

Out Skerries Water Treatment Plant

tough challenge on remote Scottish Island

Water supply challenges facing remote island communities in Scotland are considerable. A combination of the scarcity of fresh water resources, difficult geology, adverse environmental conditions and limited populations don't help matters; with none facing tougher conditions than the community of Out Skerries, a remote island located due East of Shetland at the extreme Northern tip of Scotland.



Out Skerries - remote islands off extreme Northern tip of Scotland

courtesy Scottish Water

The community, comprising 70 people located on three bridge connected islands, had major difficulties in securing drinking water of sufficient quality and volume, resulting in the need for the water supply authority to periodically have to take emergency measures to augment the capacity of the islands' infrastructure.

The existing treatment process failed the Water Supply (Water Quality) (Scotland) Regulations 1990, on colour, THM's, iron and aluminium concentrations. The volume of water available for treatment and supply was also prone to limitations during periods of low precipitation, which are unexpectedly common for this small group of islands.

Raw water supply to the treatment works comprised a collection trough ring encircling the largest hill on the island to collect rainwater run-off. This trough fed an impounding raw water reservoir created by a dam across a natural rock recess combined with an additional steel storage tank, from which the flow was pumped to the treatment process which comprised filtration, chlorination and distribution.

Water supply challenge

The challenge that the water supply authority required to address was, to both augment the supply of raw water resources and improve the quality of the final water distributed to consumers.

It was decided to install two groundwater abstraction boreholes (one duty and one standby); 14 exploratory boreholes were drilled in total of which four were considered useable, with boreholes 9 and 11 being selected on the basis of highest water quality and sustainability of yield. Whilst this assisted the availability of raw water, it worsened the treatment issue, as the groundwater had elevated levels of chloride salts due to the proximity of the sea.

Raw water quality for each source, together with final water specification, has been tabulated in Table 1.

The challenge, therefore, was to control the available water within the system and provide a process that could treat either source in whatever volumes and blends was available. In practise, this required a treatment process that was sufficiently robust to handle raw water high in both salinity and organic carbon concentrations and flexible enough to cope with significant fluctuations in these concentrations as different combinations of the available resources were employed.

Contract

PCI Membranes was awarded a contract to design and build a new water treatment plant to replace the existing works, which also comprised installing new borehole pumps. See diagram of the borehole pumps Table 1.

Table 1

Parameter	Units	Surface	Borehole 9	Borehole 11	Final Water
Colour	°Hazen	76.1	6	6	5
Turbidity	FTU	1.6	94	15	0.4
pH		6.9- 7.8	7.4 – 7.9	7.2 – 7.3	8.0 – 9.5
Aluminium	µg/l	357	163	157	50
Iron	µg/l	332	251	342	50
Manganese	µg/l	18	202	192	20
TOC	mg/l	15	3.4	2.9	2
TSS	mg/l	4.9	-	-	-
Alkalinity	mg/l HCO ₃	12-285	275	339	-
Chloride	mg/l	414	194	742	250
Sodium	mg/l	213	152	151	200

tubular nanofiltration process, which uses 12mm tubular membranes with an innovative mechanical foam ball cleaning system.

The high cross flow velocity within the tubular membranes, which is obtained by employing a recirculation rate in the order of five times the forward feed, minimises the accumulation of foulant materials upon the filtration surface, thereby maximising the interval between cleans. This feature, together with the ability to routinely clean the membranes by mechanical means alone, enabled all waste streams to be discharged, under licence with the Scottish Environmental Protection Agency, into the local environment (a major benefit at a remote site such as Out Skerries).

The nanofiltration membrane retention characteristics hold back the vast majority of impurities present in the raw water, enabling the product water to be compliant with drinking water quality standards in all respects other than salinity. The product stream is, therefore, ideal for subsequent treatment (in part) by the reverse osmosis polishing plant as it contains very few foulant materials, again enabling the accumulation of foulant materials to be minimised and hence cleaning intervals to be maximised.

