Pathogen Distributions and Trends in Southern Nevada's Wastewater for Advancing Direct Potable Reuse

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SOUTHERN NEVADA WATER AUTHORITY

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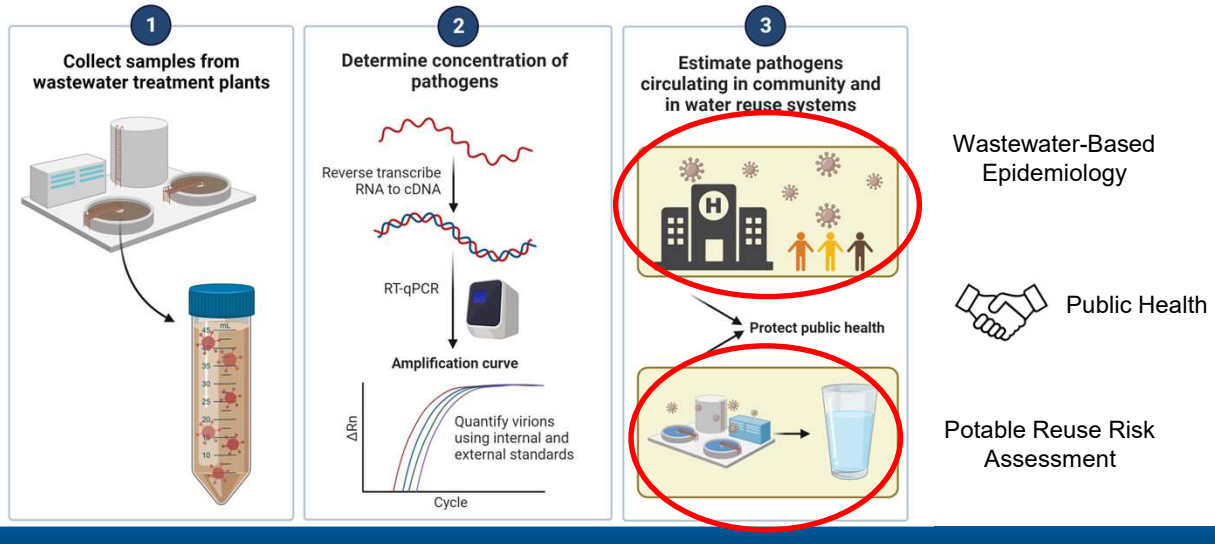
Summary



Wastewater-Based Epidemiology

Public Health

Potable Reuse Risk Assessment

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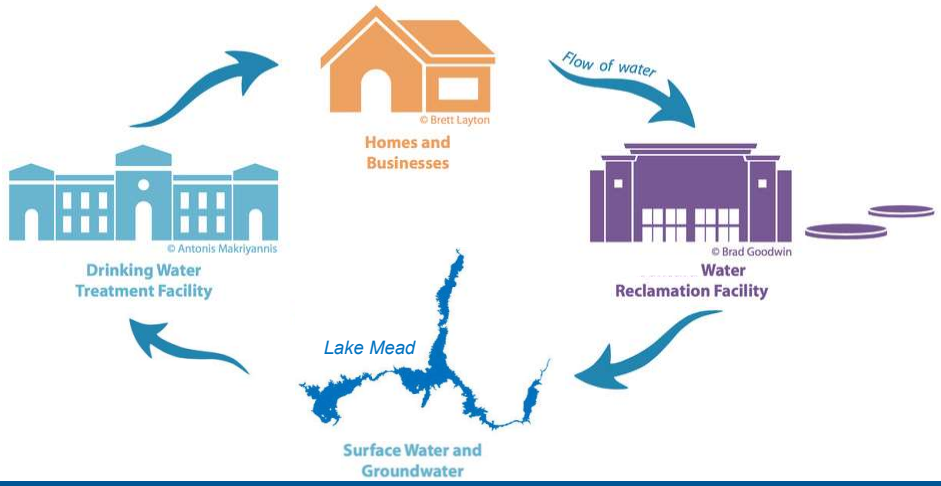
Water Reuse in Southern Nevada

