Seawater desalination in Australia and the Perth experience—a sustainable solution

Gary Crisp[1]
[1]Desalination Technical Leader, GHD Pty Ltd, Brisbane.

Abstract

In the face of the driest winter on record, the Perth Seawater Desalination Plant (PSDP) commenced delivering an annual capacity of 45 GL of much needed drinking water into the Integrated Water Supply Scheme (IWSS) in November 2006.

The PSDP, located at Kwinana, 30 kilometres south of Perth, Western Australia, has been heralded as a landmark in the development of the Australian water industry. It is a strong and worthy contender to be regarded as a world-leading model for future sustainable seawater desalination plants globally. At a peak capacity of 144 MLD, the $387 million plant (which includes $64 million of integration assets), is the largest operating seawater desalination plant outside of the Middle East, and Australia's first large-scale desalination facility for public water consumption.

The PSDP is also the largest seawater desalination plant in the southern and eastern hemispheres and looks likely to maintain this status into the foreseeable future. At full capacity, it is the biggest single water source feeding into the IWSS, providing some 17 per cent of Perth's water needs.

Construction commenced in June 2005 after a unique tendering process which involved a design competition between two short listed finalists from eleven original submissions. The plant was built on an extremely tight time schedule and budget and this came with its own set of challenges. Some key environmental challenges included; approvals and regulations, energy, concentrate management, marine monitoring, aesthetics and community involvement.

The desalination plant was built by the Multiplex-Degremont Joint Venture, in alliance with the Water Corporation. The joint venture is registered as the proAlliance (Perth Reverse Osmosis Alliance). The plant will be operated for 25 years by Degremont in alliance with the Water Corporation.

A recently completed 82 MW wind farm supplies over 272 GWhr of energy per year to Perth's electricity grid. The PSDP will consume 185 GWhr of energy per year from the grid making it the world largest desalination plant using renewable energy. Coupling this energy source with the low specific energy consumption achieved from the plants novel design, incorporating isobaric energy recovery devices (PX) from ®ERI, ensures that it is the world's most energy conscious plant.

Considering the plants partial two pass system which produces a permeate at less than 100 mg/L TDS, from a feedwater salinity of 35,000 mg/L, the achievement of a specific energy consumption of less than 3.9 kWh/m3 is remarkable.

Other unique aspects of the plant include the partial second pass which has been included to ensure a bromide content of less than 0.1 mg/L in the product water and Degremont's proprietary Densadeg sludge thicker to ensure dewatered sludge can be safely transported and disposed of to landfill. Although inert and the fact that PSDP is located along an industrial zone, Water Corporation committed to prohibit the return of ferric sulphate sludge to the ocean to ensure that there were no aesthetic impacts on the white sandy coastline.

Further, in order to meet the strict environmental conditions, the seawater concentrate is returned 470 metres into the ocean via a 40-port diffuser, with nozzles spaced at five metre intervals, to ensure total mixing of seawater concentrate within 50 metres of each side of the last 200 metres of pipeline. Therefore, the discharge is effectively no different from the naturally occurring seawater in terms of its salinity and meets the Environmental Protection

Authority's stringent criteria. Extensive real-time monitoring in Cockburn Sound will continue together with annual marine habitat mapping to ensure long term impacts of the project continue to be managed.

The additional cost for the average residential customer is AU$40 per annum, less than AU$0.70 per week, as stated by the (then) Premier of Western Australia on announcement of the project in July 2004 has come to fruition as originally estimated.

Taking all the above factors into account and considering the plants small physical footprint (on land and in the sea), this plant is one of the most sustainable water sources in Australia, and the only water source in Australia that wholly caters for the triple bottom line, economic, social and environmental factors. All other sources only cater for the double bottom line, economic and social factors.

This paper will describe the contracting, design, operational and environmental characteristics of the Perth Seawater Desalination Plant and demonstrate why this project is leading the world in terms of sustainable desalination. Further, the paper will touch on future sustainable practices such as gleaning energy from osmotic pressure in combination with other renewable energy sources and how, with this in mind, future desalination sites will be strategically set aside for future generations.

