Microbial Risks of Using Seawater as Source Water for Desalination

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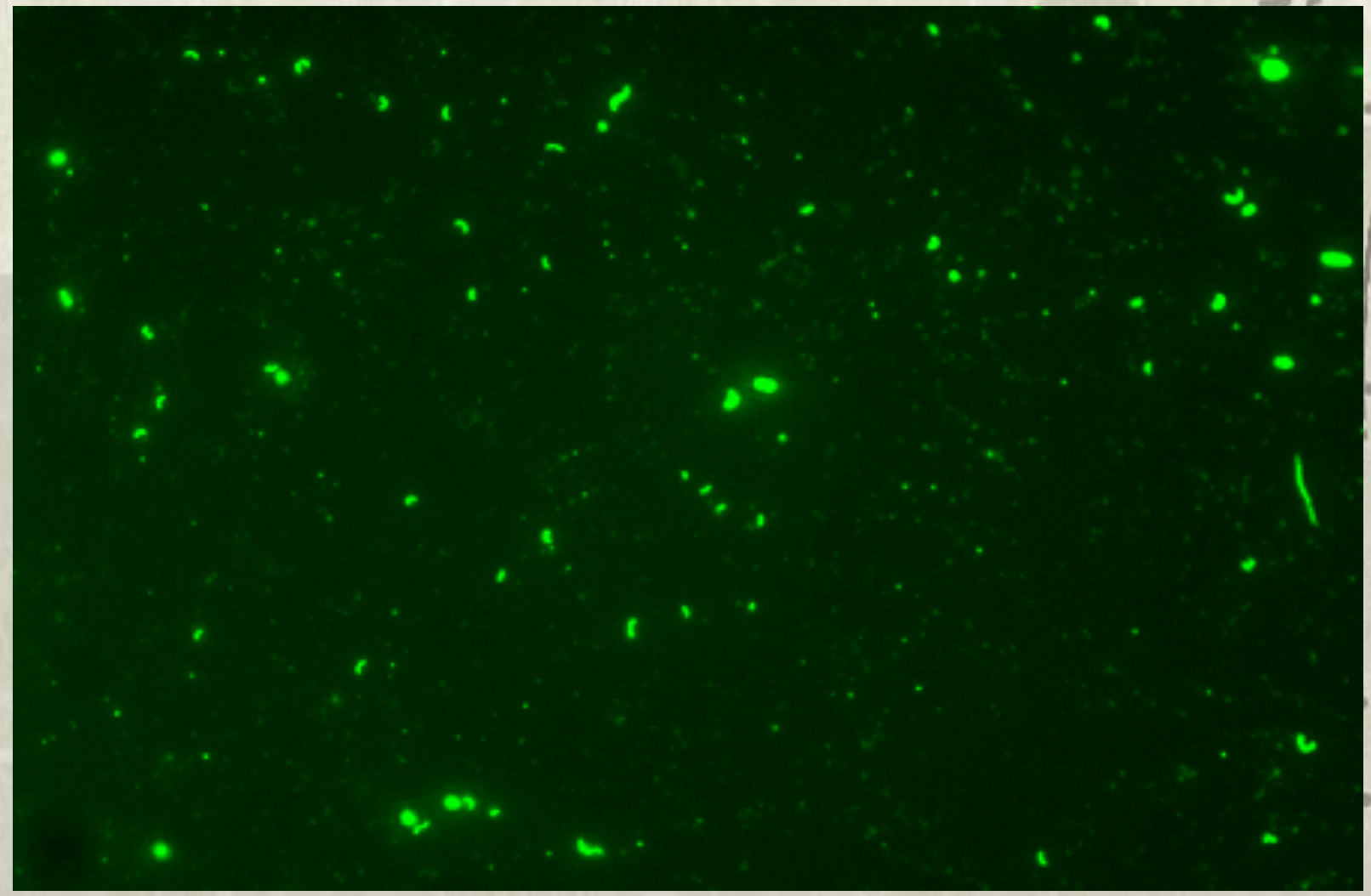
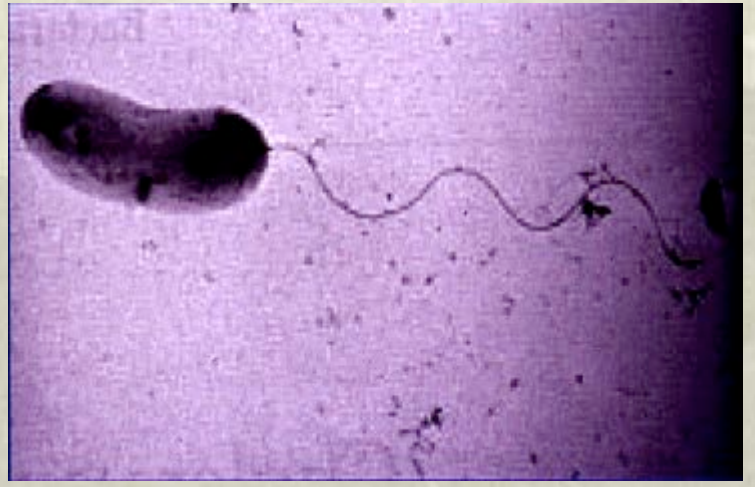
SYBR Green Staining of Bacteria and Viruses in Seawater