de Facto Reuse



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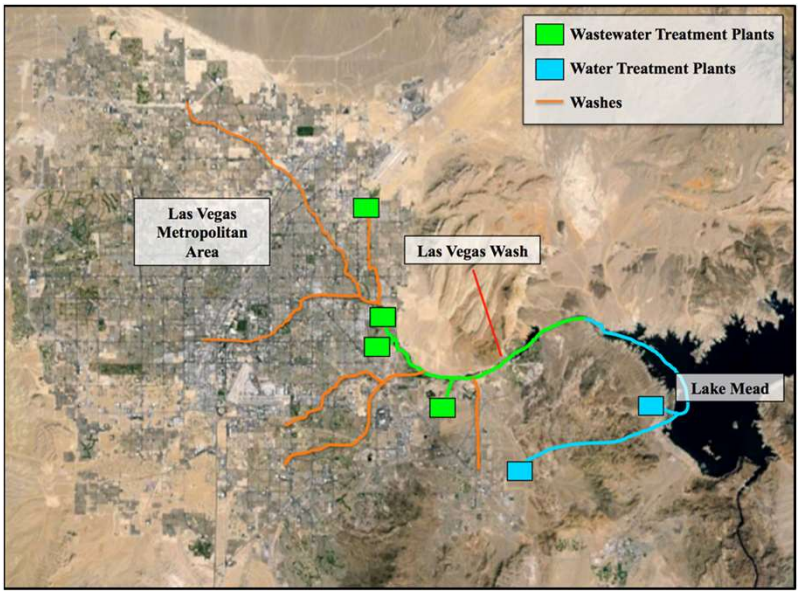

Treated wastewater makes up ~1% of the water at the drinking water treatment plant intake

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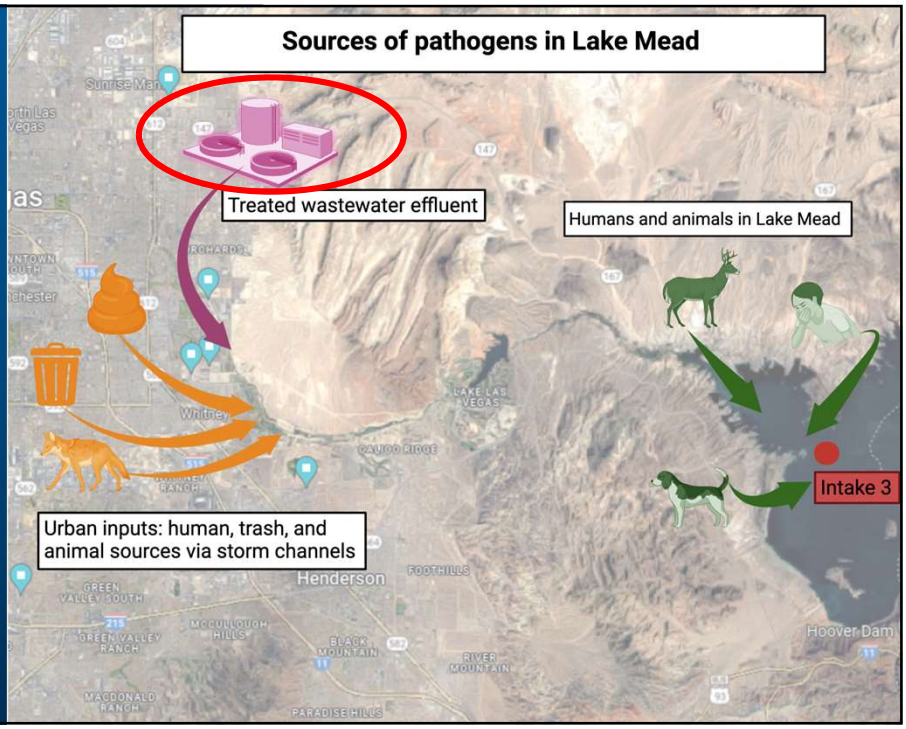
How will these sources impact drinking water if lake levels drop?