***Keywords*:** desalination, seawater concentrate management, energy use, ecological footprint, sustainable water source

Introduction

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Perth Seawater Desalination Plant description

Perth Seawater Desalination Plant (PSDP) is located in Kwinana, an industrial area approximately 25 km to the south of Perth. The plant draws water from the ocean via an open intake catchment, located in Cockburn Sound approximately 200 metres offshore in 11 metres of water 6 metres below sea level.

The complete process (which takes about half an hour, sea to storage) includes the following steps:

- an open intake,
- screening to protect the feed pumps and dual media filters,
- single stage dual-media filtration,
- cartridge filters for polishing and security,
- a two-pass reverse osmosis process,
- potabilisation treatment (including remineralisation, fluoride injection, disinfection).

Plant optimisation

The PSDP design has been optimized in relation to the following factors:

- availability,
- redundancy,
- flexibility of operation.

The plant consists of two 50%-capacity streams and adequate redundancy has been catered for in relation to major equipment (pumps, blowers and air compressors, filters, electrical transformers). Plant operation is automated and flexible to cater for diverse seawater feed variations (temperature, TDS), and to give a variable flow according to different operation options (recovery, permeate flow, number of racks in operation, demand and membrane age).

Intake structure
Intake screening at the intake structure consists of course barred screens offshore and automatically cleaned travelling band screens onshore.

Seawater forwarding pumps
The PSDP seawater forwarding pumping station is based on wet well /dry well design. The hydraulic conditions in the intake structure were monitored using computerised fluid dynamics. The study confirmed the initial choice in terms of tank design including the pump inlet arrangement.

Pre-treatment design
The pre-treatment design was based on the results of a pilot study performed during the summer and winter of 2004 and the winter of 2005 as discussed below. Filtration velocity, media type and effective size and water conditioning were optimised for high and low temperatures and varying water qualities. The seawater is fed by gravity to the seawater pumps. The raw water is pumped and water conditioning is performed in-line using static mixers. The treatment line dosing includes pH correction using sulphuric acid and coagulation using ferric sulphate and a coagulant aid.

Filtration is performed by 24 pressurised dual media filters using anthracite and sand as filter media. Based on an acceptable filtration velocity established in the pilot plant trials, the nominal flow can be achieved from 20 filters. The filtration is based on a 24 hour filtration cycle, each filter being periodically backwashed with air and water which takes one hour. The backwash water can be either filtered water or brine.

Pilot test
The pilot tests were conducted for pre-treatment only, while the RO design was based on the membrane supplier's software and Degrémont knowledge on membrane performances and rack hydraulics. The desalination plant pre-treatment design was based on a 4-month pilot test performed during the preliminary engineering phase. The main objectives of this study were to select the number of filtration stages, the type of filtering media and the coagulation conditions.

Pilot test were performed during two periods, one in the summer of 2004 and the other in the winter of 2005. The water quality remained relatively stable over the two periods of tests. The level of particles, characterized by turbidity and SDI values were relatively high for an open seawater intake.

The pilot unit used for this study comprised of 4 transparent columns, each equipped with a feed pump and able to operate under gravity or pressure. Coagulation was performed in-line using ferric chloride and coagulant aid. The pH of coagulation was adjusted using sulphuric acid. Different media were evaluated, including pumice, anthracite and sand, with different particle size according to the number of filter stages: single or double stage filtration.

The seawater was monitored for temperature, turbidity, conductivity and pH on a continuous basis, and for SDI, UV absorbance, TOC and salinity on grab samples. The filtered water was monitored for turbidity on-line, and for iron, pH, salinity, UV absorbance on grab samples. Periodical evaluation of algae count was also performed, as well as bacteria counts.

