KEY POINT: The primary environmental concerns related to surface water discharge from inland facilities include compatibility of the concentrate with the receiving water and impacts to aquatic organisms.

SUMMARY OF ISSUES

- Desal concentrates are sometimes discharged to rivers and other inland surface water bodies in accordance with local, state, and national water quality regulations (Mickley 2006).

- An increasing challenge for surface water disposal at inland facilities involves limiting the continued degradation of waterways caused by discharge of higher salinity effluents. Salinity limitations in receiving waters may be direct in terms of TDS or indirect in terms of chloride and sulfate (as an example). New discharges can raise ambient levels and eventually additional discharges will raise ambient levels up to the receiving water limit. At this occurrence, additional discharges that increase TDS will be prohibited. New discharges may impact permit limits for existing dischargers through reducing allowed discharge variances.

- The same situation exists with regulated constituents in the TDS. For instance, a discharge high in nitrate may bring the ambient receiving water level up to the receiving water limit; thereby reducing if not prohibiting additional high nitrate dischargers.

- Impacts of discharge to surface water can be greater in freshwater than in estuaries or the marine environment, where salt is a natural component of the ecosystem. Some freshwater organisms are only able to tolerate low levels of dissolved solids. As salinity levels increase in rivers, streams, and lakes, a shift to more salinity-tolerant species can be expected (NRC 2008).

- Concentrate from a brackish groundwater source may also contain toxic trace elements such as nitrate, arsenic or selenium, or radioactive constituents, in elevated concentrations. Concentrate streams containing these elements can cause significant impact to the receiving environment if not handled correctly (NRC 2008).

- When concentrates originating from groundwater are discharged to fresh or brackish waters, major ion toxicity can result (NRC 2008 from Mickley et al., 2001). This toxicity occurs when the ionic composition differs sufficiently from that of seawater adjusted to the same salinity. Toxicity due to this “imbalance” of ions relative to seawater has been
seen in mysid shrimp with respect to high calcium or fluoride or low potassium (NRC 2008).

- Dissolved gases and lack of oxygen can also be concerns for concentrate disposal. Concentrates from the treatment of most groundwater have very low levels of dissolved oxygen (DO). Prior to discharge, DO levels must be increased to avoid negative impacts on receiving stream biota. If the groundwater contains hydrogen sulfide, hydrogen sulfide in the concentrate must be suitably reduced before its discharge to prevent negative effects.

- Water containing high salt concentrations may create brackish layers in receiving lakes. Since saltwater is denser than freshwater, relatively saline concentrate can sink and form a layer at the bottom of receiving rivers, lakes and streams. This can have harmful effects on benthic (bottom) communities. However, regulations are in place to prevent this from occurring.

- Concentrate from brackish groundwater can be very corrosive. Pipelines transporting brackish water concentrate to an outfall must be fitted with special protective liners to avoid the discharge of corroded materials (metals). An alternative is to adjust the pH of concentrate.

**STRATEGIES**

To minimize environmental effects, concentrate discharge to rivers needs to be coordinated with background water quality, composition of the concentrate, discharge rates, blending characteristics, and local water quality standards. Some key considerations include (Xu et. al. 2009):

- Evaluation of discharge dispersion and recirculation of the discharge plume to the plant intake. In cases where the groundwater is obtained in the relative vicinity of the discharge site. However, it is common practice to locate outfalls downstream of beach or alluvial intake wells. This issue is more of a concern for coastal plants.

- Establishment of aquatic organism salinity tolerance for the site-specific conditions of the discharge location and outfall configuration. This is more of an issue for coastal plants discharging to the sea; inland the issue is approached through the requirement of WET tests.

- Evaluation of the potential for Whole Effluent Toxicity (WET) of the discharge. WET refers to the aggregate toxic effect to aquatic organisms from all pollutants contained in a
facility's discharge. It is one way EPA implements the Clean Water Act's prohibition of the discharge of toxic pollutants in toxic amounts); and

- Assessment of whether the discharge water quality meets effluent water quality standards applicable to the concentrate discharge

Concentrate disposal to environmentally sensitive areas may require special measures to protect aquatic life and endangered species. For example, the Taunton River 5 mgd (18.9 ML/d) brackish water desal plant uses concentrate storage and blending tanks to hold RO concentrate, and discharges to the estuary based on the tide cycles. This ensures the salinity of blended concentrate is similar to the receiving river, and minimizes the impact on aquatic organisms by preventing the exposure to a wide range of salinity variation (Clunie et al. 2007).

**BENEFITS & COSTS**

**Benefits**

Where available, this method is typically the most straightforward and cost-effective solution – dependent on the conveyance distance between the desal plant and the outfall location.

**Costs**

The costs for surface water discharge are site specific, and mainly determined by (Mickley 2006):

- Concentrate conveyance costs from the desal membrane plant to the surface water discharge outfall. The costs are typically closely related to the concentrate volume and the distance between the desal membrane plant and the discharge outfall.

- Costs for outfall construction and operation. The costs depend on the outfall size, diffuser system configuration, outfall length and material, and concentrate treatment prior to discharge.

- Costs associated with monitoring environmental effects of concentrate discharge to surface waters. The costs associated with environmental monitoring of surface water discharge may be substantial, especially if the discharge is in the vicinity of an impaired water body, in an environmentally sensitive area, or in areas with limited natural flushing.
KEY UNCERTAINTIES

Inland facilities are facing increasingly difficult challenges related to concentrate management. Challenges related to concentrate discharge to fresh surface water include:

- Larger concentrate flows of increasing plant size limiting disposal options;
- Cumulative environmental impacts on receiving waters from an increasing number of desal plants in a region;
- More stringent discharge regulations making disposal more difficult and complicating the permitting process; and
- Increased public concerns over environmental issues, which may affect desal decision making.

The concentrate management challenge is particularly acute in the arid southwest U.S. where disposal to surface water is often not a viable option for large-scale plants. For areas where surface discharge is a potential option, concentrate management is challenged by more stringent discharge regulations.

It is worth noting here that the limited research to date on the environmental effects of concentrate management practices has primarily been focused on seawater desal plants, because globally, seawater plants tend to be the largest desal facilities. Currently, the vast majority (>95%) of desal facilities in the United States, both in the number of plants and in total capacity, use brackish source water.

ADDITIONAL RESOURCES


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