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Wastewater pathogen data informs both wastewater-based epidemiology and water reuse

- Forward Approach (Water Reuse)
  - Water reuse applications focus on preventing the transmission of diseases by treating wastewater before it is reused
- Backward Approach (Wastewater-based Epidemiology)
  - WBE uses wastewater to analyze and monitor the prevalence and trends of diseases within communities
- Community health priority
  - Both water reuse and wastewater-based epidemiology prioritize community health

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Wastewater-based epidemiology (WBE)

- Monitor concentrations of chemicals or biological agents in wastewater/sewage
- Analyze data to characterize activities, behavior, or disease within a community
- Assess specific issues over time and space:
  - COVID-19 infections
  - More common infections (influenza, norovirus)
  - Re-emergence of eradicated diseases (polio)
  - Illicit drug use (opioids)

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Southern Nevada sewersheds and wastewater sampling

Rapid adoption of wastewater surveillance for SARS-CoV-2 due to recent microbial source tracking work

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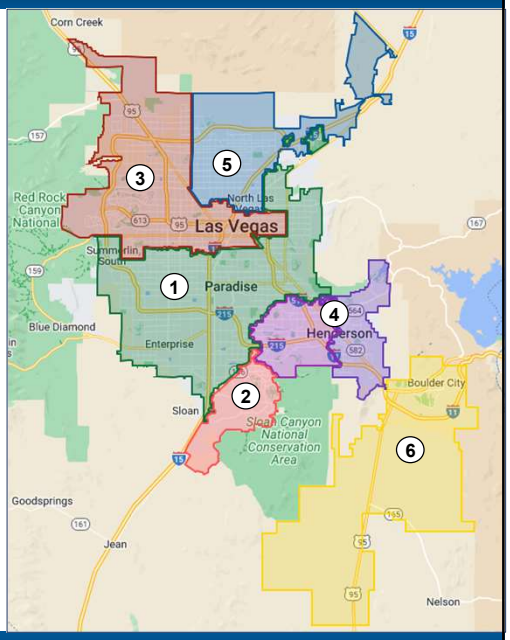
Southern Nevada sewersheds and wastewater sampling

Facility/ Sewershed	Population served	Flow rate (mgd)	Sample type and source
1	872,009	100	Grab influent Grab primary effluent
2	86,330	5	Composite influent
3	757,418	42	Composite/Grab influent
4 [b, c]	N/A [b]	N/A [b]	Composite influent
4A [b, c]	133,977	15	Grab influent
4B [b]	114,532	6	Grab influent
5	255,008	20	Composite influent
6	16,399	0.8	Grab influent

[a] 10,000 mL samples are processed using hollow fiber ultrafiltration (HFUF) prior to pelleting by centrifugation.
[b] Facility 4 is the 24-hr composite of Facility 4A (west trunk line) and Facility 4B (east trunk line).
[c] Facility 4A (and by default Facility 4) receives solids and bypass flows from Facility 2.



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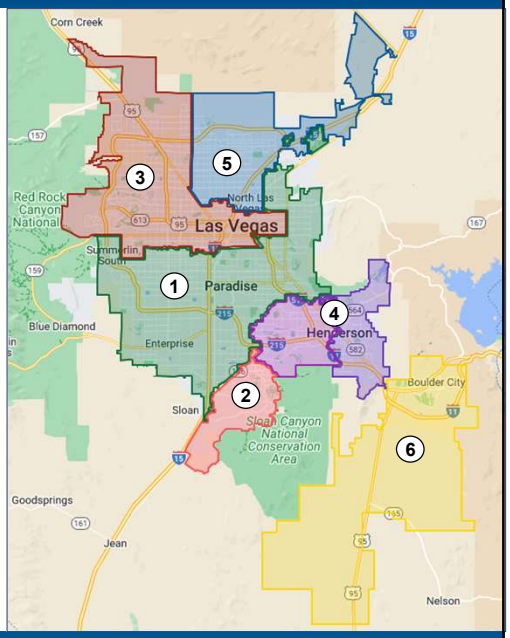
Southern Nevada sewersheds and wastewater sampling

Spot the difference...



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Waterborne Disease

Selecting Pathogen Targets for Potable Reuse

Common Targets:

1. Enteric Viruses
2. Giardia
3. Cryptosporidium

Conventional Drinking Water Regulation

Surface Water Treatment Rule

Surface Water Treatment Rule

Interim/Long Term 2 Enhanced Surface Water Treatment Rule

No.	Pathogen	Episodes	Hospitalizations	Deaths
1	Norovirus	20,796,079	55,825	569
2	*Giardia intestinalis*	1,121,864	3,289	31
3	*Salmonella* spp. (non-typhoid)	1,095,079	20,608	403
4	*Campylobacter* spp.	1,058,387	10,599	95
5	*Clostridium perfringens*	966,120	438	26
6	*Cryptosporidium* spp.	678,828	2,473	42
7	*Shigella* spp.	421,048	4,672	32
8	*Staphylococcus aureus*	241,188	1,063	6
9	*Toxoplasma gondii*	173,415	8,859	654
10	*STEC* non-O157	138,063	331	0