The entire flow is processed by the tubular *Fyne* plant, with a proportion then being sent through the RO plant to remove dissolved

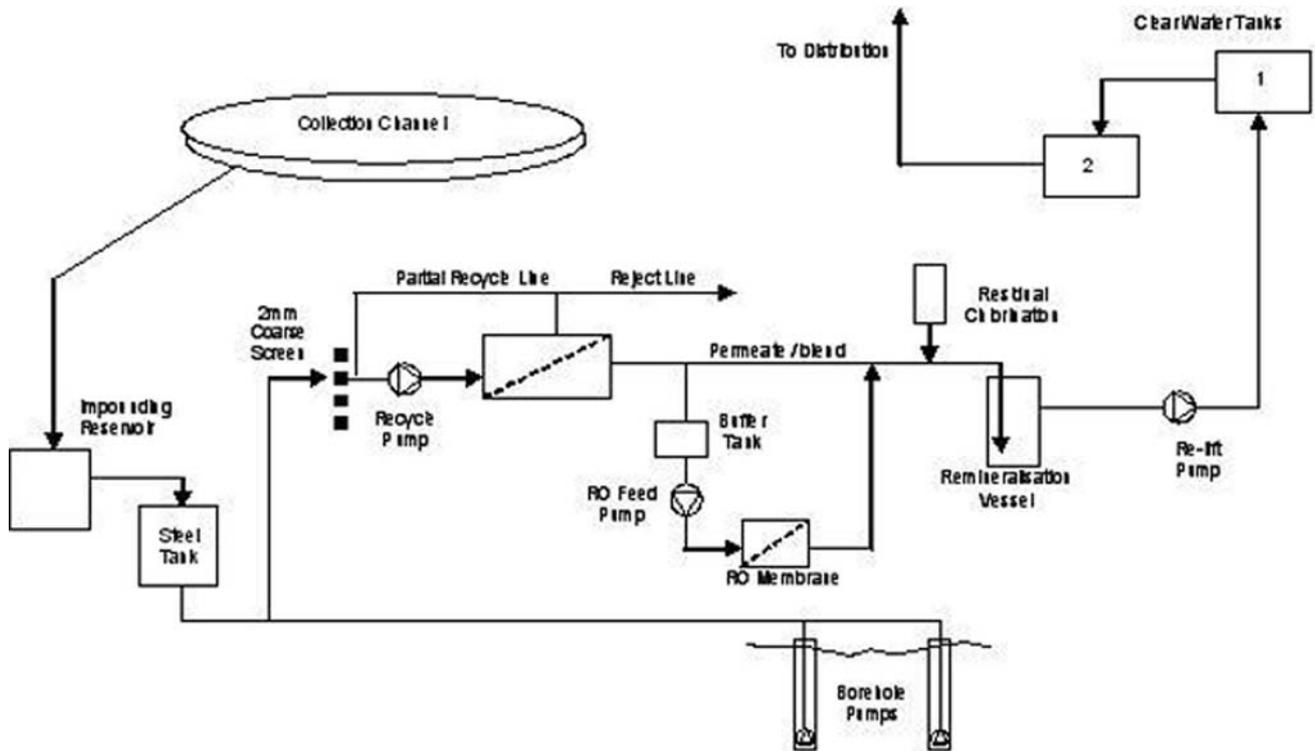


Diagram shows the process at Skerries WTW

The solution

The system is designed to utilise ground water availability wherever possible, however, hydrogeological sustainability studies had shown that the borehole sources could only be employed initially for ten hours each per day (subject to conductivity limits) at a rate of 6 litres/hour to avoid a deterioration in abstracted water quality. Minimising draw-off from the surface water impounding reservoir (to make up the required demand that is not satisfied by the ground water resources) provides the maximum security from prolonged periods of dry weather, which can, of course, be hard to anticipate. The two raw water sources are blended in the existing steel raw water storage tank prior to entering the plant.

To assist in reducing costs; the old filters were converted to provide treated water storage. Heart of the plant is the “*Fyne*”

salts (the remainder bypassing this stage), with the subsequent re-blended flow having sufficiently low salinity to meet drinking water quality standards. The combined flow is then provided with a residual disinfection dose of sodium hypochlorite before final hardening by contact with calcium carbonate media and lift pumping to the treated water storage tanks. The barrier nature of membrane technology typically provides simple, robust treatment processes, however, the unusual nature of the raw water supplies in this case (salinity together with organic carbon) demanded a more sophisticated solution.

As the operator of the Out Skerries water Supply Plant also holds a number of responsibilities within the island community, the plant was designed with full automation included, thus demanding only periodic inspections for routine maintenance.



Fyne Reverse Osmosis Plant for installation at Skerries

courtesy North of Scotland Water, now Scottish Water

The plant was supplied, installed and commissioned by *PCI Membranes* (an ITT Sanitaire company) to North of Scotland Water with commissioning having been completed in September 2003. The client's representative for process and civil engineering consultancy was *Hyder Consulting*. This installation although slightly unusual in the challenges overcome, is just one example of 40 *Fyne* Plants operating worldwide. ■



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