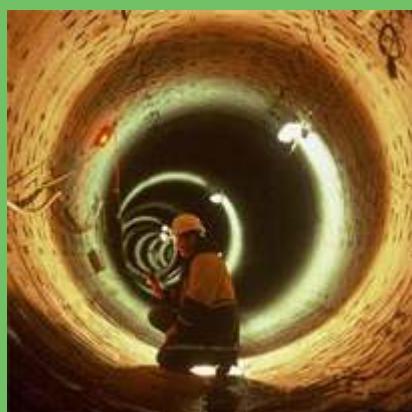




Introduction to Water Treatment

Peter Hillis

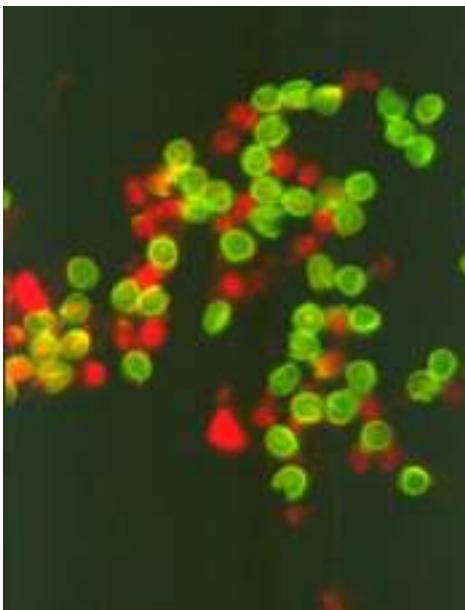
Principal Process Engineer
United Utilities



Why do we treat water?

- Protect Public Health
- Provide Safe Drinking Water
- Waterborne disease
 - Cryptosporidium
 - E.Coli
 - Cholera
 - Giardia
 - Polio
 - Typhoid
 - Malaria
 - Botulism
 - Hepatitis
 - Legionellosis

“water utilities should ensure that the design and operation of treatment plants is optimised in a cost effective way for particle removal, taking into account the level of the risk at each plant”



recommendation 22 of second Badenoch Report

Infectious diseases caused by pathogenic bacteria, viruses, and protozoa or parasites are the most common and widespread health risk associated with drinking water.

WHO Guidelines for Drinking Water Quality

Cases of cryptosporidiosis

- 1993 – Milwaukee – 403,000 ill with 10% hospitalised
- 1995 – Torbay, Devon – 575 cases of illness
- 1996 – Cranbook British Columbia – 2,000 cases of illness
- 1996 – Kelam, British Columbia – 15,0000 cases of illness
- 2000 – Clitheroe, Lancashire – 46 cases of illness
- 2001 – North Battlefield, Saskatchewan – 7,100 cases of illness
- 2005 – Anglesey – 200 cases of illness – 61,000 people on a boil water advice
- 2008 – Anglian Water – 250,000 customers on boil water for over 1 month

How do we treat water?

- Holistic approach
- Start at the source
- Protection of catchment
- Prevention of contamination
- Intake protection
- Monitoring

Water Treatment Processes

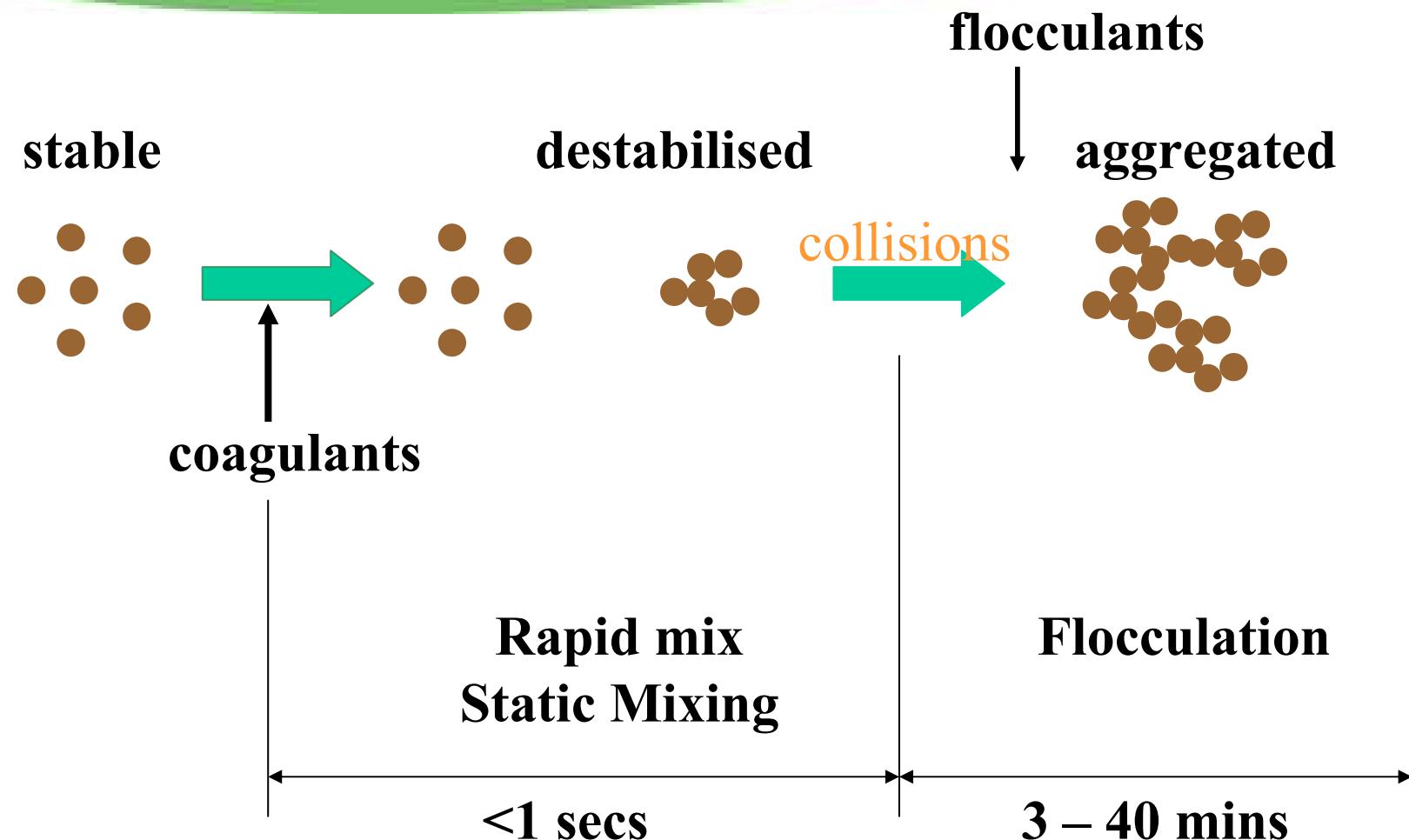
- Inlet works
- Fish screens
- Band screens - mm
- Microstrainers - micron