Source: Scalan et al. 2011

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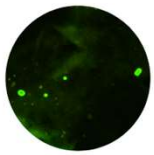
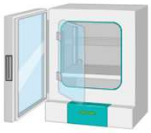
Quantifying Pathogens

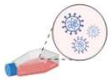
Work begins October 2022

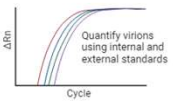
October 2022-December 2023... "fresh" samples

2020-2022 samples...."archived" samples



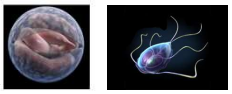






Microscopy

Cryptosporidium & *Giardia*



Units

Oocyst or Cyst

oocysts/L cysts/L

Culture

Adenovirus & Enterovirus

Most Probable Number

MPN/L

Molecular

Adenovirus, Enterovirus & Norovirus GI and GII

Genome Copy

gc/L

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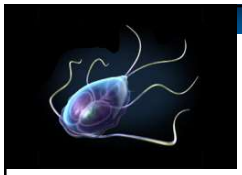
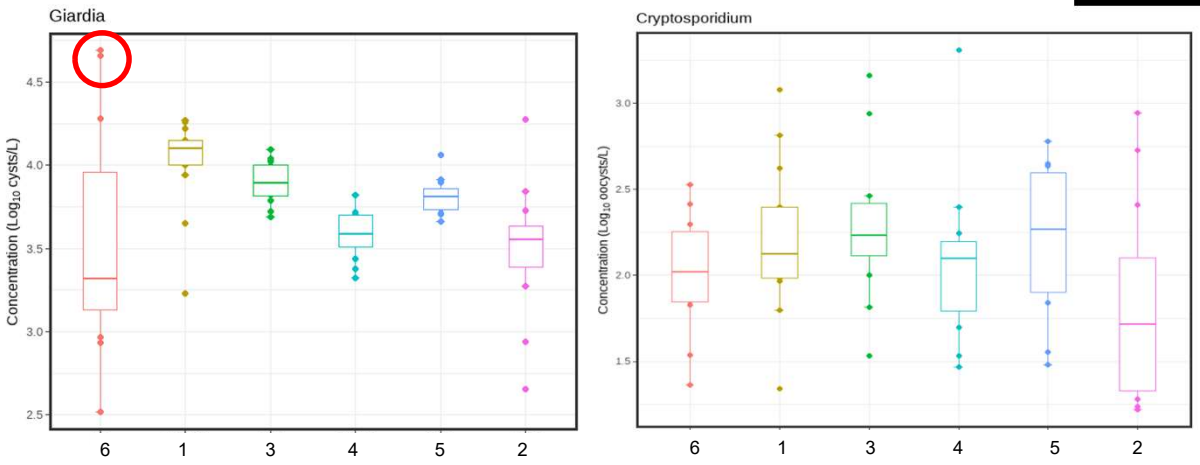


Pathogen Concentrations



High variation due to "grab" sampling

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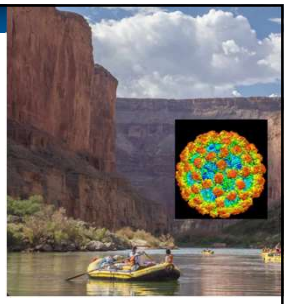
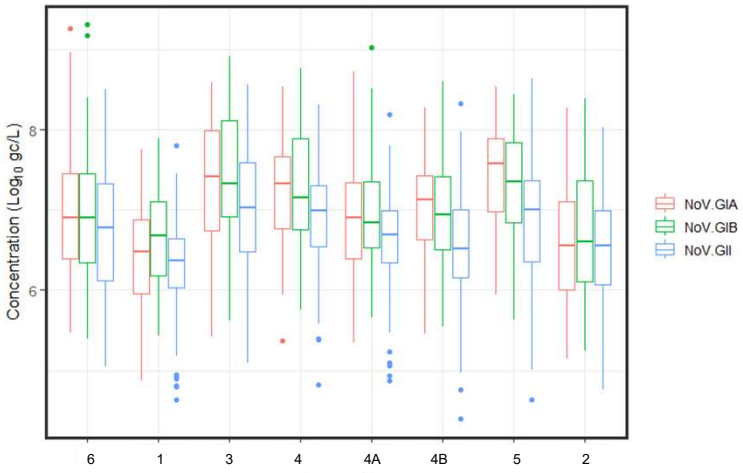
Pathogen Concentrations



