[Effect of hydraulic retention time on microbial community structure in wastewater treatment electro‐bioreactors - ElNaker - 2018 - MicrobiologyOpen - Wiley Online Library (oclc.org)](https://onlinelibrary-wiley-com.uml.idm.oclc.org/doi/full/10.1002/mbo3.590)

Hydraulic retention time (HRT) – pay attention to 10 & 16-h timepoints.

* Bacterial counts in bioreactors increased as the hydraulic retention time was increased from 6 to 50 hours.

[The effect of hydraulic retention time on the stability of aerobically grown microbial granules - Pan - 2004 - Letters in Applied Microbiology - Wiley Online Library](https://sfamjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1472-765X.2003.01479.x)

Conclusion:

* “HRTs between 2 and 12h provided the hydraulic selection pressures favourable for the formation and maintenance of stable aerobic granules with good settleability and activity.”

Viral removal rates:

* 95.5% (conventional activated sludge) & 99.3% (aerobic granular sludge): [Removal of bacterial and viral indicator organisms in full-scale aerobic granular sludge and conventional activated sludge systems - ScienceDirect (oclc.org)](https://www-sciencedirect-com.uml.idm.oclc.org/science/article/pii/S2589914719300763#fig4)
* 98%: [Elimination of human enteric viruses during conventional waste water treatment by activated sludge (cdnsciencepub.com)](https://cdnsciencepub.com/doi/abs/10.1139/m86-170)
* 99.97%: [Assessment of virus removal by a multi-stage activated sludge process - ScienceDirect (oclc.org)](https://www-sciencedirect-com.uml.idm.oclc.org/science/article/pii/0043135476900592)

[A Critical Review on Ultraviolet Disinfection Systems against COVID-19 Outbreak: Applicability, Validation, and Safety Considerations (nih.gov)](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7571309/)

* “Disinfection using UV radiation has been a fast-growing chemical-free technology over the past decades. UV radiation is highly efficient at controlling microbial growth in any medium, such as water and air, as well as on any type of surface.”

Wastewater pH & turbidity:

* Insignificant positive correlation: [ijerdv4n2spl\_02-with-cover-page-v2.pdf (d1wqtxts1xzle7.cloudfront.net)](https://d1wqtxts1xzle7.cloudfront.net/38999982/ijerdv4n2spl_02-with-cover-page-v2.pdf?Expires=1626130684&Signature=Pxfx7VcuqCY1ga24NiKNi4me~YgAFXGQ1w3c6VFovecY~W4-B6fkGMLlcO3j-s2t3L~iasj5EsrQRzfbDGqbj2NKLGrHxIw7R4BRKlREh7dIyIRB-7AMoMgY7Uw20rwd6Jd0Ks7xuZV8e3VKmNN8YWS1-2wv-mt3y32B-u3M1ce1lR1cdsn4Am1QHE6qxfi1JQa6cvhfI6WfeIW8jOH~ldkZRMmih0v89ViNUVmtEZwPTBrzyZ3Lrovct3AG8KWnElpBfdJXnJszbEhGbkAisrkJg-m8VCMfqEL68IqnEUJmAgEXOHttG3weVyuwzDwrlEXuy9w5FuAv-RpIcWMAeQ__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA)