Coagulation - Definitions

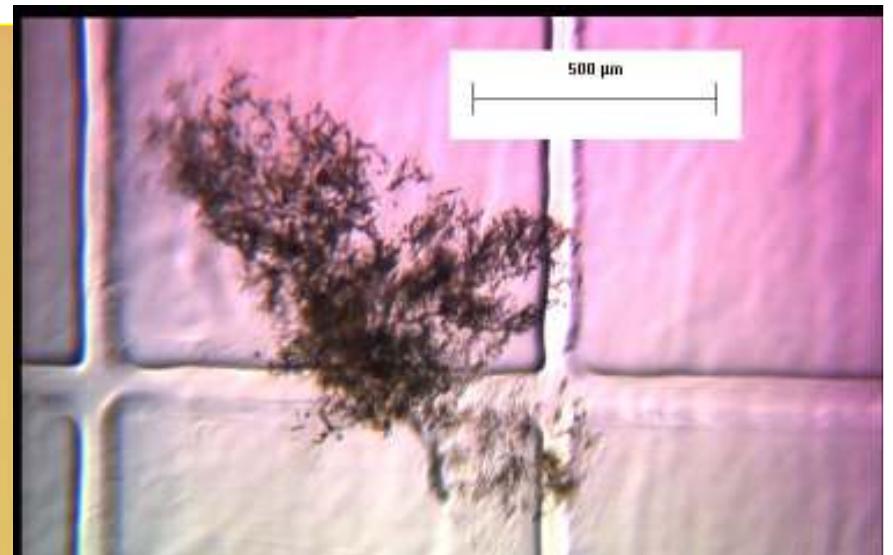
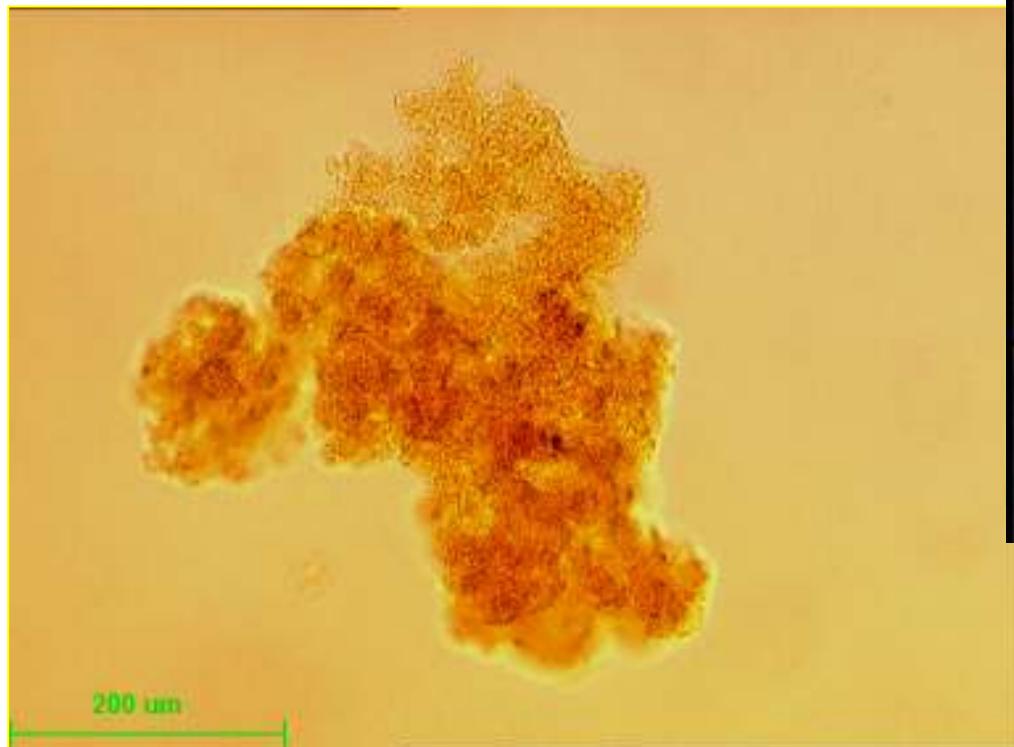
- **Coagulation:** destabilisation of particles / formation of microflocs
- **Coagulants:** chemicals which destabilise particles and colloids
- **Flocculation:** aggregation of destabilisation particles/ microflocs into larger aggregates (Flocs)
- **Flocculants:** Chemicals which assist in the formation of large aggregates.