Norovirus



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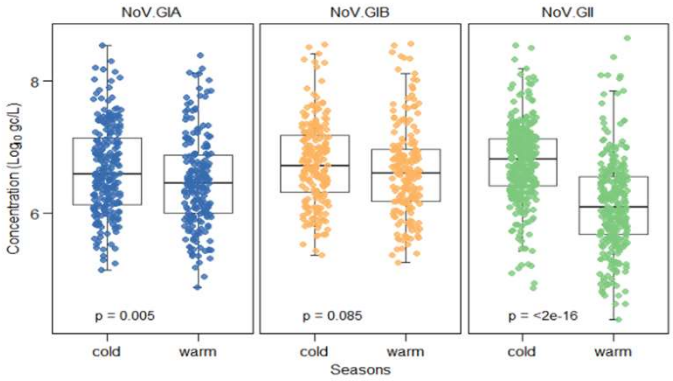
Seasonality

- "Warm" = summer and fall, "Cold" = spring and winter



Norovirus is more prevalent in the cold seasons….staying true to the "winter vomiting bug" moniker

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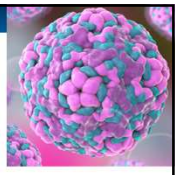
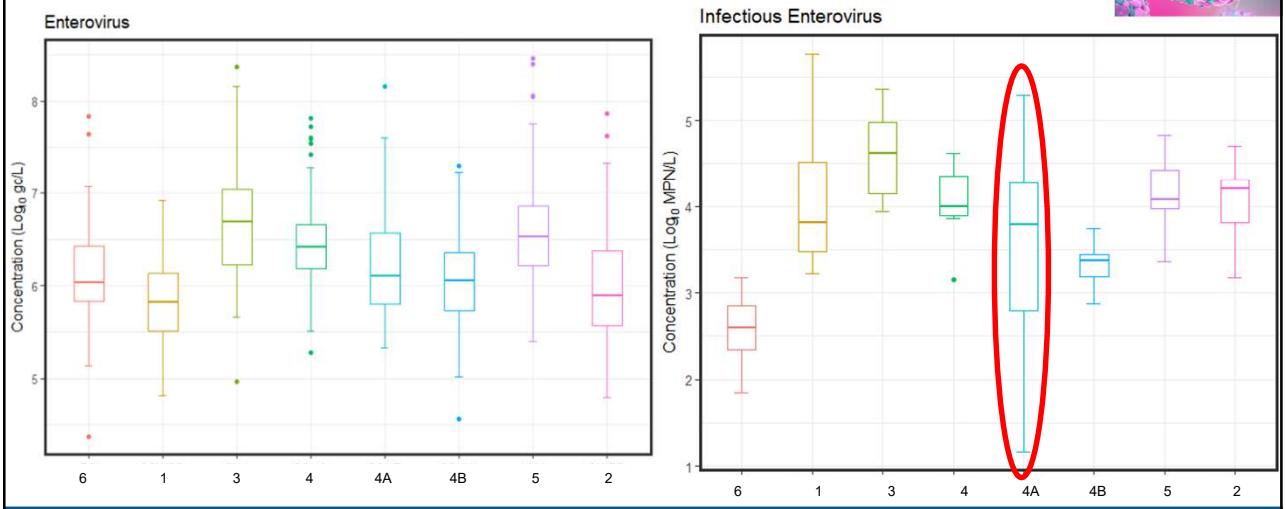
Pathogen Concentrations