[doi:10.1016/S1001-0742(07)60010-2 (sciencedirectassets.com)](https://pdf.sciencedirectassets.com/273588/1-s2.0-S1001074207X60017/1-s2.0-S1001074207600102/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjECYaCXVzLWVhc3QtMSJGMEQCIAbYOneI1PTwjNlmiX1mH8JDk%2F1IOiCDLpvK2gpK4HXFAiB5EuXaRC1G4oVuILcaxSJ9oghjTt4cmP0lxJ50sXZLhSr6AwgfEAQaDDA1OTAwMzU0Njg2NSIMYG4zc7ijxRD%2FsXQFKtcDXM1daxa3%2FWbt3oifbl2vaLgBXtowwBJON2HSnHQ868aPHf56Eot1Q1Gv1eArtwO86KmTsQjFrH9IfBfGLlaPIoK4Lb9P3%2Fm2n60AomnNdmpm6dy7SkwW2dmD3kGvh5oMtp425fy60uVtJHQYkGR2An1FXPOVG7Jd8pCM8SrRwztVy3ev2ruN%2B6ZDdAfScagaXy7NggoYpuLOAFT0HDJTRFwsEvE7FlOpytNqoP4PPPVcDyKK5VIiiUl5AOwo8j1oxwqot1wVByBKYKpdWve6ZP0n%2F3f7Ao5cLdi9t3H8zQGT3DDo85s3grcJmBCOPeLroBGl2QplhX%2Bf3%2FkxJ7GB2CAN%2B8plniIGccznxQHvQ6T9%2BTS6lPF0TuOlvUzYbrl%2BSWIzplOaOzy3a2fqVlKzKTt3%2FhI1mf68fxa7gwurajsoy7HGmAIOAz%2FcR%2FIMguURu2Xj5yyLH2NiHmDIRpSQVDa32gWw3oz6k111vkLGgq8%2FI27LjipKCfW6XYR2v2m6waL4IJIchAIW4jm9nCLJ6OsD5hD5xGPRsJASK1LL09QqSuTE3wMEC9JOsYOppxnooyhszV3FR%2BsVJqAFvalap2nAtJg%2BCqZ6cwFBPGZEG0ifNsP16qUtMJSvvYcGOqYBYymbSbV6s4UytgO0SQ88Y2ovmlDgNP14LNBJNStIDlknds0JKa6ww2TFwuDw4qtKgadi5jf49kmFiipVMUMa3I3FpItYH0F9v8mSG55YWbY9ZUrCeeSXOJqWow3p%2B5xRHA%2F64kpYH178J0e4dzj65fcRgkXCgFQ%2BShGZ0KvABFc9GRh8GCWB%2Fc2PZPUxjFfrtwuk4lqboa43fKOIzLxX1hOnrlUkZg%3D%3D&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20210714T222726Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTYWATPN7U5%2F20210714%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=1ed397c6b2445079773c1ed134c4cd844bafb5944bf7db1e7e8296fa77853333&hash=63079d7b529bc9fe9d76be66ff597562b98453e199fa46954b9ae320c331e425&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S1001074207600102&tid=spdf-6edaee8e-76bb-4ca1-8d2c-84de1d55b668&sid=cb8051b153cae0464e3bd2c1478e3d25442dgxrqa&type=client)

* The study found similar bacterial community structures of RS & AS. They had different EF populations, but it was postulated to be due to a difference in plant design.

[Human enteric viruses in a wastewater treatment plant: evaluation of activated sludge combined with UV disinfection process reveals different removal performances for viruses with different features - Lizasoain - 2018 - Letters in Applied Microbiology - Wiley Online Library](https://sfamjournals.onlinelibrary.wiley.com/doi/10.1111/lam.12839)

* Influent (A) -> Post AS (B) -> Post UV (C):
  + HAstV: A > C: p = 0.0128.
  + GII: A > B: p = 0.0010.
  + GII: A > C: p = 0.0002.
  + RVA (Group A Rotavirus): A > C, p = 0.0442.
  + HAdV: A > B, p = 0.0013; A > C, p = 0.0201.
* “since our quantitative PCR detects both infective and defective viral particles, and considering the UV light effect upon viral viability, the concentration values at the final effluent are not at all indicative of infectious viral particles and the results should be taken with caution, avoiding overestimation of the amount of infective particles in the sample.”

[Characteristics\_and\_performance\_of\_aerob20160421-15571-ggj9hs.pdf (d1wqtxts1xzle7.cloudfront.net)](https://d1wqtxts1xzle7.cloudfront.net/44968364/Characteristics_and_performance_of_aerob20160421-15571-ggj9hs.pdf?1461277367=&response-content-disposition=inline%3B+filename%3DCharacteristics_and_performance_of_aerob.pdf&Expires=1626466980&Signature=M-HcAnkkV~GTvF-J~Dvl6kjzUdPoZRKnx7TcMNTP7KWJmtihaH2NSD2SqiYmypmOA8ezgXn4a-B-BJYnFF91GSNOhTJoRaoc9Vmkt-kbiBvkZQAPJBXscF7mk6eHa50obYfzoUjK95mcVmEGC1j54BuiswU43hTkszwEB24r-GKLAZLA4oX~e0WglFISKemTzFw8--V7AgBMoM0vqOX9PveYYAWvCr6UAmHSG6ESMHGi34QEt1jB2fvNwpm153O9roUtSH9HZuFoTl6pMwY-kNgkozF4eviPAY7phz~rO81oFFufynVvO~qxoISEwJogrw1hoGG859Uz4O~GfrPZWw__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA)

* Growth rate increased from 24h-12h-6h.