Definitions





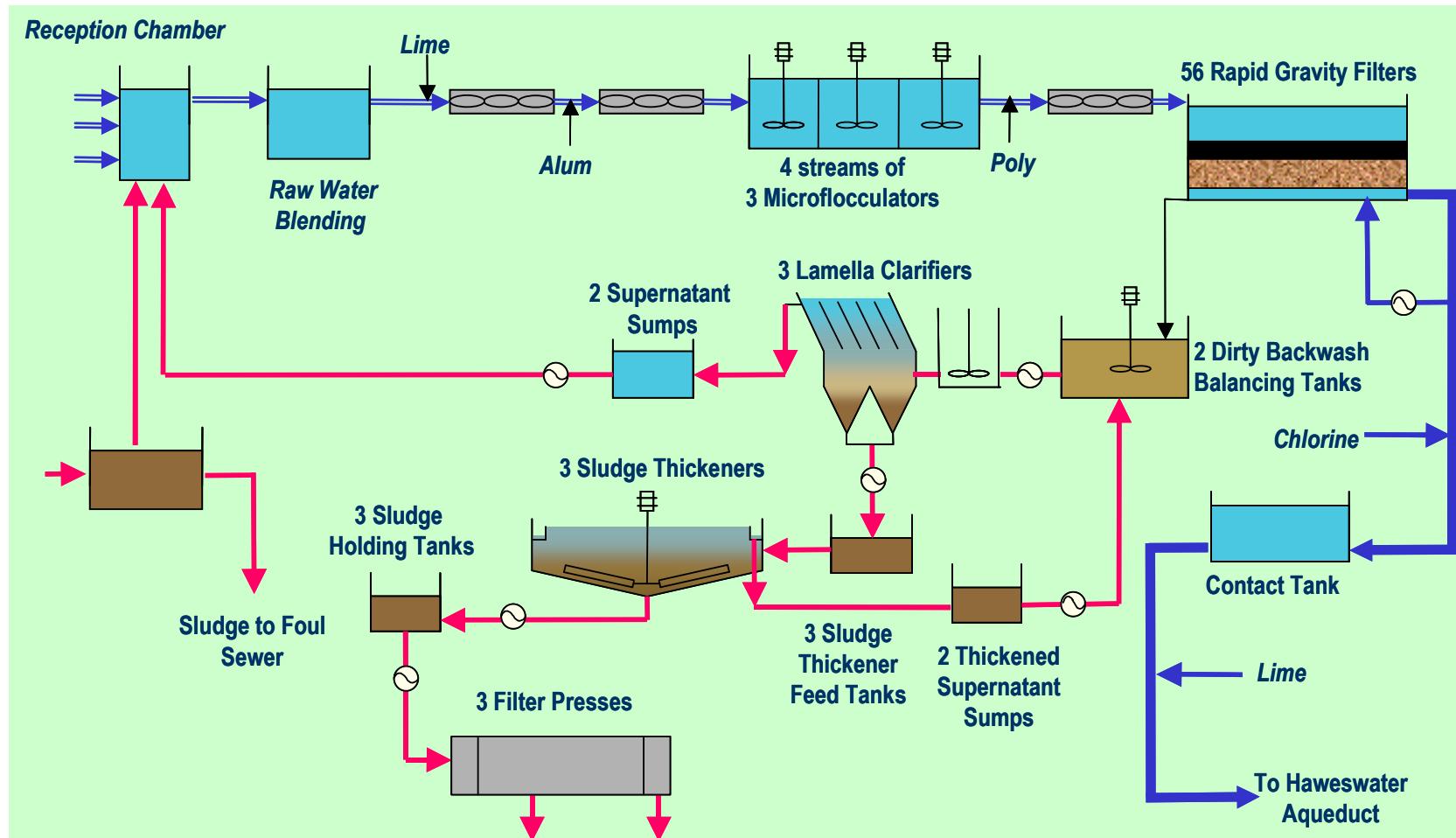
Individual Flocs



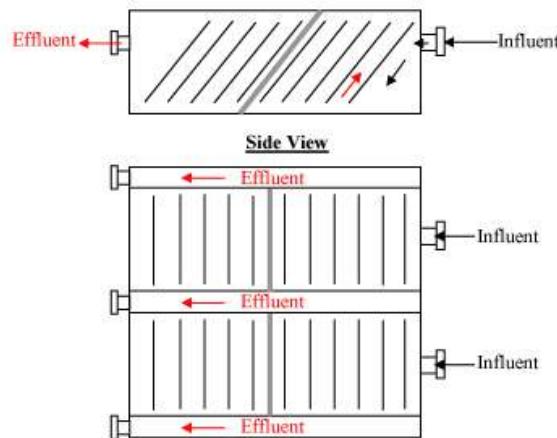
Separation Processes

- Removal of floc material
- Physical processes
 - Clarification – Settlement processes – Settlement Tanks, Lamella's, Actilfo, Dissolved Air Flotation
 - Filtration – Rapid Gravity Sand Filtration, Direct Filtration, Microfiltration (Membranes)

