Associations of Water Quality and Flow with SARS-CoV-2 RNA Levels in Wastewater

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Abstract

Measurements of water quality and flow within the sanitary sewer infrastructure are rare upstream from wastewater treatment plants. However, these locations can provide information specific to buildings and communities. With data gained from wastewater surveillance efforts to track COVID-19, this study aimed to evaluate relationships between water quality and the virus that causes COVID-19, severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). SARS-CoV-2 levels and water quality metrics (pH, specific conductivity, temperature, dissolved oxygen, and turbidity) were collected at hourly and weekly time scales as well as at different population scales. Flow and water quality were also collected on the time scale of minutes.

Results show inconsistent correlations between SARS-CoV-2 levels and water quality or flow. Wastewater flow and water quality monitoring revealed rapidly changing parameters at times scales less than the 5-minute monitoring time intervals. As a result, flow rates and water quality were not significantly and consistently correlated with SARS-CoV-2 RNA levels. Despite the large number of samples (n>85 at multiple sites), the highly variable characteristics make water quality and flow poor predictive tools for the SARS-CoV-2 levels in wastewater. Regardless of the lack of correlation with SARS-CoV-2, this study provided rare data on wastewater quality in areas upstream of wastewater plants.

We recommend continued research focused on developing improved methods for sampling the sanitary infrastructure given the variability in water quality and the utility of wastewater in providing information that can promote resiliency during pandemics.

Background

With the cooperation of the University of Miami, wastewater surveillance was approved at both the building and cluster scale. The primary focus was monitoring the SARS-CoV-2 RNA levels on campus as tool for decision making during the COVID-19 pandemic. The University's facilities team assisted researchers in accessing the sewer system and with installing instruments to aid with continuous measurements. This aid allowed for sampling to occur in places that were not easily accessible and upstream from the WWTP on campus. Samples were analyzed for the RNA of SARS-CoV-2 and other biological targets as controls. For the community scale, samples were collected at a major WWTP (Central District) serving a population of 830,000 within Miami-Dade County.

Figure 1. A map of the different sampling sites used in the statistical analysis.

Figure 2. The layout of the Gables campus sewer lines that were sampled.

Results

Table 1. Values of Spearman correlations, for samples collected weekly from September 2020 until July 2022, between SARS-CoV-2 RNA levels in wastewater and water quality parameters

	Individual Building Residential Dorms												Hospital		Clusters					Community		All Sites
	A	E	Hm	Hp	Kc	Kg	L	N	P	R	W	V	6	8	1	2g	2c	3	S	Dc	Dg	
(Number)	54	45	85	85	52	52	96	79	96	85	84	85	65	61	91	86	62	71	38	77	72	2049
pH Lab							0.43		0.67												0.37	-0.11
pH Field									0.52												0.37	
Water Temperature	-0.51								-0.37					0.70							0.62	-0.14
Specific Conductivity							-0.37		-0.47							-0.70						0.08
Turbidity	0.65						0.37		-0.37						0.35		-0.60				-0.43	0.21
Dissolved Oxygen									0.35													-0.22

Table 2. Spearman correlations for samples collected hourly at building, cluster, and community scales.

Sites	Building	Cluster	Community
pH lab			
pH Field			
SPC	-0.55		
Turbidity			
Dissolved Oxygen			
Air Temp	0.47		
Humidity			
Flow Averaged			

Figure 3. pH, specific conductivity, dissolved oxygen, and turbidity collected from hourly grab samples from sewersheds corresponding to the building, cluster, and community scale. Note data for temperature is not shown as samples were returned to the laboratory on ice thereby impacting the temperature readings.