Another example of a wide range due to "grab" sampling

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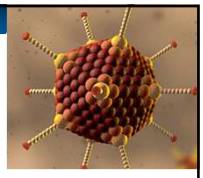
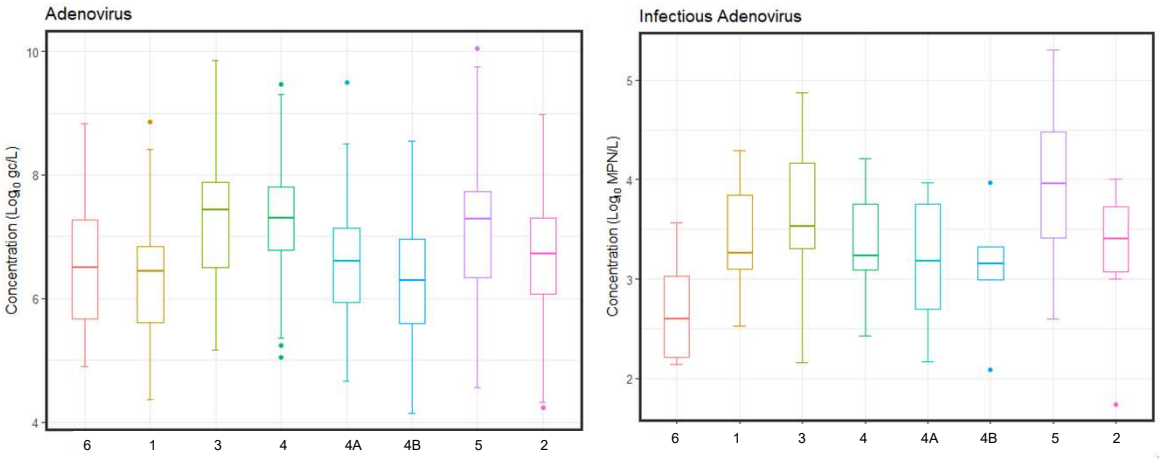
Pathogen Concentrations





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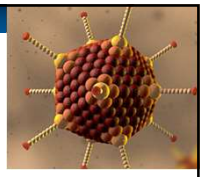
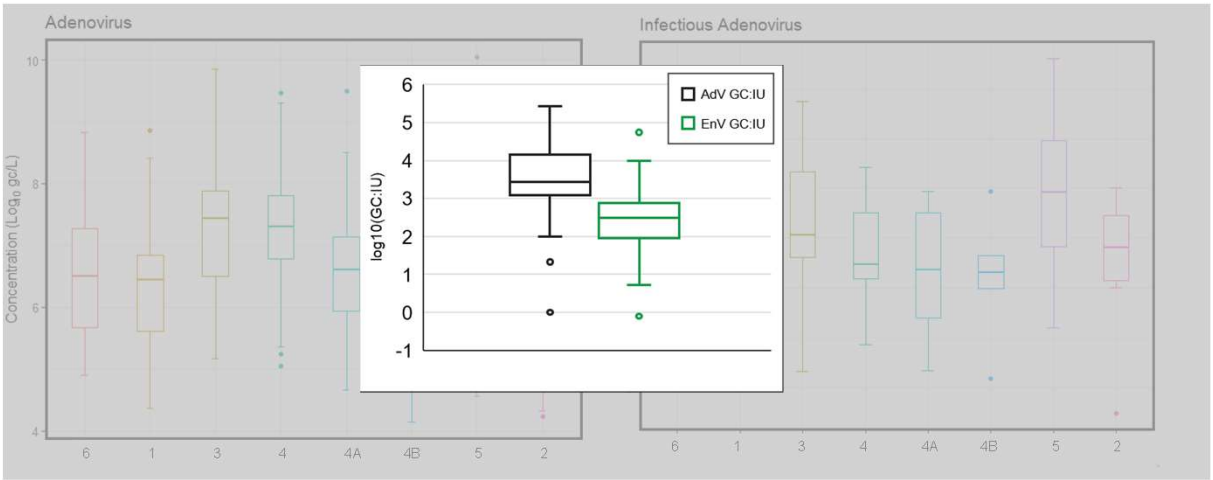
Pathogen Concentrations





Quantifying the relationship between "infectious units" and "genome copies" is critical for risk assessment