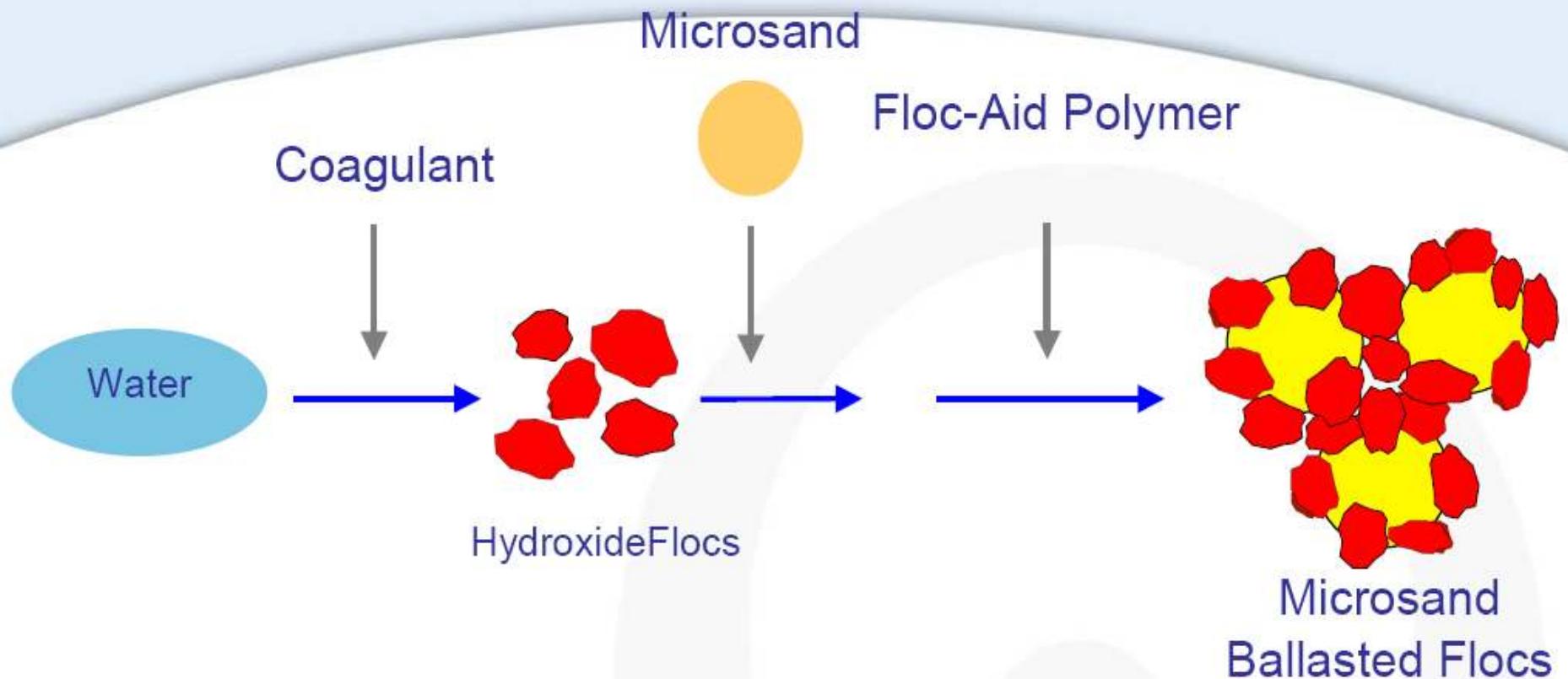
Direct Filtration – Watchgate WTW



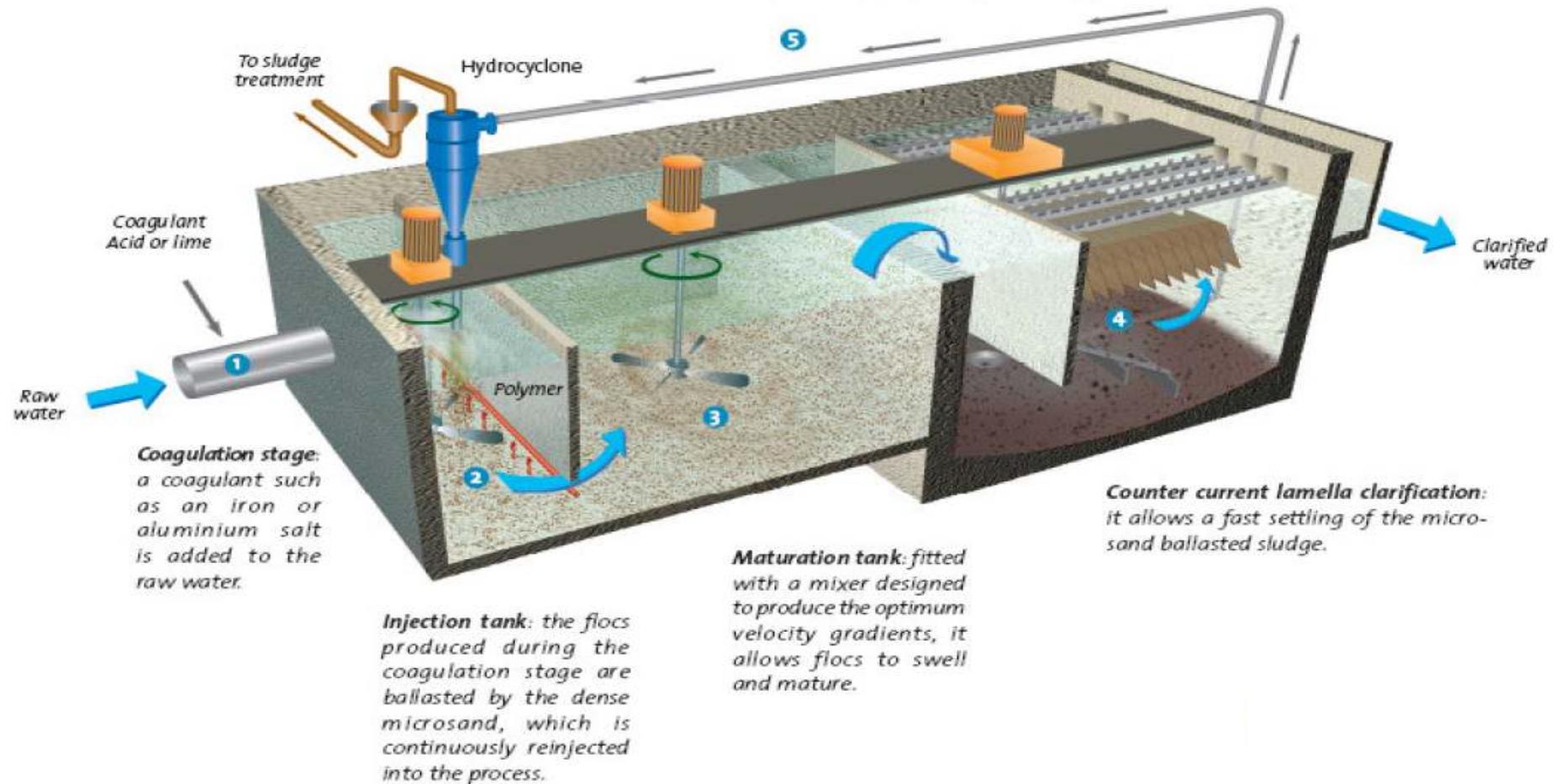
Lamella Clarifier



ACTIFLO® Principle



The Actiflo® process



Raw

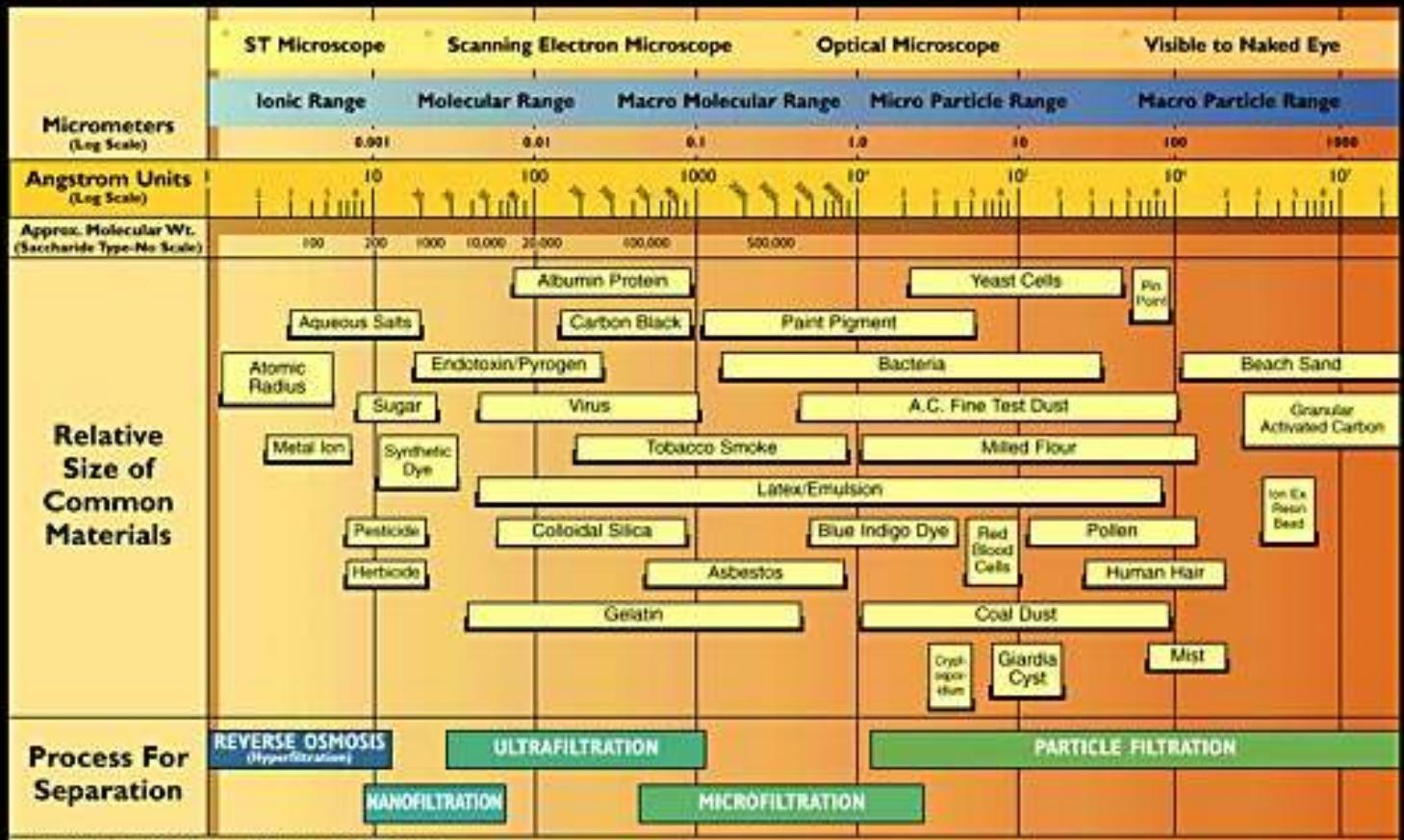
Clarified/Filtered



Membranes



The Filtration Spectrum



Note: 1 Micron (1×10^{-6} Meters) = 4×10^{-10} Inches (0.00004 Inches)
 1 Angstrom Unit = 10^{-10} Meters = 10^{-6} Micrometers (Microns)

