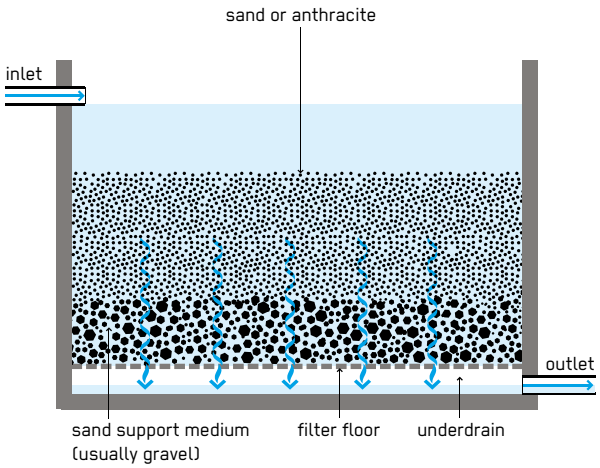
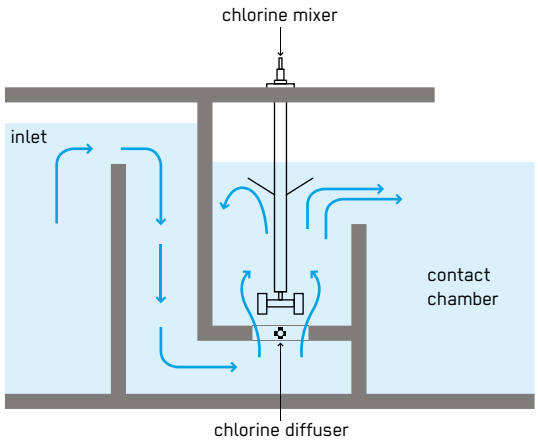
Tertiary Filtration and Disinfection

Phase of Emergency	Application Level / Scale	Management Level	Objectives / Key Features
* Acute Response * Stabilisation ** Recovery	Household * Neighbourhood ** City	Household * Shared ** Public	Removal of residual suspended solids and pathogens
Space Required	**Technical Complexity**	**Inputs**	**Outputs**
* Little	** Medium	● Effluent	● Treated Effluent



tertiary filtration (e.g. depth filtration)



disinfection (e.g. chlorination)

Depending on the end-use of the effluent or national standards for discharge and end-use, a Post-Treatment step may be required to remove pathogens, residual suspended solids and/or dissolved constituents. Tertiary Filtration and Disinfection processes are most commonly used to achieve this.

Post-Treatment is not always necessary and a pragmatic approach is recommended. The effluent quality should correspond with any intended end-use, the quality of the receiving water body or local regulations for effluent discharge. The World Health Organization Guidelines provide useful information on risk assessment and management associated with microbial hazards and toxic chemicals. Chlorine solutions can disinfect an effluent with low organic content and reduce pathogens in faecal sludge, however, the chlorine is scavenged by oxidation of organics and thus not used in an efficient manner. Disinfection of sludge is not Post-Treatment and can be done through Lactic Acid Fermentation **(S.19)**, Urea Treatment **(S.18)** and Lime Treatment **(S.17)**.

Design Considerations: Tertiary Filtration processes can be classified as either depth (or packed-bed) filtration or surface filtration (e.g. membranes). Depth filtration involves removal of residual suspended solids by passing the liquid through a filter bed made of a granular filter medium (e.g. sand). If activated carbon is used as the filter medium, the dominating process is adsorption. Activated carbon absorbers remove a variety of organic and inorganic compounds, and also eliminate taste and odour. Surface filtration involves the removal of particulate material by mechanical sieving as the liquid passes through a thin septum (e.g. filter layer). Depth filtration is successfully used to remove protozoan cysts and oocysts, while ultrafiltration membranes reliably eliminate bacteria and viruses. Low pressure membrane filtration processes (including gravity-driven membrane filters) are being developed.

Disinfection includes the destruction, inactivation, and/or removal of pathogenic microorganisms achieved by chemical, physical, or biological means. Due to its low cost, availability and easy operation, chlorine has historically been the disinfectant of choice for treating wastewater. Chlorine oxidises organic matter, including microorganisms and pathogens. Alternative disinfection systems include ultraviolet (UV) light and ozonation. UV light found in sunlight kills viruses and bacteria. Disinfection can thus take place in shallow ponds. UV radiation can also be generated through special lamps, which can be installed in a channel or pipe. Ozone is a powerful oxidant and is generated from oxygen in an energy-intensive process. It degrades both organic and inorganic pollutants, including odour-producing agents.

Materials: Post-Treatment technologies require special materials. Accessing chlorine, UV lamps, filter materials such as activated carbon or membranes may be a challenge, especially during an acute response phase. Accessing chlorine may be sensitive as it can be used for the construction of chemical weapons.

Applicability: The decision to install a Post-Treatment technology depends mainly on quality requirements for desired end-use and/or national standards. Other factors to consider are effluent characteristics, budget, availability of materials, and operation and maintenance capacity. Post-Treatment can only be applied effectively after a functioning secondary treatment. Pathogens tend to be masked by suspended solids in unfiltered secondary effluent. Chlorine should not be used if water contains significant amounts of organic matter, as disinfection by-products can form. Post-Treatment is not a high priority during the acute response. However, as it is very effective in removing pathogens, it can be considered for implementation during recovery to minimise public health risks.

Operation and Maintenance: Post-Treatment methods require continuous monitoring (influent and effluent quality, head loss of filters, dosage of disinfectants, etc.) to ensure high performance. Due to the accumulation of solids and microbial growth, the effectiveness of sand, membrane and activated carbon filters decreases over time. Frequent cleaning (backwashing) or replacement of filter material is required. Expert know-how is required, especially to avoid damaging membranes or to determine the right dosage of chlorine and ensure proper mixing. Ozone must be generated on-site because it is chemically unstable and rapidly decomposes to oxygen. In UV disinfection, the UV lamp needs regular cleaning and annual replacement.

Health and Safety: Personal protective equipment should be used at all times. If chlorine (or ozone) is applied to an effluent that is not well treated, disinfection by-products such as trihalomethanes may form and threaten environmental and human health. There are also safety concerns related to handling and storage of liquid chlorine. Activated carbon adsorption and ozonation can remove unpleasant colours and odours, increasing the acceptance of reusing reclaimed water. Filter media are contaminated after use and need proper treatment/disposal when replaced.

Costs: Sand filtration and ponds are relatively cheap (but the latter needs a lot of space), while activated carbon and membrane filters are costlier. In activated carbon adsorption, the filter material needs to be regularly replaced. Ozonation costs are generally higher compared to other disinfection methods. Chlorine is often widely available and not expensive.

Social Considerations: Professionals are needed to operate and manage Post-Treatment technologies.

Strengths and Weaknesses:

⊕ Additional removal of pathogens and/or chemical contaminants
⊕ May allow for direct reuse of the treated wastewater

⊖ Skills, technology, spare parts and materials may not be locally available
⊖ Constant source of electricity and/or chemicals needed
⊖ Filter materials need regular backwashing or replacement
⊖ Chlorination and ozonation can form toxic disinfection by-products

→ **References and further reading material for this technology can be found on page 195**