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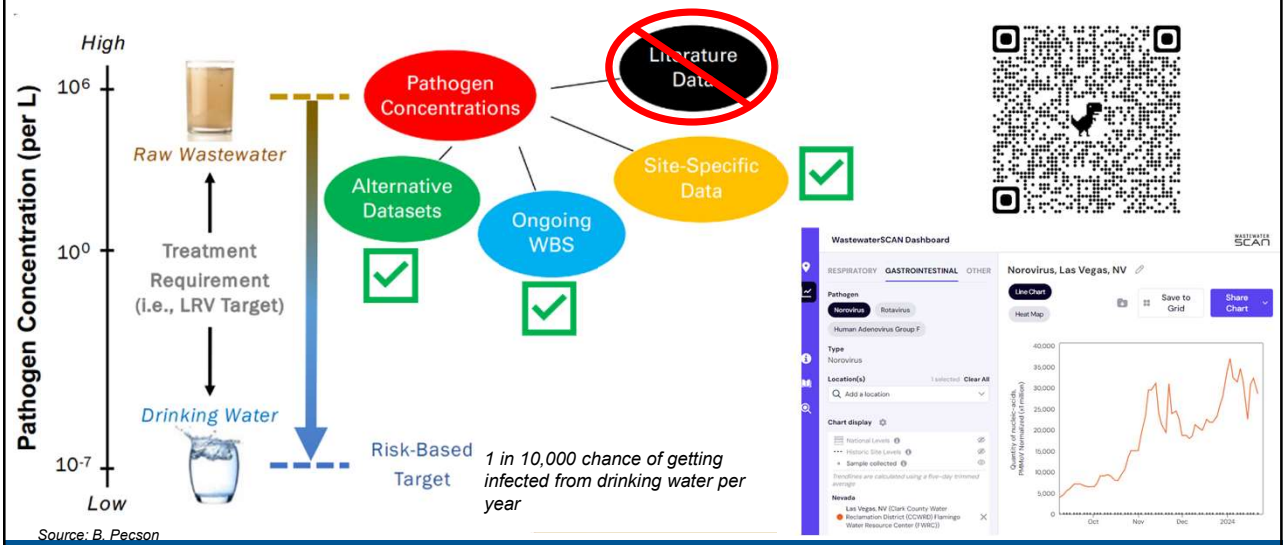
Quantitative Microbial Risk Assessment (QMRA)



Source: B. Pecson

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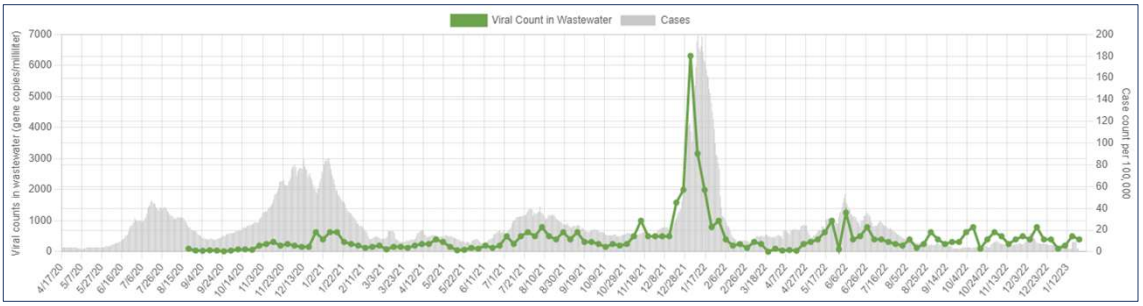
Can we see similar relationships between enteric pathogen clinical data and wastewater data as SARS-CoV-2?



- Enteric pathogen infections are not usually notifiable or reported
- Data availability is sparse
- Need additional way of getting case data at a local or regional basis

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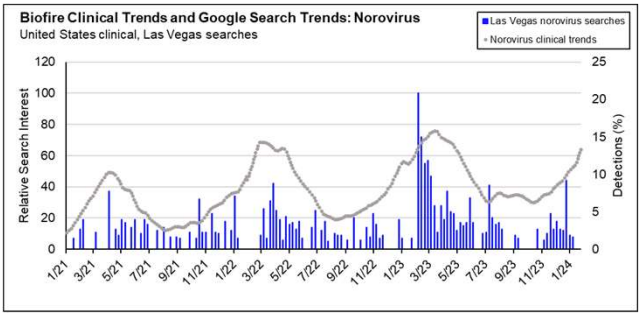
Alternative indicators of community health