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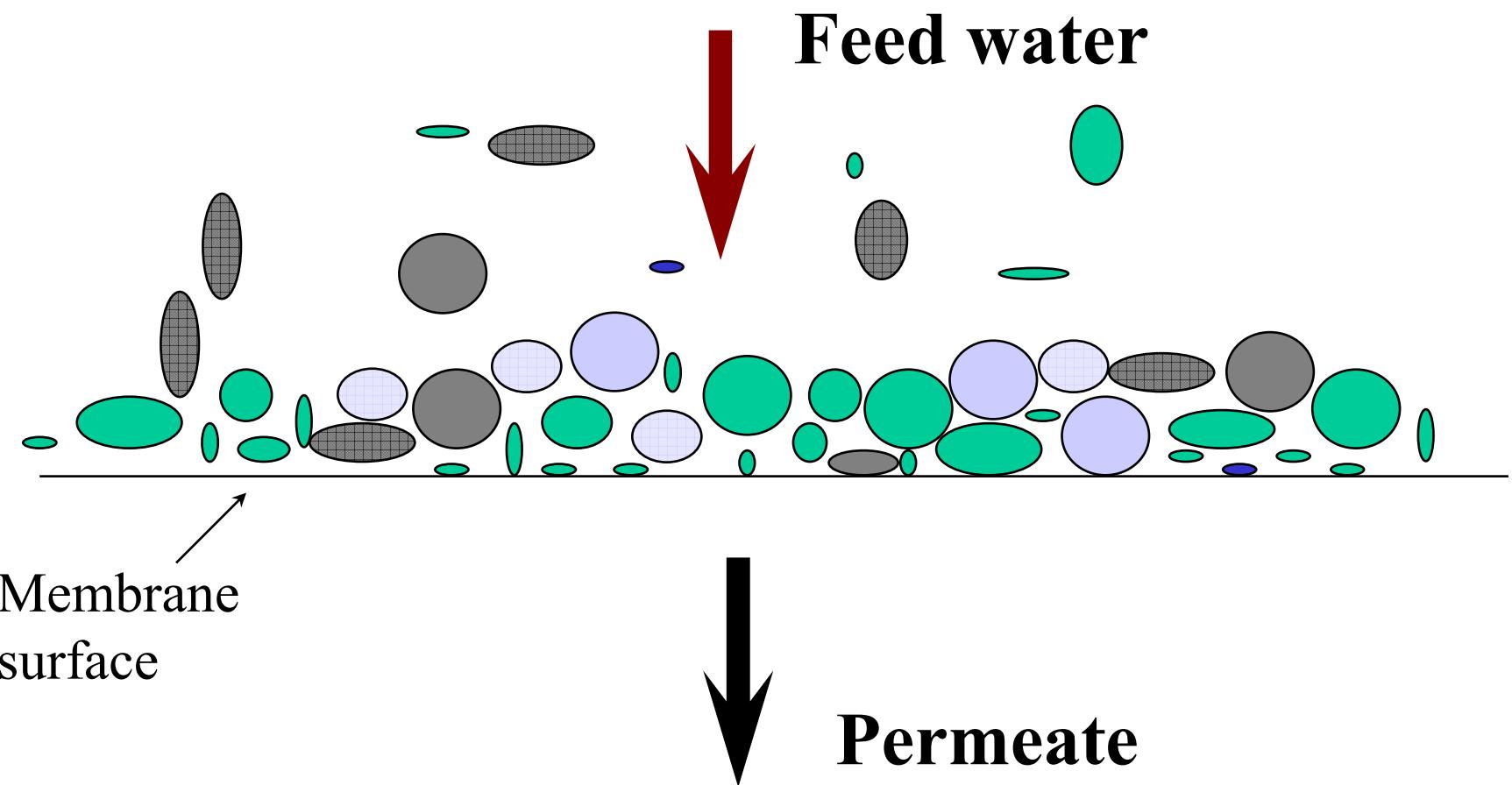
Osmonics, Inc.
 Corporate Headquarters
 5951 Clearwater Drive • Minneapolis, Minnesota 55343-8900 USA
 Toll Free: 800/848-1750 Fax: 612/933-0141

Osmonics Asia/Pacific, Ltd.
 Bangkok, Thailand Fax: 011-66-2-39-18183
 Tokyo, Japan Fax: 011-81-48-622-6309

Osmonics Europa, S.A.
 LeMee Sur Seine (Paris), France
 Fax: 011-331-64-37-9211
Printed in USA, PN 1590 Rev E



Membrane Microfiltration





Secondary Processes

► Removal of inorganic contaminants

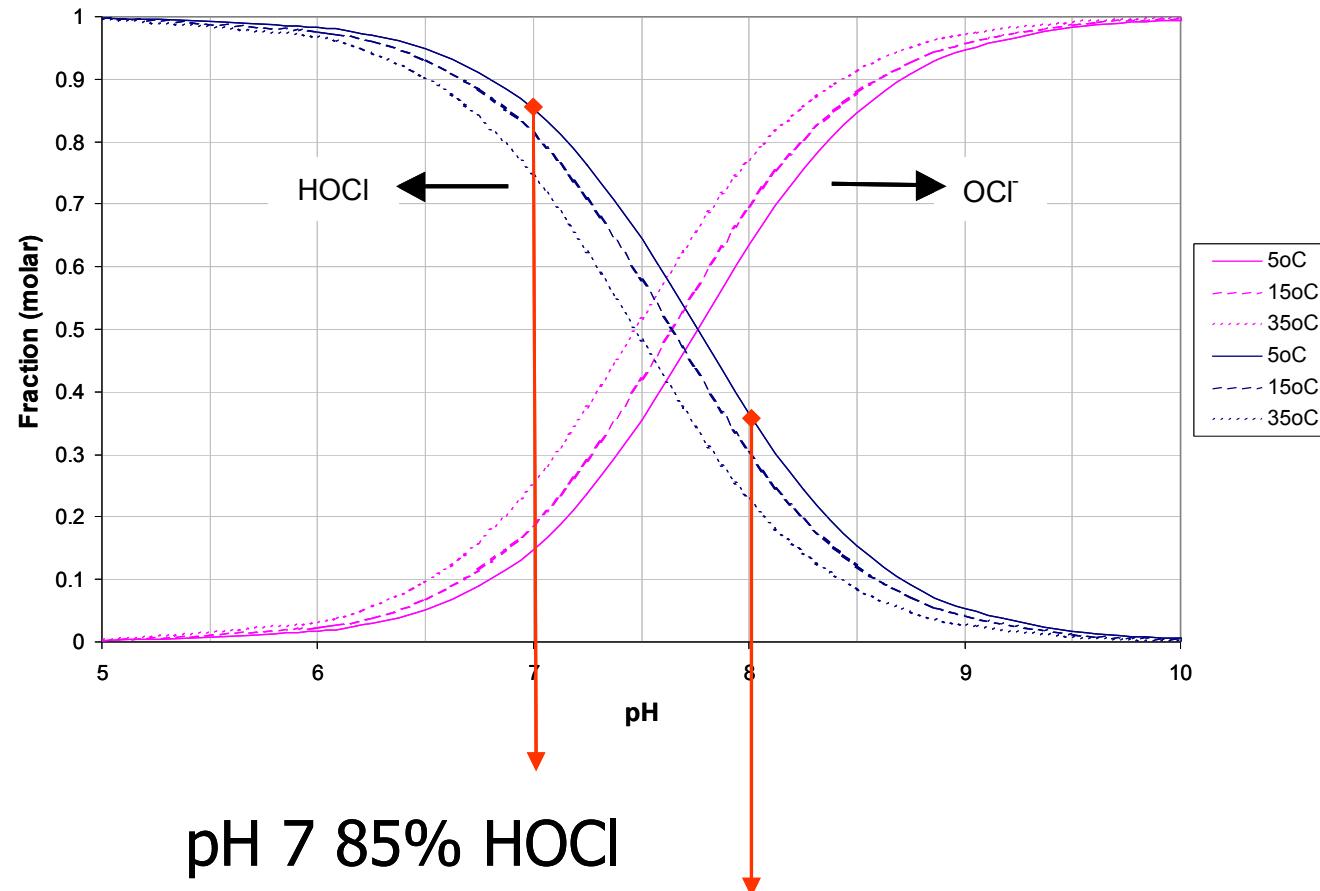
- Manganese
- Iron
- Aluminium
- Arsenic
- Micropollutants

Disinfection

- Process of removing harmful organisms from water supply
- Starts at the beginning of the process – catchment
- Continues through removal of particles
- Final Disinfection
 - Chlorine
 - UV
 - Ozone
 - Chlorine Dioxide
 - Chloramination