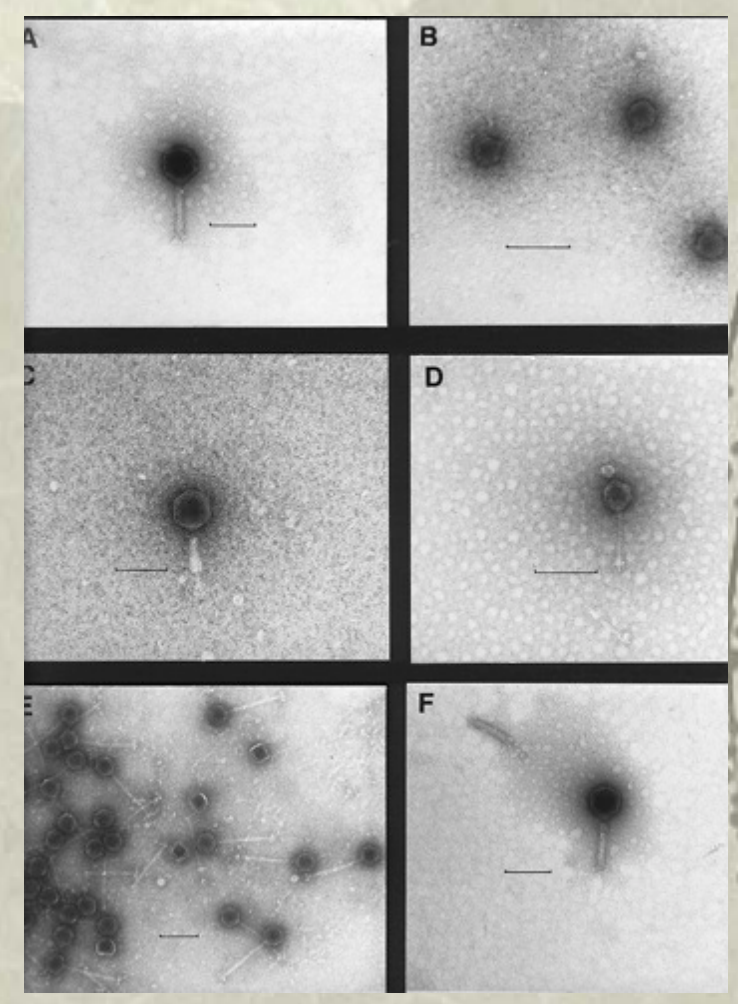


Bacteria: 10E6/ml; Viruses: 10E7/ml; in coastal California water

Electron micrograph of bacteria and viruses in coastal waters



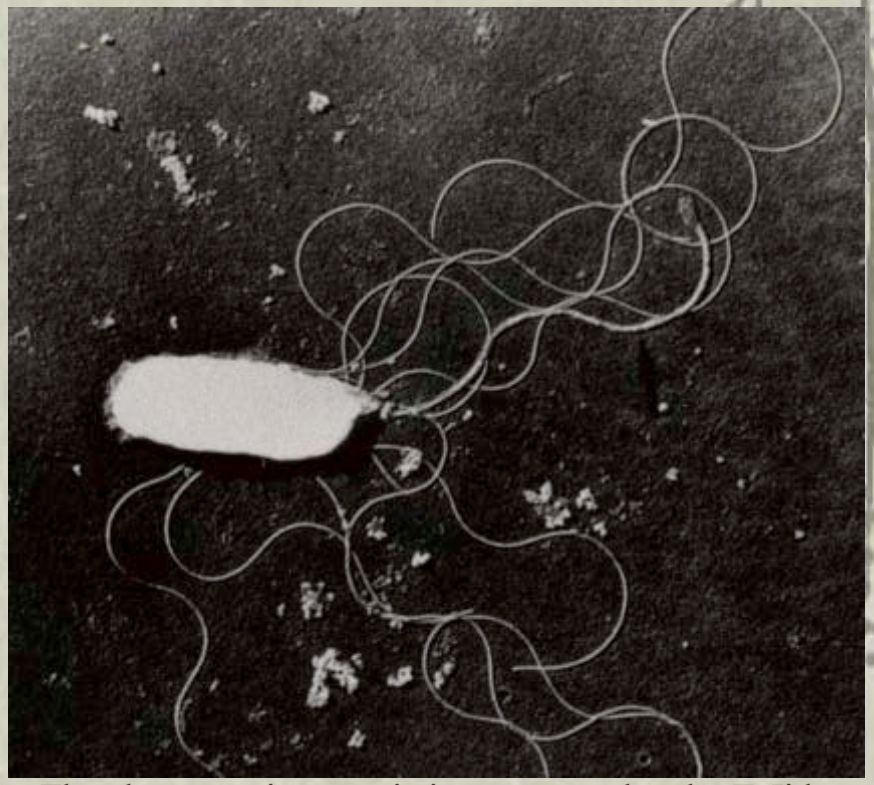
Vibrio cholerae



Bacteriophage

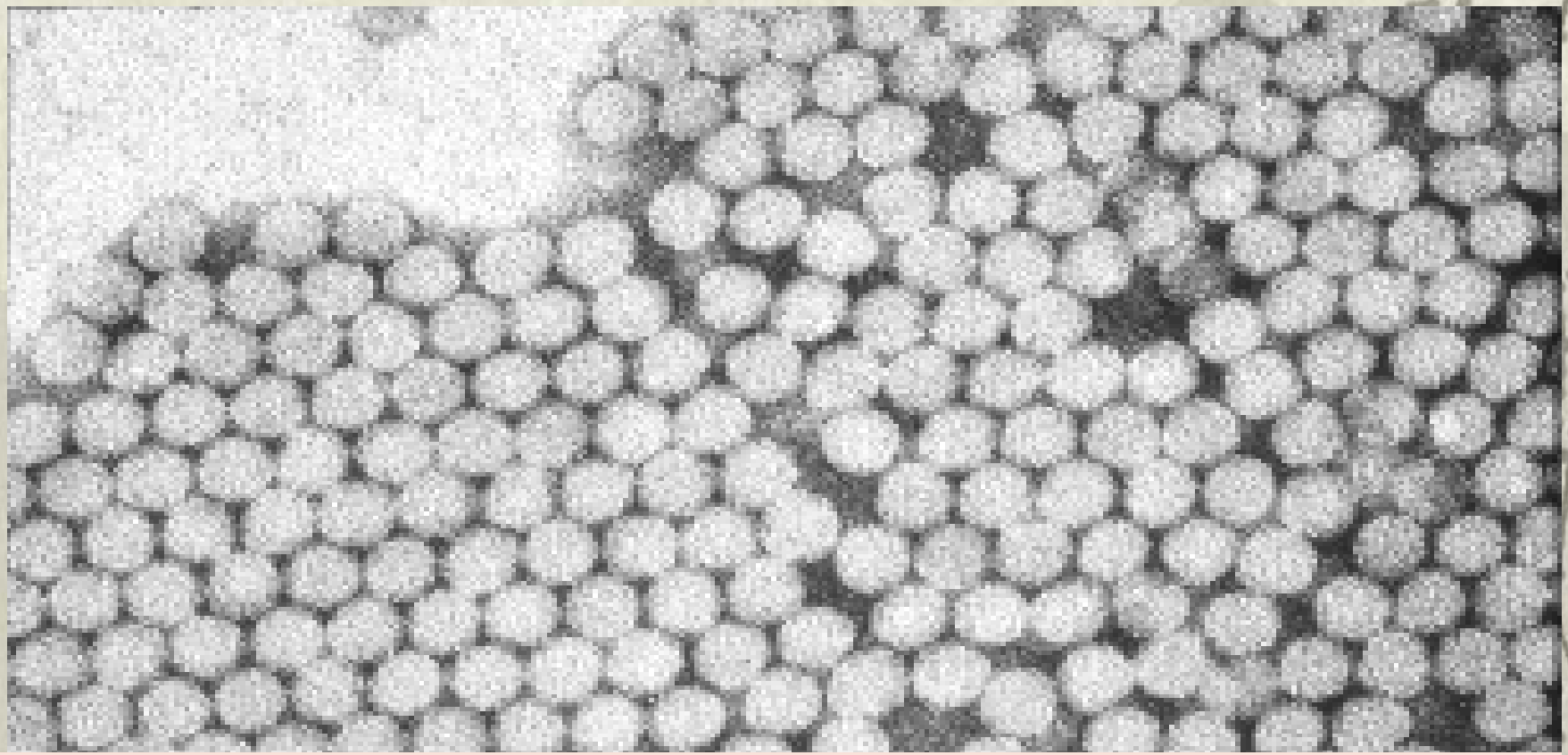
Marine Opportunistic Pathogens

- *Vibrio parahaemolyticus*
- *Vibrio vulnificus*
- *Aeromonas* spp.



The electron microscopic image was taken by T. Iida

Human viruses



- More than 100 different types of viruses are found in human waste and are potentially transmitted by water.