Google

SNHD Southern Nevada Health District

BIOMÉRIEUX BIOFIRE® Syndromic Trends



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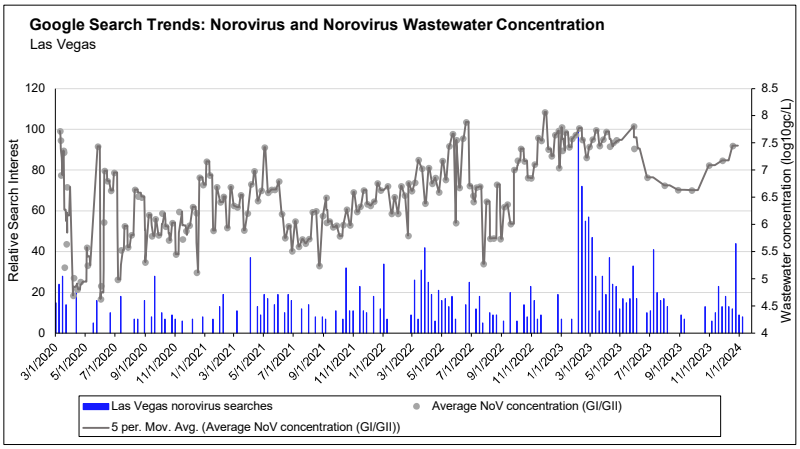
Alternative indicators of community health



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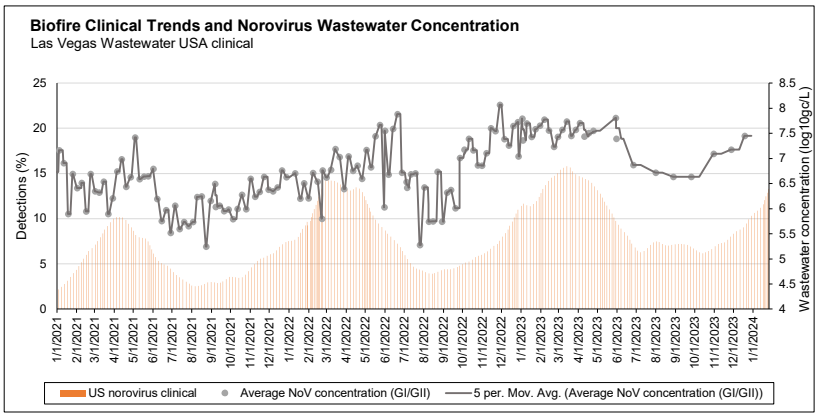
Alternative indicators of community health



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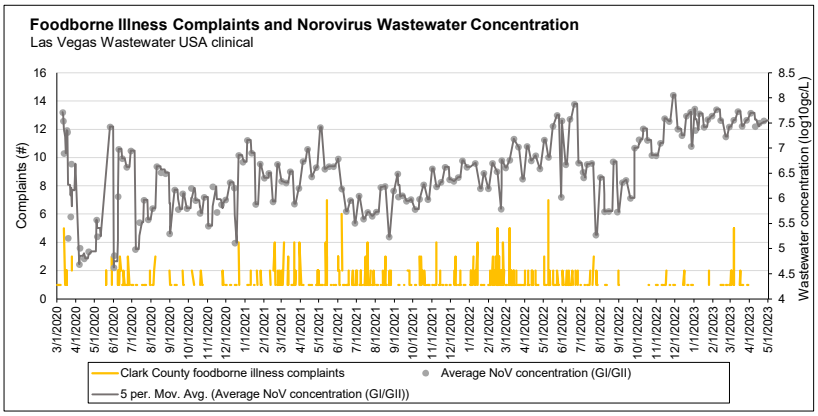
Alternative indicators of community health



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Conclusions

- Pathogen dataset from Southern Nevada sewersheds
  - Spans over 3 years
  - Over 1k samples collected
  - Both pandemic and “post”-pandemic conditions represented
  - Well-characterized peak events
- Useful for forward applications: Water reuse risk assessment
- Useful for backwards applications: Community health trends
- Wastewater surveillance continues through CDC NWSS!
- Next steps: characterizing risk!

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Thank you

- UNLV
- Public Health Partners:
  - Southern Nevada Health District
  - Nevada State Public Health Laboratory
  - Nevada Dept. of Health and Human Services
  - Utah Public Health Laboratory
- **Wastewater Facility Partners!**

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Questions?

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