Chlorine

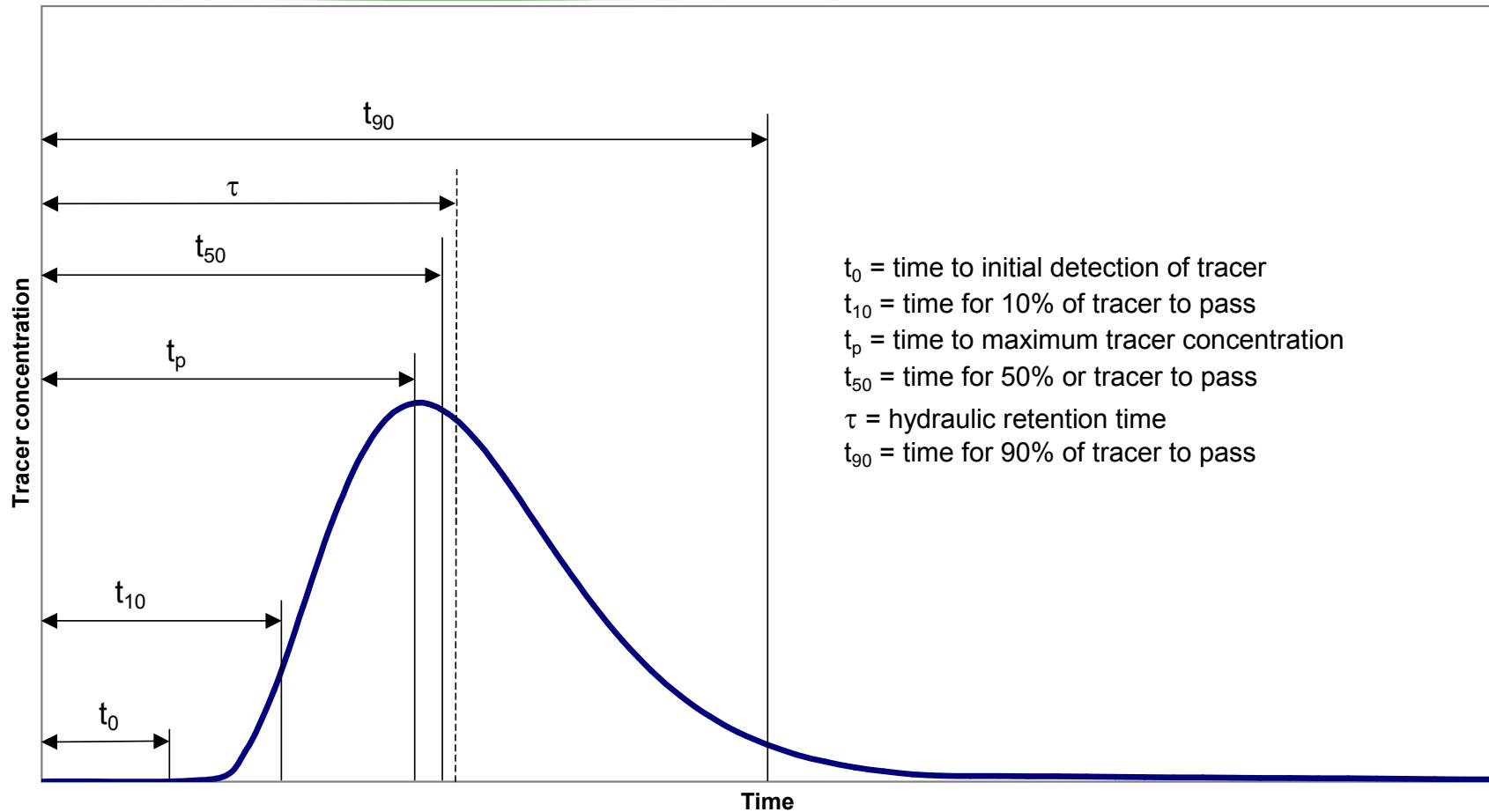


pH 8 35% HOCl

Chlorine Contact Time

- CT Principle
- Concentration (mg/l of Chlorine) * Time (mins)
- WHO guidelines – 30 mg.min/l i.e. 1 mg/l of chlorine for 30 minutes
- UU Standards – Effective CT Principle
- Effective Disinfectant
- Effective time
- 15 mg.min/l surface water
- 5 mg.min/l secure groundwater

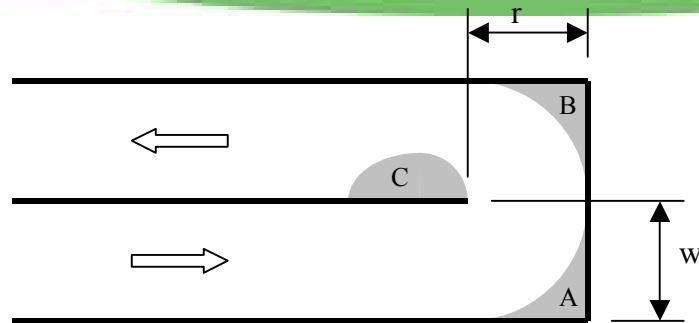
Defining Contact Tank Performance



Tank performance based on t_x

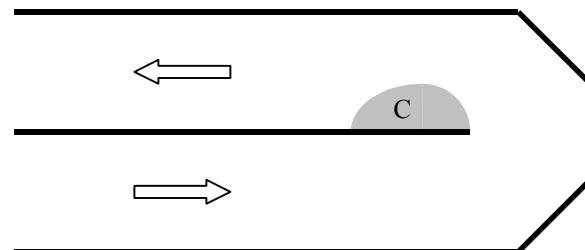
Baffling	t_1/τ	t_5/τ	t_{10}/τ
Poor	0.14	0.27	0.37
Average	0.30	0.44	0.52
Superior	0.55	0.66	0.73

