Summary of Issues | Strategies | Benefits & Costs | Key Uncertainties | Additional Resources

KEY POINT: *Primary public health and environmental concerns associated with pretreatment stem from the use of chemicals to treat the source water and the disposal of the residuals formed during the pre-treatment process.*

SUMMARY OF ISSUES

- **Chemical use**. Potential public health and environmental impacts associated with pretreatment stem from chemical conditioning (addition of biocides, coagulants, flocculants, antiscalants, etc.) of the source water and the potential propagation of chemicals (and their by-products) into the finished product water (WHO 2007).

  Additionally, accidental spills of chemicals or the leakage of these substances may occur during delivering, handling, or from storage tanks. This can result in safety issues and contamination of local soil (Xu et. al 2009).

- **Waste disposal.** There are also environmental concerns associated with the disposal of residuals formed during the pre-treatment process, particularly from surface water systems. The amount of residuals produced is primarily a function of feedwater quality (relative to the constituents that must be removed prior to the membrane process). For example, surface water has significant levels of suspended solids. These solids must be removed prior to RO, either in a backwash stream or as sludge, and require proper disposal. For inland desal, the most prevalent residual found in the concentrate stream is cleaning waste (WHO 2007).

  Additionally, if cartridge filters are used in pretreatment, the spent cartridge filters need to be disposed of at a sanitary landfill.

- **Construction activities and aesthetic impacts.** Construction generally includes initial earthwork activities (site grading, excavation), the laying of foundations, construction of facilities, and landscaping measures (e.g. paving, planting with trees, grass etc.) (Xu et. al. from UNEP 2008). The area affected depends on the size, design, and location of the facility. Construction activities involve heavy machinery, including bulldozers, excavators, graders, compactors, cranes, etc., as well as forklifts, loaders, and trucks for hauling away debris and excavated soils, and delivering construction materials and plant components. It is estimated that construction of the 50 mgd (189,000 m^3/d) Carlsbad Desalination Plant will take about 24 months (Xu et. al. 2009 from Poseidon Resources 2005).

Construction activities can temporarily impair the aesthetics surrounding the construction site and in nearby areas within visual and acoustic range. Construction activities can also cause an increased volume of traffic or transportation. The impacts will vary in terms of intensity and duration depending on construction phases (day and night differences, working week *versus* weekend, busy and more quiet construction periods). The annoyance may be caused by the movements of construction machinery and increased traffic on roadways, the emissions of dust, exhaust fumes and noise, or the stockpiling of soil, debris, equipment and materials if exposed to public views (Xu et. al. from UNEP 2008).

Click here to return to top of page

STRATEGIES

Chemical use

Guidance for chemical handling and safety should be developed with regard to the proper handling of chemical deliveries, security concerns, operational concerns, safety issues, and understanding of Material Safety Date Sheet. Another important consideration is the use of chemicals and formulations for pretreatment and cleaning that possess little or no environmental risk. If possible, hazardous substances that are toxic, persistent, that tend to bioaccumulate or have other adverse properties should be avoided or substituted by chemicals and pretreatment systems that minimize impacts on environment. If feasible, treatment of residual chemicals should be considered before discharge into the environment (Xu et. al. 2009 from UNEP 2008).

Drinking water quality considerations related to chemical conditioning

In the 2007 *Guidance for the Health and Environmental Aspects Applicable to Desalination, the* World Health Organization (WHO) recommends that the following drinking water quality related issues be taken under consideration when selecting pretreatment for membrane desal systems:

- Continuous source water chlorination is not recommended because chlorine addition creates large amount of disinfection byproducts, especially if the source water is of high organic levels. Intermittent chlorination should be used instead.

- The pretreatment system effluent should be dechlorinated in order to protect the structural integrity of the RO membranes and to produce consistent product water quality.

- Raw water should not be chloraminated prior to membrane separation. Chloramination generates both chloramines and bromamines. While chloramines are disinfectants with low oxidation potential and do not present a threat for the RO membranes, bromamines have an order-of-magnitude higher oxidation strength and their presence in the feed water to the RO system can cause deterioration of drinking water quality. Chlorine or chlorine dioxide are preferred to control excessive bio-growth in the intake, pretreatment and RO systems.

- Use of ferric salts for source water coagulation prior to filtration may result in reddish discoloring of the plant discharge. The spent filter backwash water from granular media pretreatment systems should be treated using coagulants (ferric sulfate, ferric chloride, etc.). This sidestream should be settled prior to discharge to surface waters in order to avoid the discoloring of the desal plant discharge.

WHO also notes that all chemicals utilized in the membrane desal applications should have an appropriate certification and quality control suitable for use in drinking water. Typically specialized governmental, public or private organizations certify products to those standards.

Management of residuals from pretreatment systems

Membrane residuals from inland brackish water pretreatment systems depend on whether the source water is groundwater or surface water. Many pretreatment systems for groundwater involve only screens, cartridge filters, addition of antiscalant (and dispersants), and possibly the addition of acid. When bacteria occurs in groundwater, pre-treatment needs increase and may approach those of treating surface water. The following discussion focuses on the more extensive pretreatment required for surface waters and, in fewer instances, for groundwater.

Depending on the type of pretreatment system used (granular or membrane filters) the spent filter backwash water (residuals) will vary in quantity and quality. Use of microfiltration (MF) or ultrafiltration (UF) pretreatment systems results in production of 50 to 80 percent less residual solids than that of conventional granular media filtration. However, UF and MF systems generate 3 to 5 percent larger volume of waste backwash water than granular media filters. MF and UF membrane pretreatment systems do not require chemical conditioning of the source water to produce effluent suitable for RO desal. Therefore, the spent backwash water from these systems is less harmful for the environment.

Discharge to a surface water body along with plant concentrate without treatment is one of the most widely practiced filter backwash water disposal methods. This method is typically the lowest cost disposal method because it does not involve any treatment prior to disposal. This method is suitable for discharge to large water bodies with good flushing – such as open oceans or large rivers.

The filter backwash water must be treated at the membrane treatment plant when its direct discharge does not meet surface body water quality requirements, or if it is not suitable for a direct disposal to deep injection wells. On-site treatment prior to surface water discharge or recycle upstream of the filtration system are possible options.

In many cases it is more cost-effective to recycle and reuse the settled filter backwash water rather than to dispose it with the concentrate. However, blending and disposal with the concentrate may be more beneficial, if the concentrate water quality is inferior and cannot be disposed of to a surface water body without prior dilution with a stream of lesser salinity.

The solid residuals (sludge) retained in the sedimentation basin are often discharged to the sanitary sewer in a liquid form (typically practiced at small to medium size plants) or dewatered onsite in a designated solids handling facility.

Construction impacts

To minimize the impacts from construction, the water supplier/contractor should work with affected stakeholders to determine and implement best management practices during construction.

Click here to return to top of page

BENEFITS & COSTS

- MF and UF membrane pretreatment systems do not require chemical conditioning of the source water to produce effluent suitable for RO desal. Therefore, the spent backwash water from these systems is less harmful for the environment. Tradeoffs associated with the use of conventional vs. MF or UF systems should be considered.

- In an inland setting, the cost of residual disposal can be very high.

Click here to return to top of page

KEY UNCERTAINTIES

N/A

Click here to return to top of page

ADDITIONAL RESOURCES

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Click here to return to top of page