Cryptosporidium and Giardia

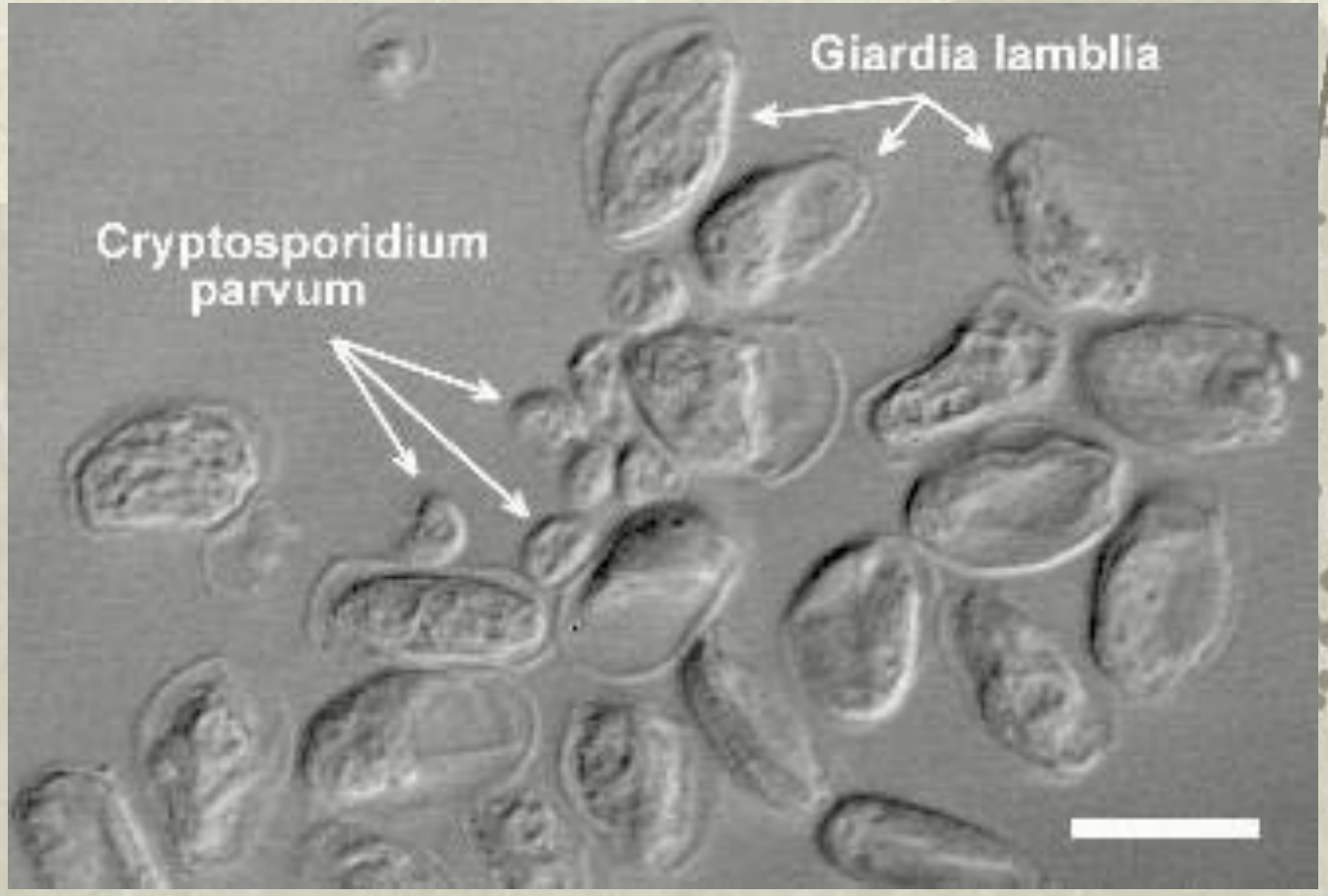