Contact tank chamber profile

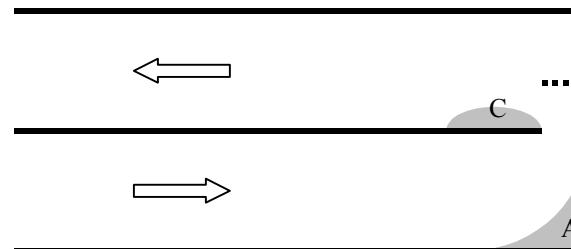


r/w influences extents of dead zones at A, B and C

Corner fillets to reduce dead zones



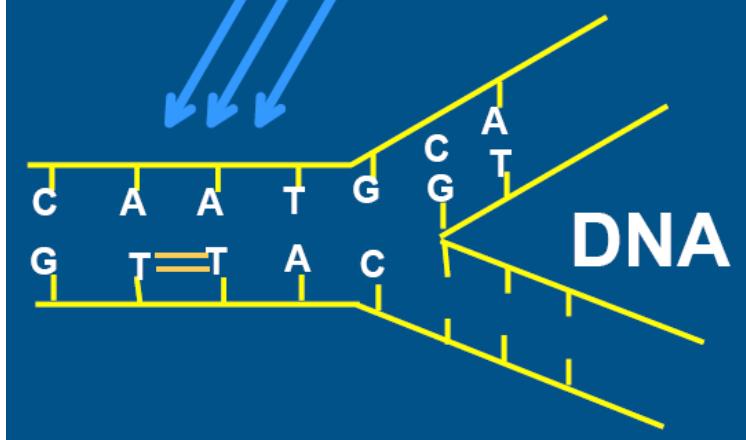
Perforated baffles with low r/w ratio



UV Disinfection

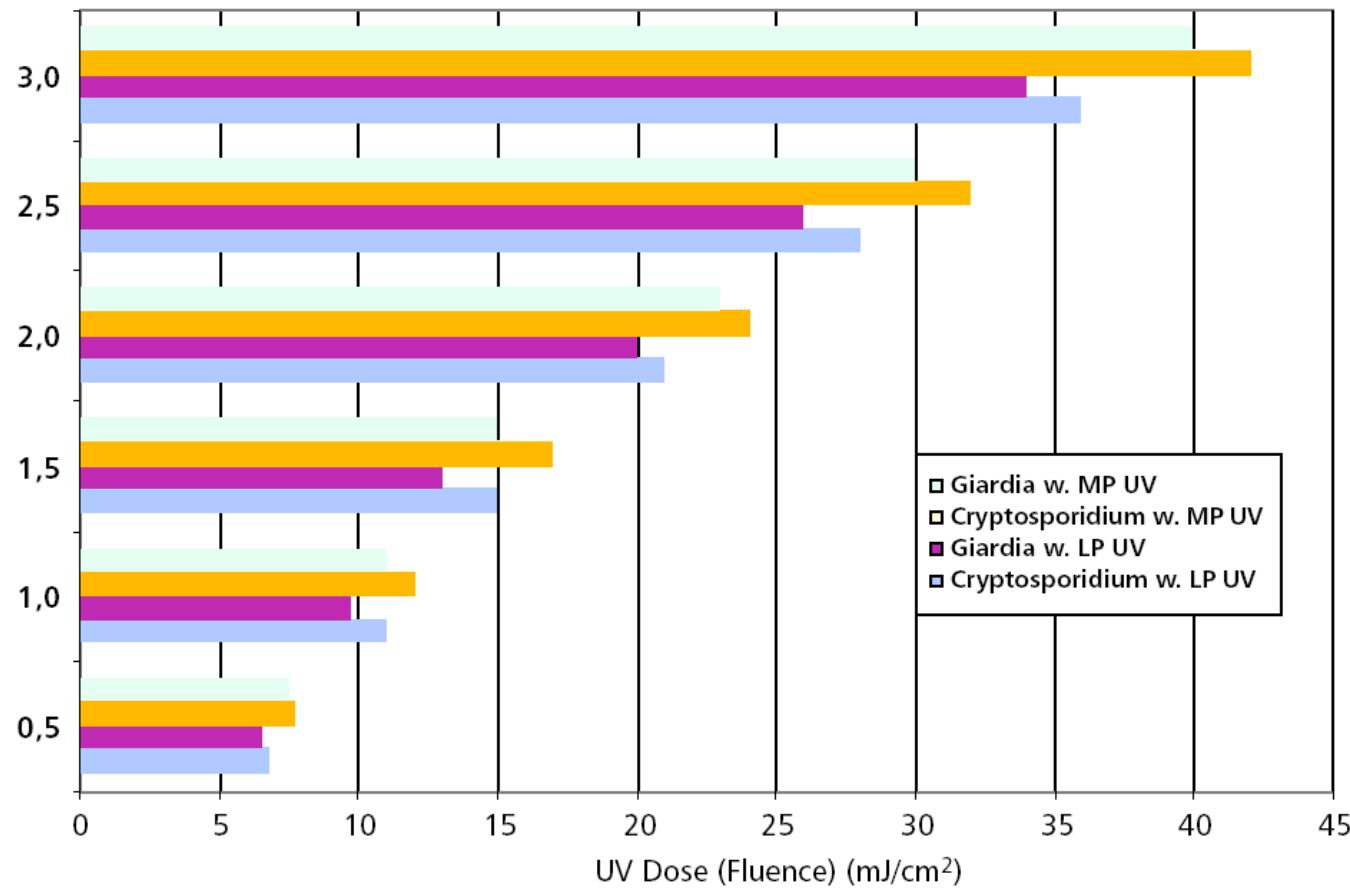


UV

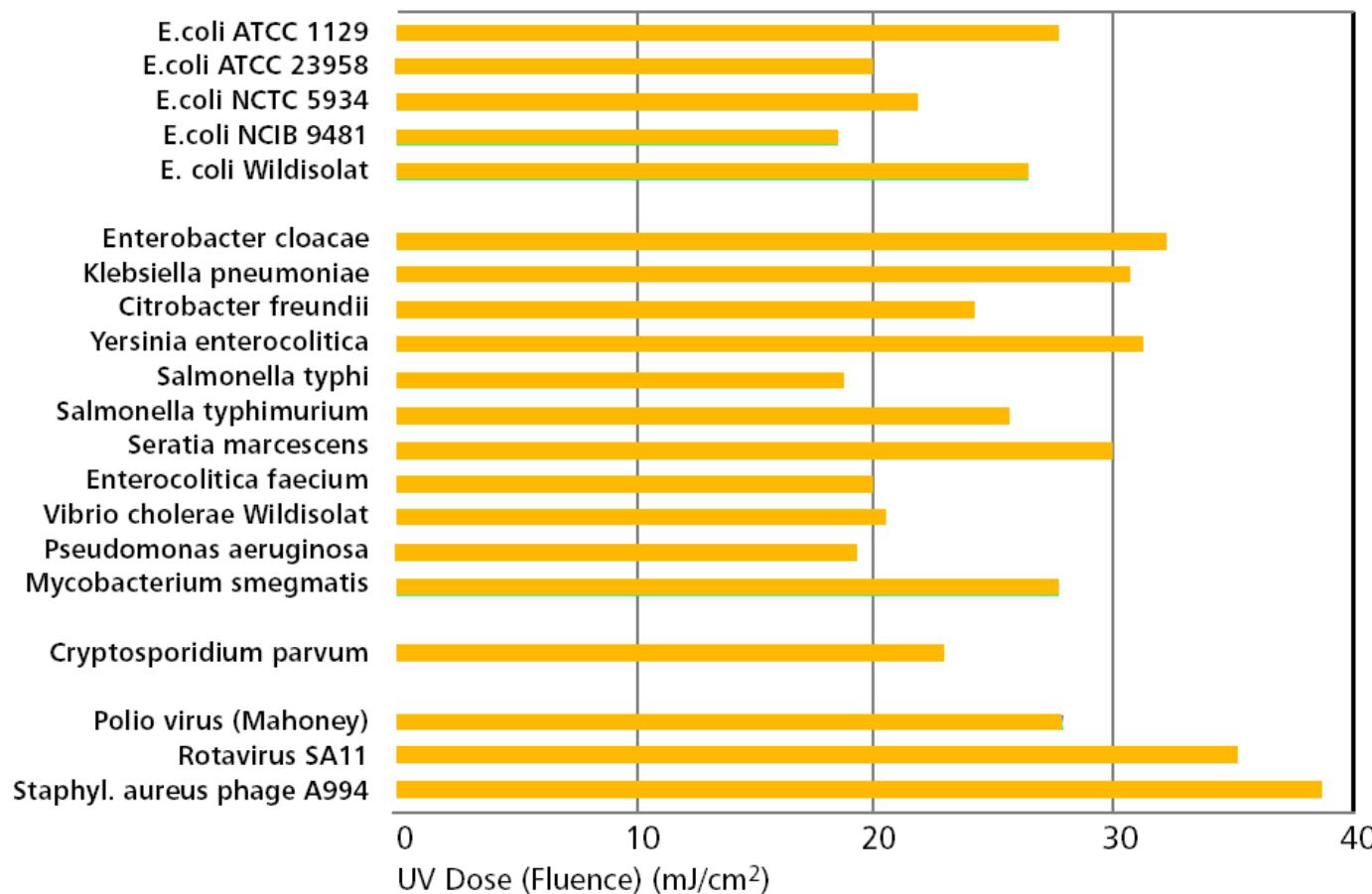


- Physical Process
- Light energy is absorbed by DNA of organisms
- Inhibits replication
- Organism that cannot replicate cannot infect