[00\_pi-xxvi.indd](http://213.230.96.51:8090/files/ebooks/Biologiya/Cook%20N.%20(ed.)%20Viruses%20in%20food%20and%20water%20(Woodhead,%202013)(ISBN%209780857094308)(540s)%20B%20.pdf#page=314)

* Other potential factors impacting on virus occurrence in raw sewage are population size, structure, and geographical location (Hewitt et al., 2011).

[Influence of wastewater treatment process and the population size on human virus profiles in wastewater - ScienceDirect (oclc.org)](https://www-sciencedirect-com.uml.idm.oclc.org/science/article/pii/S0043135411005598)

* Population size may affect virus prevalence.

[Calicivirus Removal in a Membrane Bioreactor Wastewater Treatment Plant (nih.gov)](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3147444/)

* France: Sapovirus readily detected in influent samples but didn’t show clear variations over the 9-month (October-June) duration of the study.

[Takayuki\_Miura\_Enterovirus\_norovirus\_2015.pdf (sciencedirectassets.com)](https://pdf.sciencedirectassets.com/271768/1-s2.0-S0043135415X00054/1-s2.0-S0043135415001190/Takayuki_Miura_Enterovirus_norovirus_2015.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEFMaCXVzLWVhc3QtMSJGMEQCIDqOeMjn13X8LNmJVXYxAcYDdd%2FH2SyNXGl4JHUUaP6xAiBnRqjGf%2B%2FX%2BZPTwZaMJs8P0wqXRrqPn4ks2F1HTV83zyr6AwhMEAQaDDA1OTAwMzU0Njg2NSIMCr1SM1mQTOun5%2FaoKtcDDa8iVJ%2BMwnnlK6Ru8RCWBQyJI6hs%2F7Tqo11BckL7rGBOIJo4NPkw5PuSjiPSNTiqzCdmDIVIjlFXHQUgs20NhXpM7tTye22rQ9CFxgvHSRmyLRKL2xJbvBAO41au8d4xsqsToBSbkbfLhSY0OnFKj6yX11UTR4i%2F5FWRCQuKw1whUbyq%2BLctbTA1euJkMn0BC7rjdS1tVEGu2i8LAiOa2SqEeUkZbJPyy%2FFF88sPl%2FOKR6jI6rQlwHKTMD%2FDLou02cq8imwXkvftPq7CWE%2Fqx1XqbBb%2FEw1Cfvd6jYfAX7Cg%2BnvDRFa%2Fi%2BAgoiZvhIM%2BChmt4KCrInJp8LZMzXpuQ%2F1gWPbhcxDx81ZnT5YZf3ATDWuiu4YWJa5%2FLni7Go544dKVIOr%2FOVI%2FYskt%2F2dy6pwvHhE9lmnRhF9zkzWOv2ymV%2BCuPzTFKRQC4rMPE0aG9UrbU5D6I5k3ZiHVKZtu9Vzwmsoa6Tc4E9Zp8AIzUBiafE1R3fw2VTXclCbmgClqwoi4o27AN7T17OkGsVuMVUdLGBXxINF6i%2F%2BHYwmMw728oFb5oMQq74LSVbTB1kKF%2BeIOFiq87ADSoU3zNHYah79SgfctdfFRSpZNT%2F9%2F6J2oaig1v2c0MLitx4cGOqYBNusneJrkgJ3Fap%2BAkn1rQptSZ1KvhEckeuSm7sdWWTeKNM%2BJo7TUfVIVN8VejwByFXB9JkVWSUuhMZpppPa%2FJhO6QDUj094jmgWpvUaQlyimGswKE82LVwOnylVk8bGuzu3F9jygwDXHYhV%2BS6zYX4vaSOX0oQXamHo05qPUa28ek%2FjfnNvaQwWgzQ0gjlMFw9ya3URL%2Fw0LLXgDK0yZQsKK8hxLSw%3D%3D&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20210716T202420Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTY6S6NXXO4%2F20210716%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=1fb806fc0a15e6001c2f7cc9c5ae4b01b8641ee7d20e3ea1227145bb99615a62&hash=49eb3f03472213d8cb6d9f9981bf51e974593de2ca808cc8a8921082dfcded71&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S0043135415001190&tid=pdf-cdb69ea4-bd57-4ead-bbc1-a3d3d0c94eb3&sid=619b333590ca4845b458d6122ceeaa0deb7dgxrqa&type=client)

* pI speculated to be one of the factors contributing to the different viral behaviors observed.
  + “However, further study would 346 have to be conducted to determine i) distribution of viral types or strains, ii) the net surface charges 347 of viruses at pH 5.8−7.2 in the anoxic and oxic mixed liquor samples (Table 3), iii) the effect of 15 348 virus-particle association in untreated wastewater on viral adsorptive behavior to activated sludge.”
* “When virus concentration in a 406 treated wastewater sample is below the detection limit, accurate estimation of the removal 407 efficiency is needed to evaluate the factors affecting the virus removal efficiency (Kato et al., 2013)”.