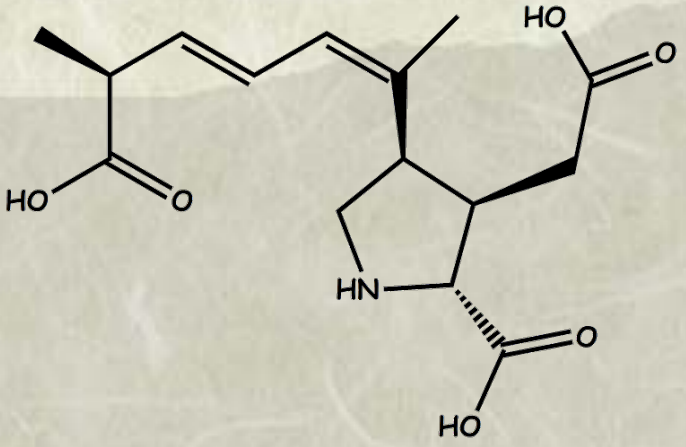
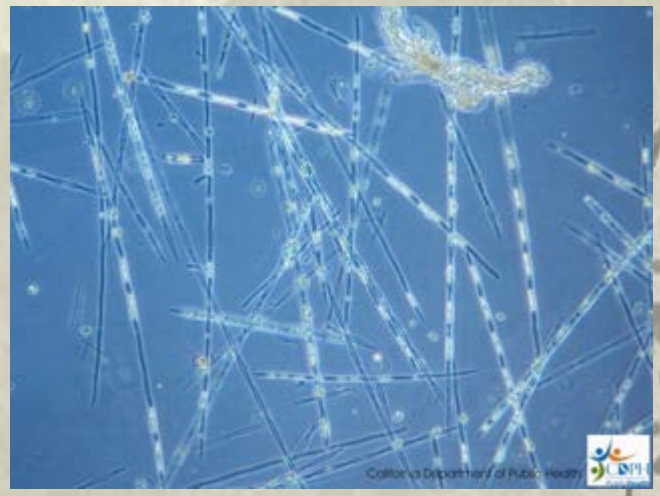


