Electronic Supplementary Material (ESI) for Environmental Science: Processes & Impacts.

Electronic Supplementary Information for: Estimating probability of illness due to swimming in recreational water with a mixture of human- and gull-associated microbial source tracking markers

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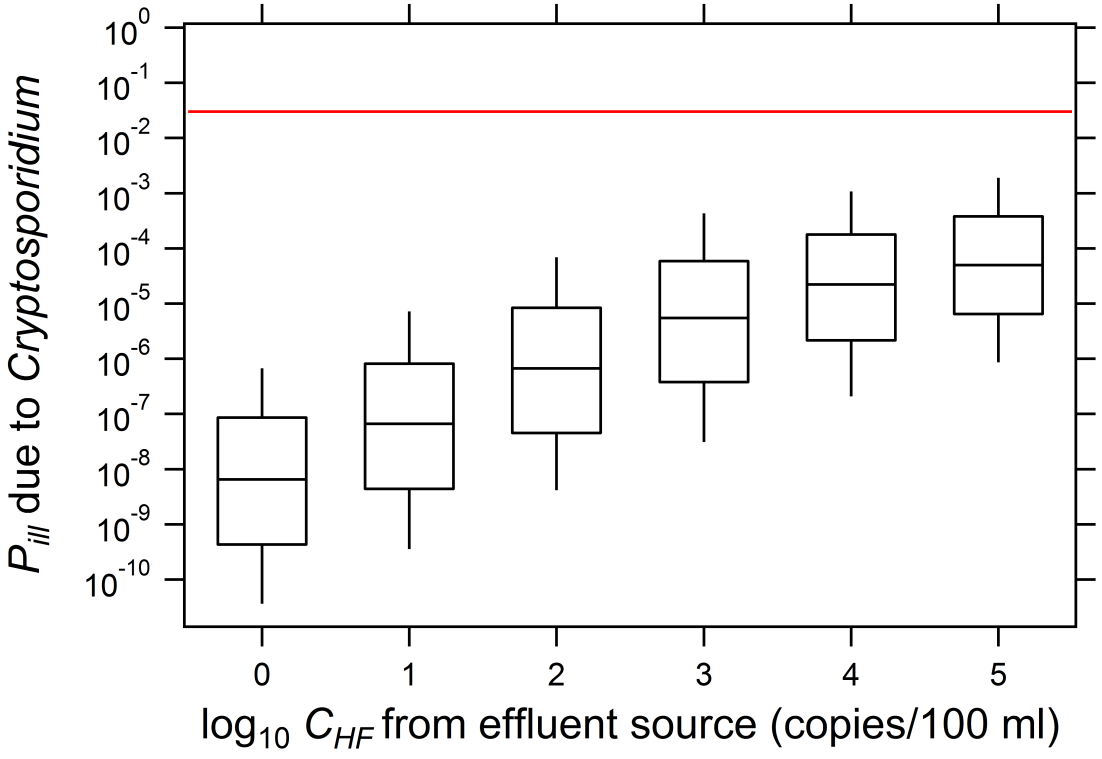

Figure S1: Box and whisker plots of $P_{ill}^{effluent}$ due to *Cryptosporidium* versus $\log_{10} C_{HF}$ from disinfected effluent. See Figure 2 for description. See main text for abbreviation descriptions.