[crAssphage genomes identified in fecal samples of an adult and infants with evidence of positive genomic selective pressure within tail protein genes - PubMed (nih.gov)](https://pubmed.ncbi.nlm.nih.gov/33137401/)

* crAssphage belongs to the order Caudovirales.

[Caudovirales - ScienceDirect (oclc.org)](https://www-sciencedirect-com.uml.idm.oclc.org/science/article/pii/B978012384684600001X#:~:text=Morphology,receptors%20on%20susceptible%20bacterial%20cells.)

* Caudovirales has no envelope.

BACK-UP – Manuscript part about naked viruses’ resilience:

* “Additionally, our findings have provided further evidence to support the resilience of non-enveloped viruses (a class which Adenovirus, CrAssphage, and PMMV all belong to [[Quantification of human adenovirus and norovirus in river water in the north-east of France | SpringerLink](https://link.springer.com/article/10.1007/s11356-018-3045-4); [crAssphage genomes identified in fecal samples of an adult and infants with evidence of positive genomic selective pressure within tail protein genes - PubMed (nih.gov)](https://pubmed.ncbi.nlm.nih.gov/33137401/); [Caudovirales - ScienceDirect (oclc.org)](https://www-sciencedirect-com.uml.idm.oclc.org/science/article/pii/B978012384684600001X#:~:text=Morphology,receptors%20on%20susceptible%20bacterial%20cells.); [Pepper mild mottle virus as a water quality indicator | npj Clean Water (oclc.org)](https://www-nature-com.uml.idm.oclc.org/articles/s41545-018-0019-5)]) compared with enveloped ones [[Survivability, Partitioning, and Recovery of Enveloped Viruses in Untreated Municipal Wastewater (oclc.org)](https://pubs-acs-org.uml.idm.oclc.org/doi/pdf/10.1021/acs.est.6b00876)].”

[Comber et al\_Seasonal variation of contaminants PEARL copy.pdf (plymouth.ac.uk)](https://pearl.plymouth.ac.uk/bitstream/handle/10026.1/13548/Comber%20et%20al_Seasonal%20variation%20of%20contaminants%20PEARL%20copy.pdf?sequence=1&isAllowed=y)

* Proposed 2 patterns of seasonal variation (of contaminants):
  + “Firstly, variation of riverine concentrations caused by seasonal fluctuations in river flow (sewage flow being relatively consistent) resulting in summer maxima and winter minima.
  + Alternatively, variation is observed that is attributable to the improved performance of wastewater treatment processes under warmer conditions. This leads to the lowest concentrations in autumn when surface water/sewage treatment temperatures tend to peak.

[Seasonal bacterial community succession in four typical wastewater treatment plants: correlations between core microbes and process performance | Scientific Reports (oclc.org)](https://www-nature-com.uml.idm.oclc.org/articles/s41598-018-22683-1)

* Seasonal variation in bacterial composition.

[es6b01384 1..9 (nsf.gov)](https://par.nsf.gov/servlets/purl/10023908)

* “PMMoV consistently showed the highest frequency of occurrence with little seasonal variation and the highest annual mean concentrations in raw sewage influent and final effluent wastewater samples.”
* “Among DNA viruses, AdV showed the highest frequency of occurrence with little seasonal variation”.

[Dynamics of crAssphage as a human source tracking marker in potentially faecally polluted environments - ScienceDirect (oclc.org)](https://www-sciencedirect-com.uml.idm.oclc.org/science/article/pii/S0043135419301678?via%3Dihub)

* “Measurement of crAssphage abundance revealed no temporal variability in the effluent”.

[The Effectiveness of Activated Sludge Procedure and UV-C 254 in Norovirus Inactivation in a Tunisian Industrial Wastewater Treatment Plant | SpringerLink](https://link.springer.com/article/10.1007/s12560-020-09434-0)

* NoV GI & GII abatement (removal) rates were, on average, 93% & 77%.