Photo Credit: H.D.A. Lindquist, U.S. EPA

Marine Toxins

- Domoic acid- Diatom *Pseudonitzschia spp.*



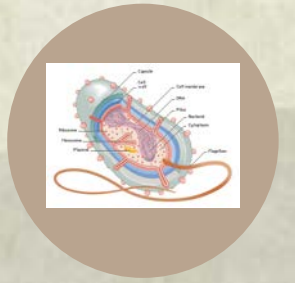


- Paralytic Shellfish Poisoning- Dinoflagellate *Alexandrium spp.*
- Neurotoxic Shellfish Poisoning- Dinoflagellate *Gymnodinium spp.*

Risk Comparison

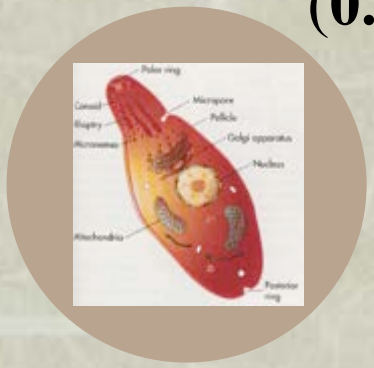
Agents	Seawater	Freshwater	Treated wastewater
Bacteria (/ml)	**10e6-10e7**	**10e7-10e8**	**10e4-10e8**
Viruses (/ml)	**10e7-10e8**	**10e7-10e8**	**10e7-10e9**
Human pathogenic bacteria	**Low**	**Medium**	**Medium**
Human pathogenic viruses	**Low**	**Medium**	**High**
Human pathogenic protozoa	**Low**	**Medium**	**Low**
Algal toxin	**Medium**	**Medium**	**Low**

Size Does Matter



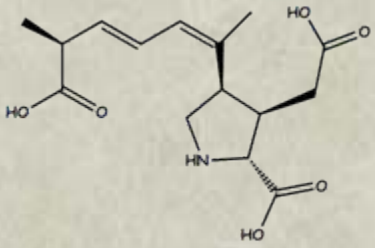
Bacteria (0.5~5μm)

Viruses (20~220nm)



Protozoa (1~300μm)

- **Small size**
- **Resistance to degradation**
- **Low infective dose**



Low MW but high dose

High Risk

Intake Site Selection

- Utilize the best available source water
- Located away from sewage outfalls, storm drains and areas with recurring harmful algal blooms (i.e. lagoons)
- Intake point below euphotic zone can reduce the overall influence of algal bloom

Source Water Monitoring

- Monitoring of pathogens in source water is not effective nor necessary
- It is useful to provide baseline information on microbial quality during site selection
- The baseline information should also be used to measure the sudden change of water quality to alert potential risk

Pretreatments

- Both traditional and new membrane pretreatment are effective at removal or reduce pathogenic bacteria and protozoa
- However, human viruses and marine toxins can by-pass the pretreatment
- The objective of pretreatment for microbes using oxidants and biocides is to prevent fouling of RO but are not sufficient to reach residual concentration for efficient disinfection.

Reverse Osmosis

- RO is an effective barrier to prevent viruses and small molecular weight marine biotoxins to enter the finished water
- However, the removal rate is subjected to the type of membrane and the integrity of the RO system, ranging from less than 3 log to 6 log for virus removal
- It is important to develop membrane integrity monitoring method to ensure adequate performance of RO system

Post Treatment Disinfection

- In spite of the multi-barrier processes in seawater desalination, disinfection of desalinated water offers additional security for public health protection
- It also protects against potential loss of membrane integrity

Conclusions

- Seawater as source for drinking water production does not present elevated risk in comparison with freshwater sources
- Selection of intake location should consider source water quality and establish baseline for future operation
- The current desalination processes are effective at removal microbial pathogens of public health concern

Conclusions

- Efforts should be made to develop effective membrane integrity monitoring methods to ensure the performance of desalination system
- Post treatment disinfection is a necessary step to ensure the safety of the water for distribution

Thank you

Questions?