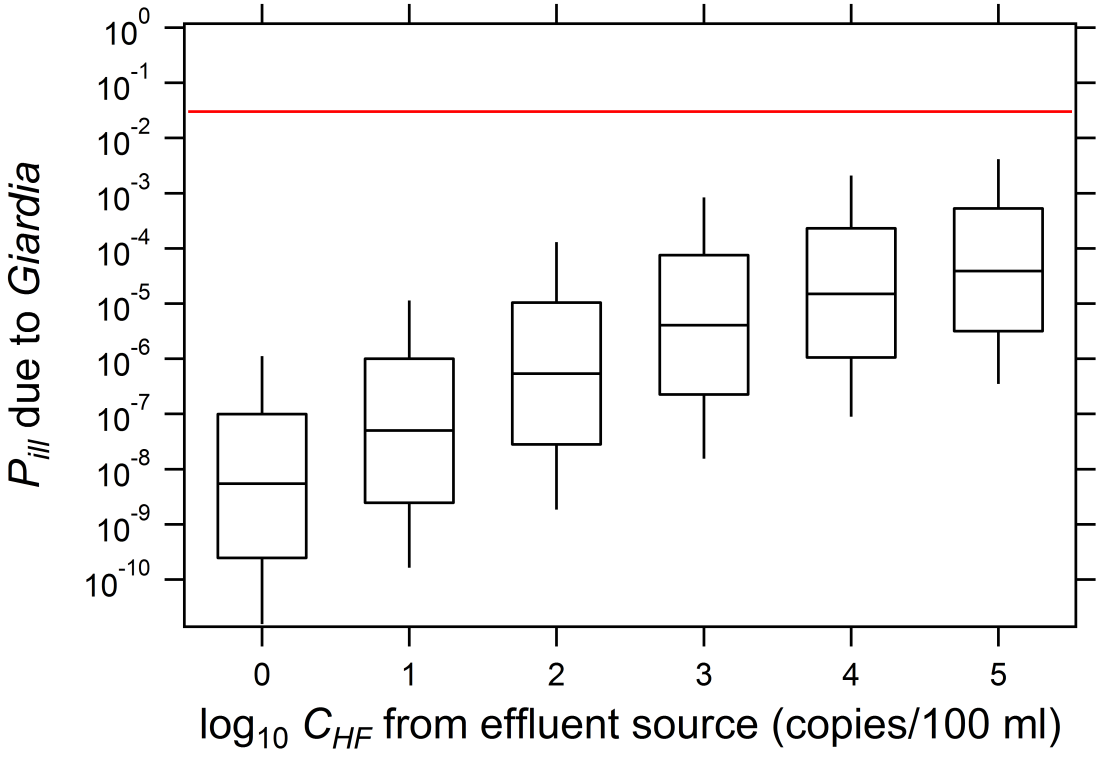

Figure S2: Box and whisker plots of $P_{ill}^{effluent}$ due to *Giardia* versus $\log_{10} C_{HF}$ from disinfected effluent. See Figure 2 for description. See main text for abbreviation descriptions.