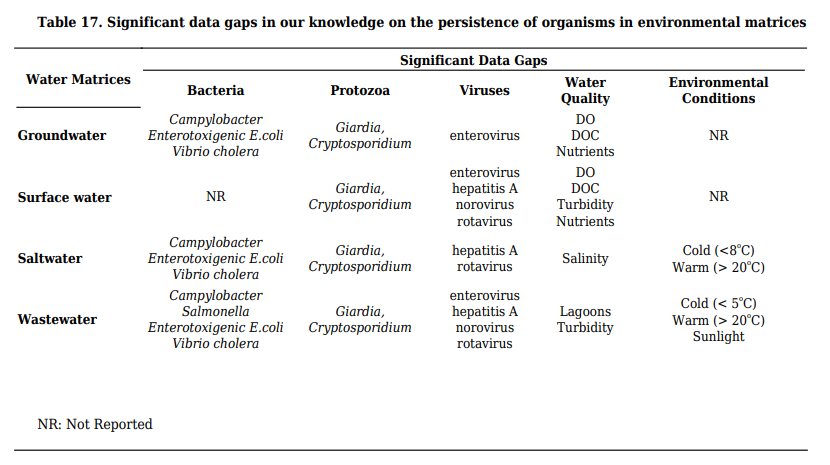
[Microsoft Word - 236900\_supp\_undefined\_84F2F460-0120-11E3-8F0E-0A3EEF8616FA.docx (arizona.edu)](https://repository.arizona.edu/bitstream/handle/10150/301699/azu_etd_12948_sip1_m.pdf?sequence=1&isAllowed=y)

* “GII NoV showed the highest reductions (2.04 ± 1.01 and 2.64 ± 0.61 log10 reductions for Plants A and B, respectively), followed by GI NoV (1.57 ± 1.13 and 2.37 ± 1.05 log10 reductions for Plant A and B, respectively), with high variability in the log10 reduction over the year; however, these differences between the reductions of GI and GII NoV were not statistically significant (t-test, P > 0.05).”
  + GII range: 90.67% - 99.94%.
  + GI range: 63.69% - 99.96%.
    - -> Up to over 99%.

[Issues Concerning Survival of Viruses on Surfaces (nih.gov)](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7091010/)

* “The rate of RNA degradation increased linearly with increasing fragment size, except viruses with a similar size of genome (poliovirus 1 and MS2). Based on these results, viral resistance to UV depends especially on fragment size of viral nucleic acid. Nevertheless, it also shows that the viral capsid structure has an important protective role against UV radiation (Simonet and Gantzer [2006](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7091010/#CR74)).”

[Persistence of Pathogens in Sewage and Other Water Types\_2.pdf (waterpathogens.org)](https://www.waterpathogens.org/sites/default/files/Persistence%20of%20Pathogens%20in%20Sewage%20and%20Other%20Water%20Types_2.pdf)



* “In general, very few data are available on the persistence of pathogens in aquatic environments.”
* “Adenoviruses in secondary and primary effluent have been found to have T99’s of up to 58 and 48 days under dark conditions at cold temperatures (4ºC).”
* 2.0 Persistence in Sewage and Treated Wastewater.
  + 2.2 Viruses and viral indicators.

[Quantitative PCR Detection and Characterisation of Human Adenovirus, Rotavirus and Hepatitis A Virus in Discharged Effluents of Two Wastewater Treatment Facilities in the Eastern Cape, South Africa | SpringerLink](https://link.springer.com/article/10.1007/s12560-016-9246-4)

* “The persistent occurrence of HAdV in the discharged treated effluents points to the potential public health risk through the release of HAdV into the receiving watersheds, and the possibility of their transmission to human population.”

[Coronavirus in water environments: Occurrence, persistence and concentration methods - A scoping review - ScienceDirect (oclc.org)](https://www-sciencedirect-com.uml.idm.oclc.org/science/article/pii/S004313542030436X)

* “The viruses considered of concern for water in WHO Guidelines, however, are principally enteric viruses (familes Adenoviridae, Astroviridae, Caliciviridae, Hepeviridae, Picornaviridae, and Reoviridae) which are, as previously reported, non-enveloped viruses. It is well known that these viruses are more resistant to environmental conditions, water treatments and disinfectants than enveloped viruses like coronavirus, as lysis of the viral envelope leads to the loss of functional receptors required for infection of susceptible cells.”