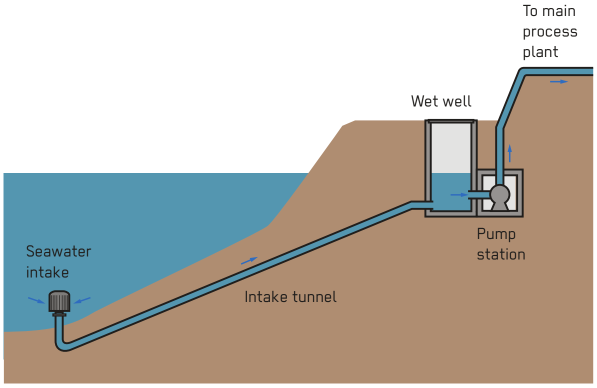
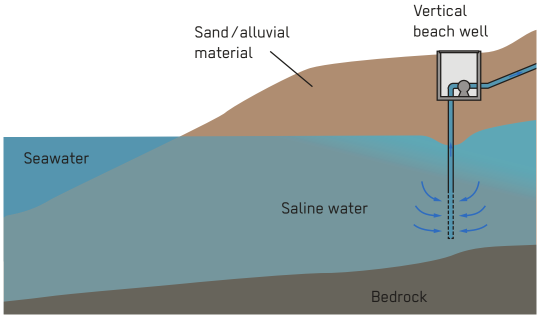
# Seawater Intake

| Response Phase | Application Level | Management Level | Objectives / Key Features |
|---|---|---|---|
| Acute Response<br>Stabilisation<br>* Recovery | Household<br>** Neighbourhood<br>** City | Household<br>* Shared<br>** Public | Surface or bank filtration intakes for seawater |
| **Local Availability** | **Technical Complexity** | **Maturity Level** | |
| *** High | *** High | *** High | |

SURFACE INTAKE




SUBSURFACE INTAKE




Seawater Intakes are used for desalination plants and non-drinking purposes, such as swimming pools or cooling. They are therefore usually not considered for emergencies unless the work is to restore damaged existing intakes for desalination plants to restore drinking water supplies.

Seawater Intakes can be categorised as surface or subsurface structures, and the choice of one or the other depends on different factors. They are usually designed for large volumes of water and must be done in such a way as to prevent damage and avoid environmental problems while producing water of sufficient quality and consistency for any subsequent treatment process.

**Design Considerations:** The main design concerns for desalination plants are abstracting sufficient water to meet the demand, minimising the environmental impact, and achieving good water quality as consistently as possible. Seawater Intakes are site specific, tend to be the most challenging aspect of desalination plant construction and can account for up to one-fifth of the total capital cost. Various factors influence the choice of site and the intake type, including the topography and geology of the coastline, raw water quality data, marine biology, pollution sources and navigation requirements. Overall, an intake and treatment plant are often sited close together to reduce pumping costs. This is especially important with Reverse Osmosis **(T.15)**, which produces significant amounts of high-salinity wastewater.
Surface intakes are usually used where large volumes are required (over 38,000 $m^3$/day), where the force of the sea is not likely to cause damage to the structure or where geology does not allow a subsurface intake. Surface intakes have an open pipe on the seabed that commonly connects to a sump built onshore, where water is first screened before being pumped onward. Issues with this arrangement include impingement, where organisms get trapped on the screen by the force of the water flow, and entrainment, where smaller organisms pass through and reach the treatment plant. Solutions for this include measures at both the ends of the intake pipe and screens to scare fish away (e.g. a velocity cap over the pipe end), to prevent larger organisms from entering (e.g. filter net