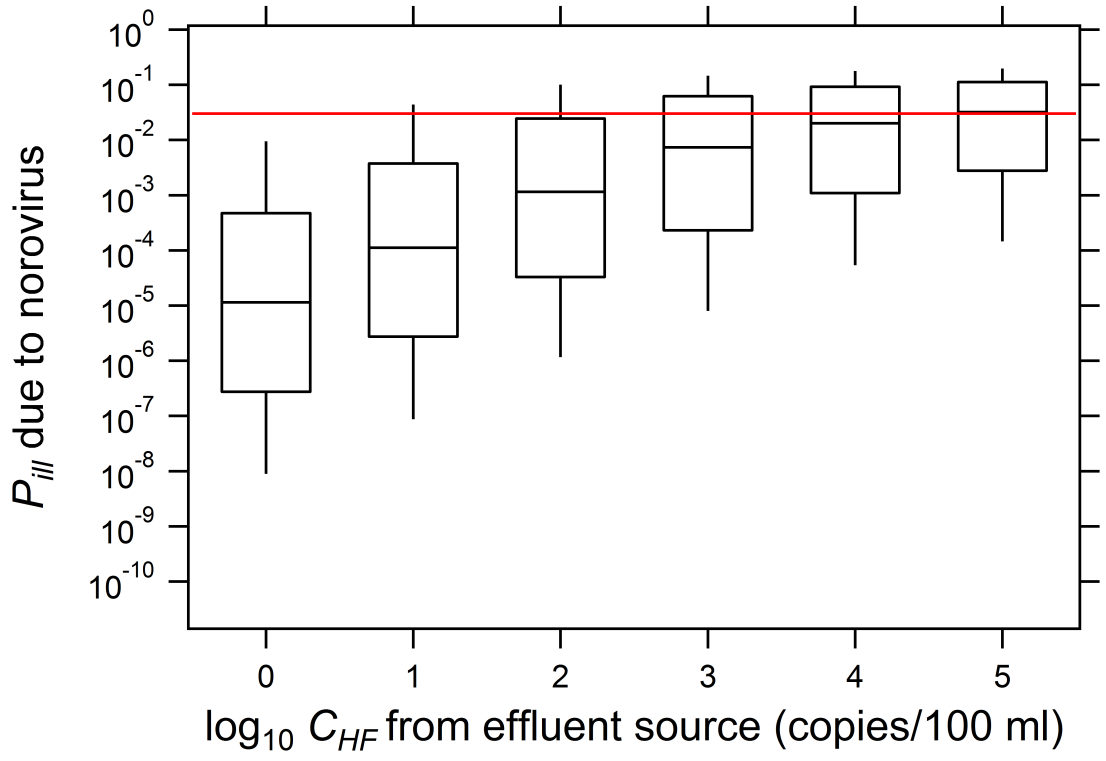

Figure S3: Box and whisker plots of $P_{ill}^{effluent}$ due to norovirus versus $\log_{10} C_{HF}$ from disinfected effluent. See Figure 2 for description. See main text for abbreviation descriptions.

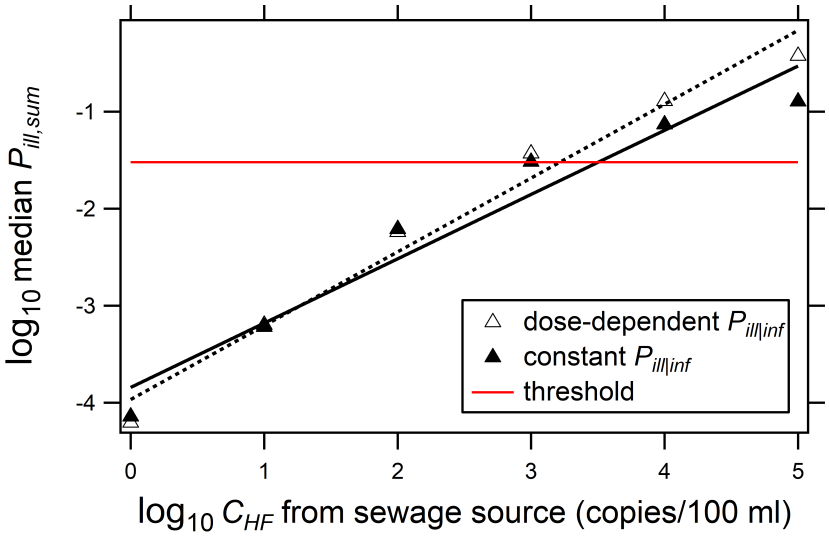

Figure S4: Median $P_{ill,sum}^{sewage}$ at different concentrations of the HF183 human marker (C_{HF}^{sewage}) in recreational water. $P_{ill,sum}$ is predicted from dose-dependent versus constant $P_{ill|inf,rp}$ for *Salmonella* and *Campylobacter*. Each $P_{ill|inf,rp}$ is paired with a specific $P_{inf,rp}$; constant $P_{ill|inf,rp}$ with a beta-Poisson $P_{inf,rp}$, and dose-dependent $P_{ill|inf,rp}$ with a beta-binomial $P_{inf,rp}$ (Table 2). The red line indicates the threshold of 3 cases of illnesses/100 swimmers.

