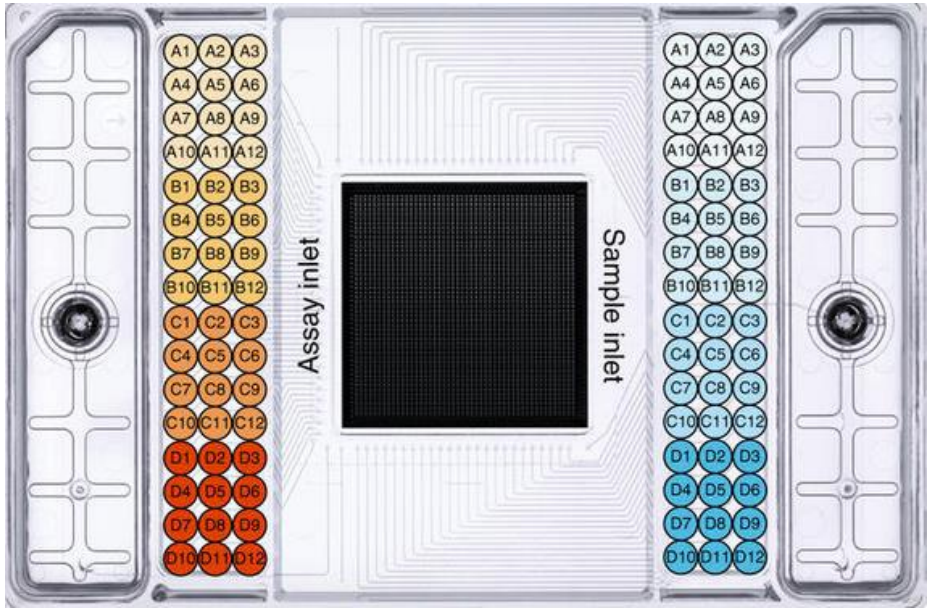
GNP Poultry Processing

Sourcewater: Processing Wastewater
Treatment by: UV /Sand Filtration/ Membrane Bioreactor/ Chlorination
Used as: Cleaning and Cooling Water

- 1,400,000 gal/day
- Phosphorus and ammonia removal

Maximizing the Benefits of Water Reuse: **Pathogens**

- Target Waterborne Pathogens
- Microfluidics Quantitative PCR
  - simultaneously quantify pathogens in water samples



Bacteria

- E Coli O157
- Salmonella
- Campylobacter
- Legionella Pneumophila
- Human bacteroides

Virus

- Influenza H5N1 (Bird Flu)
- Human Adenovirus
- Hepatitis A Virus

Antibacterial Resistance

Maximizing the Benefits of Water Reuse: **QMRA**

Quantitative Microbial Risk Assessment

- Hazard Identification and Concentration in Water
- Infectious Dose of Pathogen
- Probability of Pathogen Exposure
  - Differs by Reuse Purpose
- Risk Characterization

Recommendations

- Water Quality Standards
- Treatment Design

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