Lopez Water Project – completed 2007

Project Introduction

This project is a seawater RO desalination system that meets the peak needs of my clients' two beachfront estates with occasional gatherings of 200-300 people, the adjoining subdivision, and became the 1st legal operation to sell potable water on Lopez Island (replacing the ad hoc water deliveries of an old farmer).

Project Background

The old water system utilized two very low producing wells (.2-.4 GPM in total), supplemented by truckloads of non-potable water. Inadequate for supplying the needs of the two estates, my clients initially drilled 4 dry wells on their property prior to approaching me to design a solution. The solutions considered included rainwater catchment and RO desalination. My calculations quickly showed rainwater catchment to be insufficient.

The Sea Water Reverse Osmosis (SWRO) facility ultimately decided on generates 15,000 GPD of potable water, and has been designed to double its capacity to 30,000 GPD solely through the addition of RO pressure vessels.

My initial demand estimate was 10,000 GPD, this was an approximation only, since there is a general lack of water in the area and no data available to verify this demand. At peak use, the two estates occasionally host 200-300 people. Additionally, the adjoining subdivision of 30 houses needed water, and there was a market for potable water to be hauled off-site.

The system's outfall and intake consist of two 2" HDPE pipes constructed in the Lopez Sound tidal zone for seawater intake and concentrated brine discharge. The intake and outfall oscillate and are laterally separated 50 feet apart and weighted down on the sea-bed with concrete blocks calculated to secure the pipes with a minimal footprint. The two HDPE pipes extend out into the marine water 750 feet and 800 feet respectively.

An elevated 4" corrosion-resistant stainless steel copper alloy screen was provided at the ends of the 2" HDPE pipes for seawater intake and brine water dispersion in the sea.

The 2" HDPE pipes that are landward of the extreme low tide boundary were buried 2 feet below the existing grade. The buried 2" HDPE pipes were located in a 12" wide trench which was excavated with a small trencher to minimize the environmental impacts. The trenches were backfilled with excavated native materials consisting of sands and gravels. The 24" depth was chosen in the tidelands region to minimize the environmental impacts of trenching in a marine environment while maintaining the safety concern of future damage to the piping from storm damage, boating activities etc...

The 2” HDPE pipes located landward of the shoreline were installed at a 36” minimum depth to accommodate current regulations on minimum pipe burial depth. The seawater supply pump was installed in a dry concrete vault on shore 5’ above the extreme high water mark. Seawater was pumped to an upland building in which the SWRO desalination water system was installed.

Up to 33 gpm of seawater can be pumped to the SWRO desalination water system, 10 gpm potable water produced from the seawater, and 23 gpm of concentrated brine will be returned to the Lopez Sound via the 2” HDPE discharge pipe. The SWRO desalination water system will produce up to 15,000 gallons potable water per day. Maximum seawater withdrawal will be 50,000 gallons per day, and a maximum 35,000 gallons brine water will be returned to the sea per day. The 35,000 gallons brine water includes RO flushing water which will come from treated water after the RO system.

Project Workplace Activities

We created the design, and shepherded the project through the permitting and application phase. We also organized and executed the construction of the final Sea Water Reverse Osmosis plant. The plant was completed on time, under cost and in compliance with all health, safety and environmental regulations.

SWROs are heavily regulated – and all designs require permission from 12 separate permitting agencies (three County, eight State, one Federal); a process that lasted 18 months.

Significant SWRO Equipment Design Parameters:

1. Pre treatment is critical to RO filtration design. We utilized macrolite sand filters as a primary treatment method for larger particle removal and replaceable pleated cartridges filters from 5 to 1 micron as a final filtration barrier before the RO process. Because the plant is remote it has to be self-sufficient and low-maintenance. The facility is fully automated and can be monitored remotely for minimal on site maintenance. The macrolite sand filters, UV light, and RO membranes have an automated back flush cycle, with the cartridge filters needing to be replaced typically every 4-6 months.
2. Since chlorine is a corrosive oxidant to the reverse-osmosis membranes, it cannot be used as a disinfectant prior to the membranes without de-chlorination. This two-step process is not only a high maintenance item it is costly to transport given the remote location; for this, we used ultra-violet light to disinfect, extensively researching a PVC UV system that won’t oxidize due to the corrosive nature of the seawater environment.
3. Energy efficiency is becoming a major concern with seawater desalination since the cost associated with the process is typically higher than any other potable water treatment method. We used an Energy recovery system in which the energy

consumed for the RO process is 60% less than conventional RO systems without this technology. The energy recovery device has few moving parts, and is a reliable addition to seawater desalination.

4. To overcome biofouling, we created the system to oscillate between intake and outfall, using brine to kill biological buildup. We also specified the use of special v-shaped screens made of corrosive resistant copper-nickel mix so that lodged particles fall to the bottom of the screen and are dislodged by the backwash.
5. In an effort to help mix the dense brine when it reaches the marine environment we added an air suction intake to the outfall pipe which introduces small air bubbles to the discharge brine to help in marine mixing, achieving a complete mix within 40 feet and a 95 per cent mix within 25 feet of the outfall.
6. The seawater pump that draws water from the ocean is highly susceptible to corrosion and electrolysis. Through extensive research, we was able to source a self-priming bronze alloy pump made specifically for seawater.
7. The HDPE pipes on the ocean floor are secured with concrete weights. To minimize the environmental impact, we calculated the weights to achieve a minimum footprint, taking into consideration the pipe's distance and additional buoyancy created by the induced air. Additionally, traditional methods such as rebar could not be used, due to the corrosive effects of saltwater. The solution was to sandwich the pipes between rebar-free, high-strength concrete fastened with stainless steel bolts. Tensile strength was in the fasteners and compressive strength in the concrete.

Upon design approval, we had a window of six months in which to schedule our installation in the tidelands - a task which environmental regulations require be completed in a one tide cycle period, the longest tides in this region typically last eight hours - necessitating installation to be a well planned and executed operation. Also stipulated by the agencies was a beach work zone easement of 20 feet in width. In addition, the equipment must refuel and be maintained 300' above the tidelands. Any incomplete work in this zone after the single tide cycle was subject to re-application; hence another 18-month period and applicable fees. There is little room for any mistakes in organization or timing for this technical operation.

Prior to installation day, we organized the materials, scheduled the timing for the work, instructed the crew, and anticipated and prepared for any potential complications. My crew was made of ten men, two foremen, a project manager, and two superintendents.

Post installation, we worked with the programmer to automate the SWRO plant; including calibration of differential pressure sensors; timing and sequence of back flush procedures and membrane flushing processes.

Post treatment: To overcome the corrosion inherent in purified RO water, we calculated the levels, and automated the injection of calcium chloride, chlorine, sodium bicarbonate, and calcium carbonate to create product water with a Ph of 7.5. This automation is maintained by an operator to assure the levels of post treatment additives are at their appropriate levels.

Project Summary

SWRO is a newly developing, and rapidly evolving field. Projects are highly technical in nature, and because of the rapid rate of change, the industry and the projects are always exciting and new requiring innovation and problem solving, and constant education and updating of skills. 5 years ago the SWRO industry looked completely different than it appears today. I am certain that in another 5 years the industry will have changed just as much again. I have been privileged to be involved for the past 10 years.