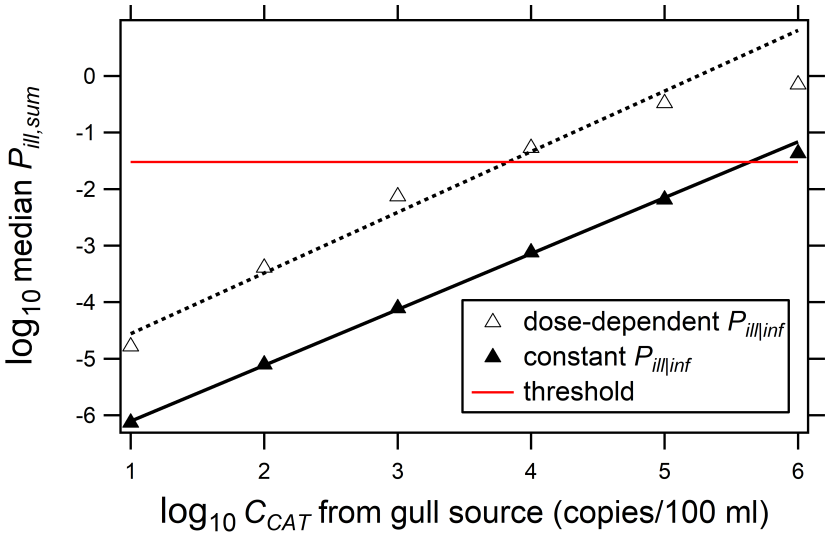

Figure S5: Median $P_{ill,sum}^{gull}$ at different concentrations of the CAT gull marker (C_{CAT}) in recreational water. $P_{ill,sum}$ is predicted from dose-dependent versus constant $P_{ill|inf,rp}$ for *Salmonella* and *Campylobacter*. Each $P_{ill|inf,rp}$ is paired with a specific $P_{inf,rp}$; constant $P_{ill|inf,rp}$ with a beta-Poisson $P_{inf,rp}$, and dose-dependent $P_{ill|inf,rp}$ with a beta-binomial $P_{inf,rp}$ (Table 2). The red line indicates the threshold of 3 cases of illnesses/100 swimmers.

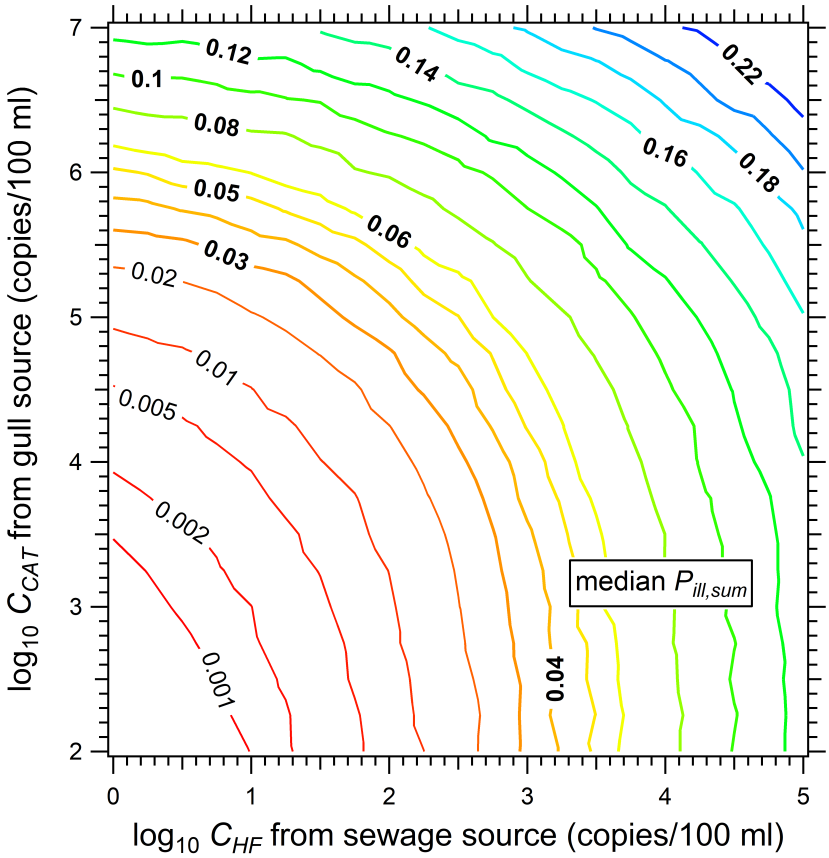

Figure S6: Median $P_{ill,sum}$ at different mixed concentrations of the HF183 human marker (C_{HF}^{sewage}) and the gull marker (C_{CAT}) in recreational water. Data in this plot were generated with a QMRA using the beta-Poisson dose response curves ($P_{inf,rp}$) and constant $P_{ill|inf}$ given in Table 2.