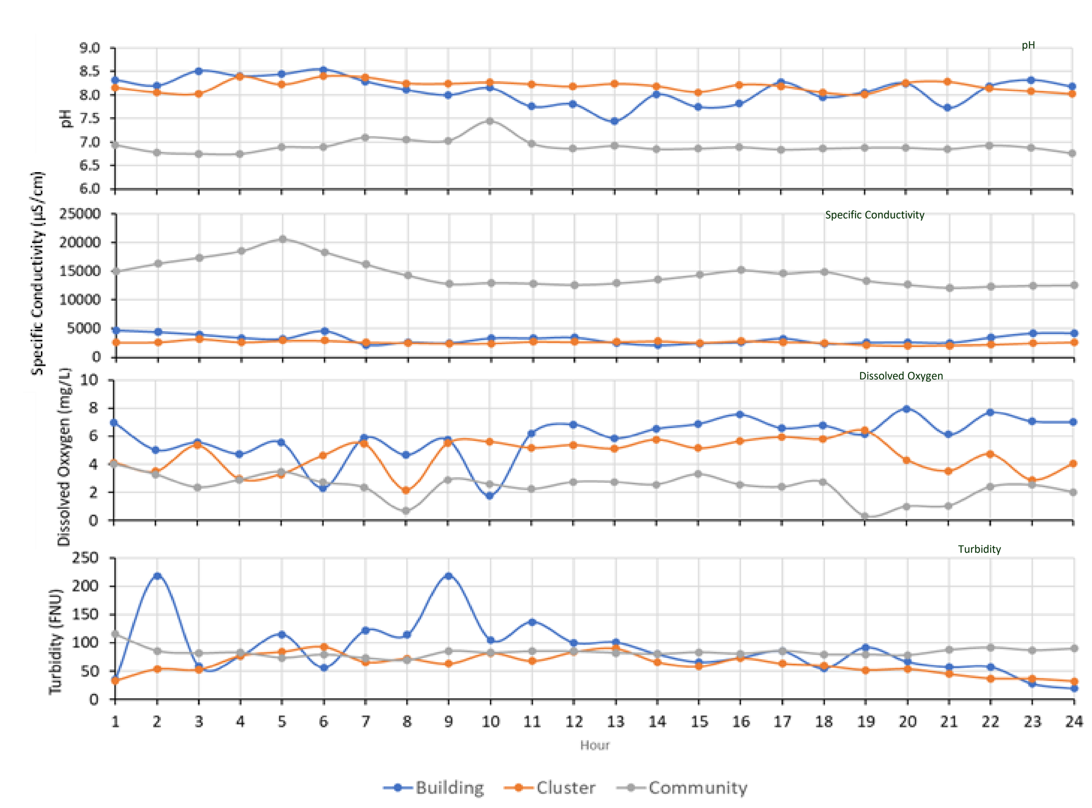
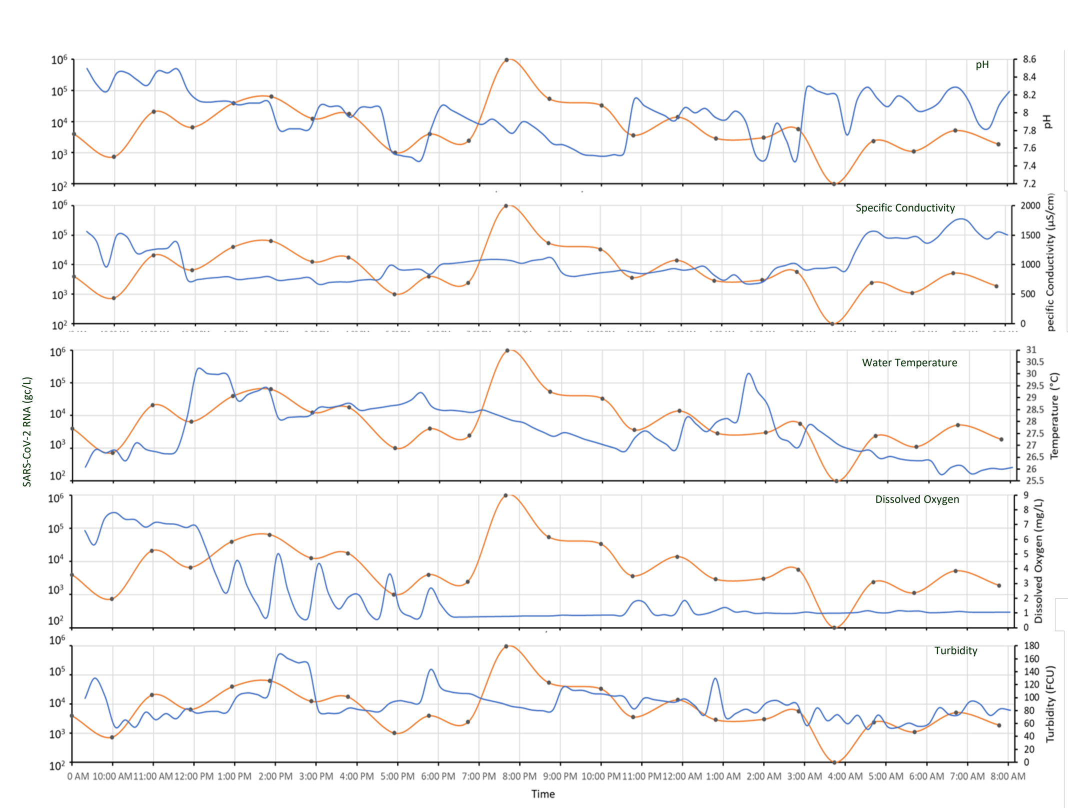


Figure 4. SARS-CoV-2 RNA (gc/L) versus pH, specific conductivity, water temperature, and turbidity for continuous measurements of wastewater at the building scale. Time interval of water quality measurements of 15 minutes.



Results

Figure 5. SARS-CoV-2 RNA (gc/L) versus pH, specific conductivity, water temperature, and turbidity for continuous measurements of wastewater at the cluster scale. Time interval for water quality measurements of 5 minutes.