Cryptosporidium Inactivation



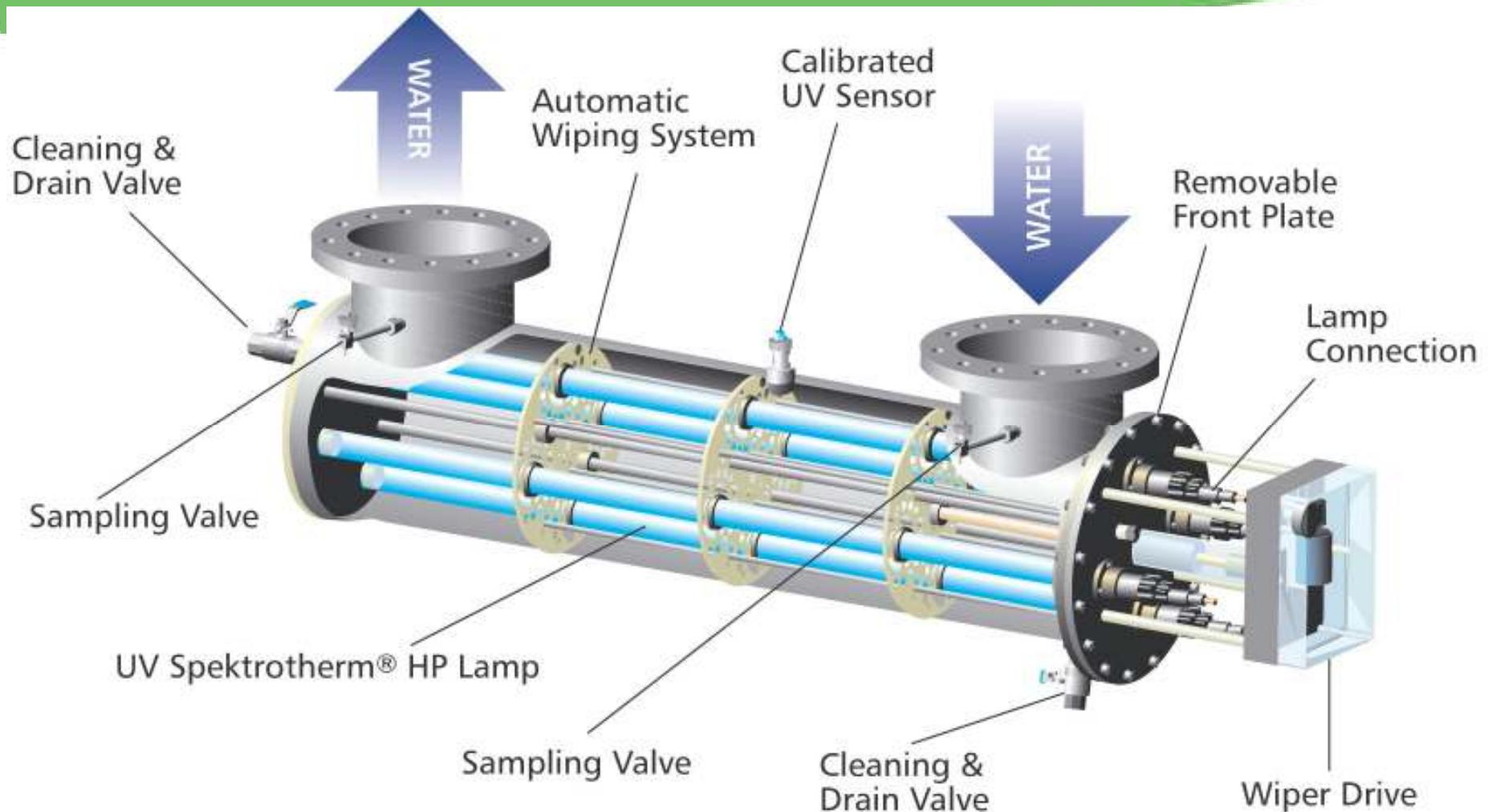
UV Disinfection



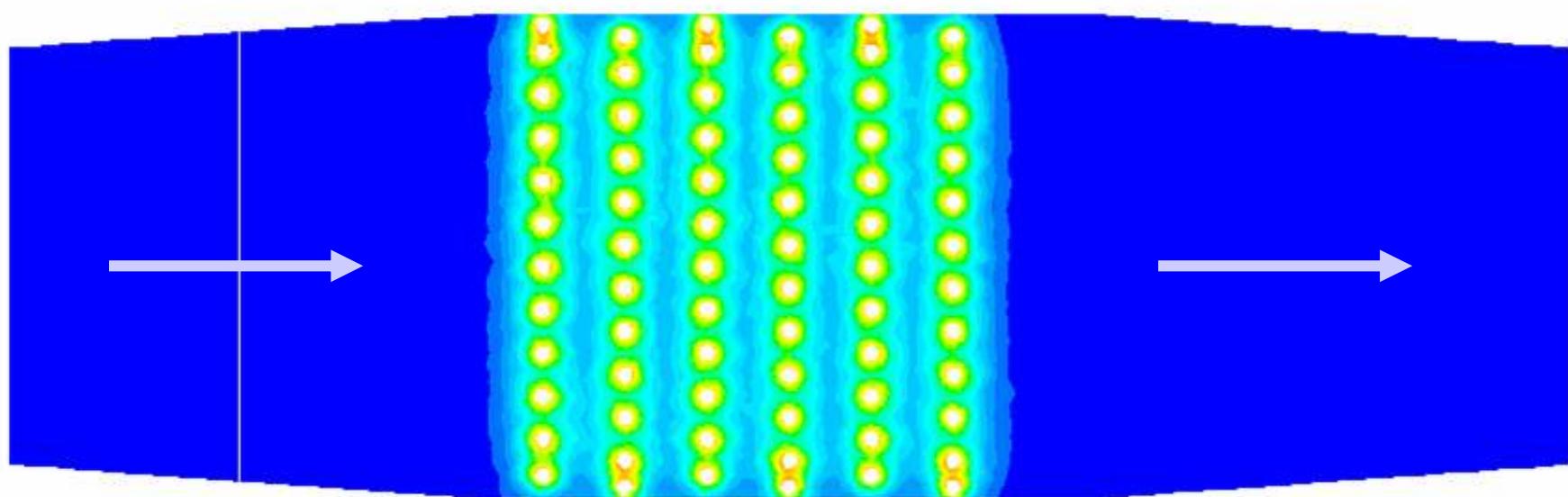
UV dose requirements include effects of photoreactivation

Source: University of Bonn

UV Disinfection



Irradiation Field



UV Plant – Clay Lane



Summary

- Primary objective to protect public health
- Water Treatment starts at source
- Multi-barrier approach
- Source to tap approach