Table S1: Primer and probe sequences used to target segments of human *Bacteroides*16S rRNA by the HF183 qPCR assay.

Primer/ Probe	Sequence (5' to 3')	Reference
HF183	ATCATGAGTTCACATGTCCG	Bernhard and Field [1]
BacR287	CTTCCTCTCAGAACCCCTATCC	Green et al. [2]
BacP234 MGB	[6FAM]-CTAATGGAACGCATCCC-[MGB]	Green et al. [2]

Table S2: HF183 assay standard curve parameters. Assay performance was judged based on efficiency, with efficiency between 0.90 and 1.10 considered acceptable.

Slope	Intercept	R^2	Efficiency
-3.5	37.9	0.99	0.94

Table S3: Sensitivity analysis of input variables for the effluent scenario. F_{HF}: concentration of HF in effluent [copies/ml]; L_{noro}: removal of norovirus during wastewater treatment; V: volume of seawater ingested [ml]; R_{noro}: concentration of norovirus in sewage [genomes/L]; $R_{Giardia}$: concentration of *Giardia* in wastewater effluent [CFU/L]; R_{Crypto}: concentration of *Cryptosporidium* in wastewater effluent [CFU/L]; $P_{ill|inf,noro}$: probability of illness given infection with norovirus; $P_{ill|inf,Crypto}$: probability of illness given infection with *Cryptosporidium*; $P_{ill|inf,Giardia}$: probability of illness given infection with *Giardia*.

	Input Value			$\lvert p75 : p25 \rvert$					
Variable	p25	p50	p75	10^0	10^1	10^2	10^3	10^4	10^5
				(copies HF/100 ml ambient seawater)					
R_{noro}	4.9×10^3	5.0×10^4	5.1×10^5	104	102	89.5	40.2	7.21	1.84
F_{HF}	1.3×10^2	1.1×10^3	1.2×10^4	95.4	94.2	83.9	40.4	7.6	2.0
L_{noro}	9.4×10^1	7.1×10^2	5.3×10^3	55.9	55.3	4.57	25.9	5.39	1.62
$P_{ill\|inf,noro}$	0.425	0.55	0.675	1.59	1.59	1.59	1.59	1.59	1.58
V	13.1	14.0	15.0	1.15	1.15	1.15	1.13	1.06	1.01
$R_{Giardia}$	0.531	5.62	59.6	1.0	1.0	1.0	1.0	1.01	1.05
R_{Crypto}	0.266	1.41	7.50	1.0	1.0	1.0	1.0	1.0	1.03
$P_{ill\|inf,Crypto}$	0.325	0.45	0.575	1.0	1.0	1.0	1.0	1.0	1.0
$P_{ill\|inf,Giardia}$	0.325	0.45	0.575	1.0	1.0	1.0	1.0	1.0	1.0

References

[1] Bernhard, A. E.; Field, K. G. A PCR assay to discriminate human and ruminant feces on the basis of host differences in Bacteroides-Prevotella genes encoding 16S rRNA. *Applied and Environmental Microbiology* **2000**, *66*, 4571–4574.

[2] Green, H. C.; Haugland, R. A.; Varma, M.; Millen, H. T.; Borchardt, M. A.; Field, K. G.; Walters, W. A.; Knight, R.; Sivaganesan, M.; Kelty, C. A.; Shanks, O. C. Improved HF183 quantitative real-time PCR assay for characterization of human fecal pollution in ambient surface water samples. *Applied and Environmental Microbiology* **2014**, *80*, 3086–3094.