barriers around the pipe end or fine mesh screens) and to reduce velocity (e.g. passive screens). Water quality can also vary with surface intakes (e.g. after storms), which can prevent desalination plants from operating. Water from an open intake will still always require significant pre-treatment to remove anything that can foul membranes in the treatment process.
Where environmental or water quality concerns cannot be met, a subsurface intake may be considered, which has several advantages over surface intakes. While they tend to abstract smaller volumes, they produce better quality water with greater consistency, therefore reducing pre-treatment requirements. They can be constructed using techniques similar to Riverbank Filtration **(I.6)**, as well as through a Ranney collector well (large diameter concrete well with radial horizontal well screens driven in horizontally), angled drilled wells or horizontal drilled wells. However, the most common technique used is vertical drilling close to the sea to tap the deeper wedge of seawater that sits underneath the fresh water in this zone. The exact type of subsurface intake can also depend on the total water quantity needed. Jetted seawater wells have also been used effectively for lower abstraction requirements, the advantage being that they are quick and easy to install. One problem with subsurface intakes, however, is the risk of destabilising the equilibrium between sea and fresh water, which could cause local wells that tap into the freshwater zone to be affected by saline intrusion.

**Materials:** Materials depend on the intake design that is used, which could be PVC pipes, locally available gravel or concrete. These materials must be corrosion resistant due to the highly corrosive nature of seawater. Pumps used, particularly for surface intakes, should also be resistant to pumping solids.

**Applicability:** Seawater Intakes are an option for the stabilisation and recovery phases of an emergency where the goal is to restore damaged existing desalination plants. A new desalination plant construction however is clearly work that is done outside of the emergency context.

**Operation and Maintenance:** Depending on the type of intake infrastructure, different O&M measures will be needed. A duplicate intake structure will allow maintenance to be carried out while the intake continues to function. Surface intakes will need regular underwater checks of screens (every two to three months) to deal with any impingement and biofouling. This typically involves checking for the presence of sea grass, oil and grease from shipping, wastewater discharges, mussels/barnacles and algal blooms, all of which can foul screens and membranes. Subsurface intakes require less maintenance. The quantity of water entering the intake should be monitored for signs of screen clogging, which will clog completely over time if left unchecked. Maintenance work will involve periodic well screen cleaning, and redevelopment will be required to maintain production efficiency. Well screen maintenance in slant and horizontal drilled wells may require specialised maintenance techniques. All intakes pump seawater, which is corrosive, so any metal parts will likely need repair or replacement at some point.

**Health and Safety:** Health implications are the same as those for the construction method chosen. For wells, health risks are associated with excavation, which varies according to the type of intake **(see I.7)**, while for borehole drilling, risks include the use of heavy drilling machinery with moving parts and overhead power lines when setting up the rig **(see I.8)**. In addition, working close to the open sea is potentially hazardous and requires adequate protective gear and a thorough risk analysis.

**Costs:** Capital and ongoing costs vary depending on the type of intake and how many wells are needed given the water quantity required. In general, costs will be higher than equivalent freshwater intakes due to the need for corrosion-resistant materials in the system. As a rough guide, capital costs of surface intakes range from tens of thousands to tens of millions of dollars, which is significantly higher on average than for subsurface intakes, varying based on the site and design. In addition, they need to have environmental assessment and pre-treatment costs included. By comparison to subsurface intakes where pre-treatment is not necessary, costs can still be high (up to 5,000,000 USD).

**Social and Environmental Considerations:** Seawater Intakes might result in the loss of recreational uses in the intake area, and there may be a visual impact of some intake structures. Surface intakes that are not designed correctly can also impact marine organisms, and subsurface intakes can cause saline intrusion into local wells.

**Strengths and Weaknesses:**

(+) Can abstract large volumes of seawater
(+) Subsurface intakes provide better quality water, and pre-treatment is then not needed
(+) Subsurface intakes have less environmental impact

(−) Surface intakes have impingement and entrainment risks, and additional pre-treatment is required after abstraction
(−) Finding a suitable protected site might be challenging
(−) The success of subsurface intakes depends on the local geology
(−) Subsurface intakes can have a negative effect on nearby fresh water sources, and may disturb sensitive coastal ecosystems

→ **References and further reading material for this technology can be found on page 215**