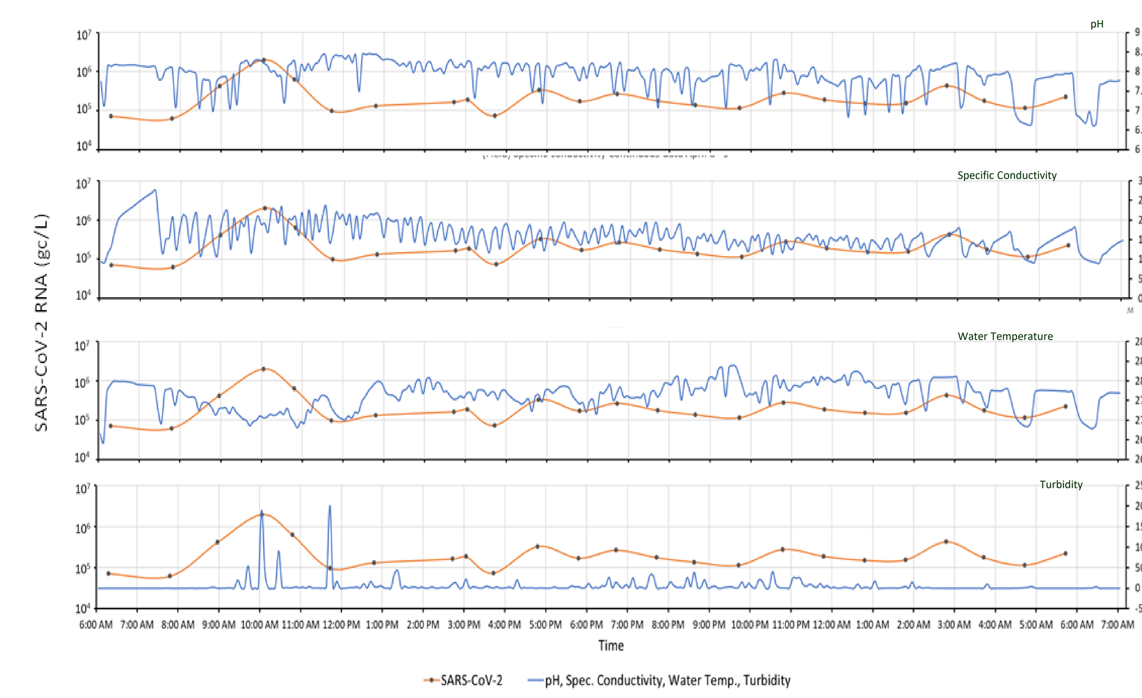
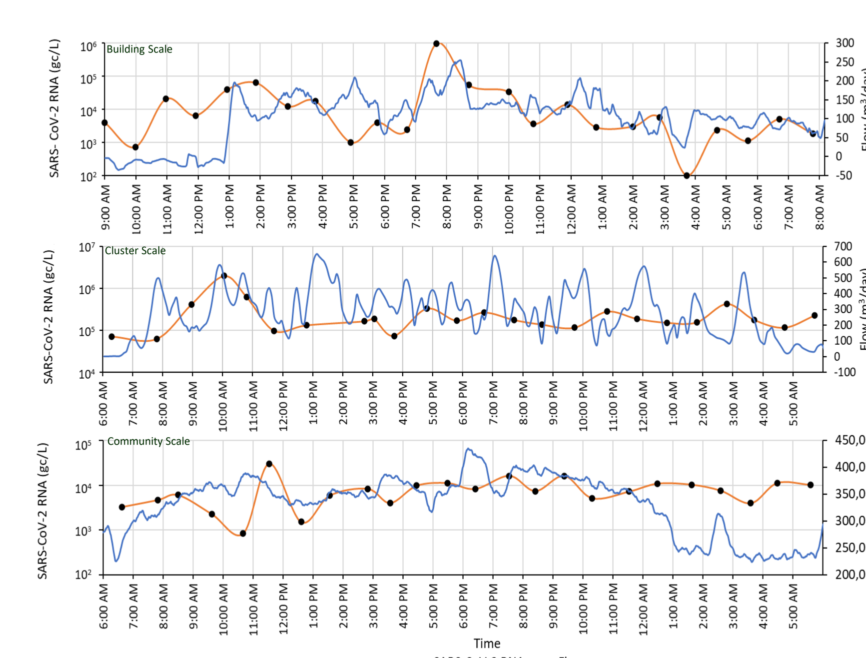


Figure 6. Flow at continuous (few minutes) time scales versus SARS-CoV-2 levels in wastewater collected at building, cluster, and community scales.



Conclusions

- Results showed inconsistent relationships between water quality and SARS-CoV-2 levels.
- The lack of correlation is due to the highly fluctuating sources of water in the upstream areas of the sewershed resulting in short-term variations which could not be captured by the measurements of SARS-CoV-2.
- The results of this study can be used to provide a baseline for wastewater surveillance in upstream locations.

Future Directions

- Future designs of the wastewater sewage collection network should consider its second function as a portal for collecting samples that provide critical information about population health.
- Developing and prioritizing these systems now will provide the framework for responsiveness and resilience in the future.

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