The first part of the pilot test performed in summer 2004 was dedicated to the comparison of single stage filtration versus double stage filtration, rather than to the comparison of different media in a single filtration stage configuration. The comparison was made on filtered water quality and filter clogging velocity.

In all the configurations, the filtered water turbidity and SDI remained below 0.1 NTU and 4 %/min respectively. The optimization of the water conditioning and the use of a ripening phase allowed for the achievement of filtered water SDI's consistently below 3.5%/min (average 3%/min) on a reliable basis. Based on these results, a single stage filtration process was selected to pre-treat the seawater from an open seawater intake.

The second period of tests was carried out during winter from June-July 2005. During these tests, the program focused on single stage filtration. Several types of media from local suppliers were tested to select the suppliers for the plant under construction.

Reverse osmosis
A single pipeline conveys pre-treated seawater via 5 micron cartridge filters to the HP pumps and energy recovery devices. The first pass has twelve seawater reverse osmosis (SWRO) racks, each with a production capacity of 13,350 kL/d, or a total of 160 ML/d. Each rack uses 1,134 FilmtecTM model SW3OHRLE400 membrane elements housed in ProtecTM 7M side-port pressure vessels.

The product water, depending on variables such as seawater salinity, membrane age and temperature, ranges from 150 to 300 mg/L, at about 45% recovery. The RO trains are fed with six Weir split-case centrifugal HP pumps, each with a capacity of 1,144 kL/h at 620m of differential head, driven by 2,600 kW Siemens Motors. The best efficiency point of these pumps is approximately 86%. The reject stream from the RO modules is passed to twelve arrays of sixteen ®ERI model PX-220 energy recovery devices, each array with a capacity of 800 kL/h, where the pressure is transferred to an equal volume of seawater. This pressure is boosted by about 5% and circulated into the RO modules by twelve Union® vertical booster pumps, each with a capacity of 661 kL/h at 39 m of differential head, driven by 112 kW motors controlled by VFDs. The plant is arranged with six SWRO trains on each side of a central pump aisle. Three HP pumps feed a high-pressure manifold or "pressure centre" which in turn feeds a bank of six SWRO racks. Flow from the manifold to each train goes through a high-pressure control valve which allows fine adjustment of the membrane feed pressure. Each rack has a dedicated PX-device array and booster pump. The PX device arrays are situated between the membrane-vessel racks.

To further reduce salinity of the product water to 10-50 mg/L and reduce bromide to 0.1 mg/L the first-pass permeate goes to a second pass consisting of six low-pressure 'brackish water' reverse osmosis racks, with further product water extracted from the reject stream of the first stage, giving a recovery of 90%. Post-treatment chemicals include hydrated lime, gaseous chlorine and carbon dioxide. Product potable water flows through a four-hour buffer tank before being pumped approximately 13 kilometres to the fresh water reservoir that supplies the city of Perth with drinking water. Reject brine, after use as backwash for the dual-media filters, is pumped 0.5 km out to a diffuser field in Cockburn Sound.

Energy recovery devices
In a SWRO system equipped with PX (Pressure Exchanger) energy recovery devices, the membrane reject is directed to the membrane feed. The transfer of pressure from the reject stream to the seawater is performed by direct contact of the two streams inside the ducts of the PX rotor. The rotor contains no intervening pistons or valves. A small diameter rotor duct, in essence a 'tube' full of low pressure seawater is connected to the high pressure reject, which forces the seawater out at high pressure. Immediately afterwards, the tube, now nearly full of low pressure reject, is released to ‘drain’ and the reject pushed out by incoming seawater at feed pump pressure. There is virtually no interfacial mixing because:

- the tubes are small diameter,
- each operation is performed in around 0.05 seconds.

This is accomplished by mounting a bundle of tubes in a rotor which presents each tube to the appropriate ports in the end casings. The rotor spins freely, driven by the flow at a rotation rate proportional to the flow rate, usually around 1,000 rpm.

The concept was devised by Mr Leif Hauge in a prototype initially fabricated in stainless steel. The commercial breakthrough came when the rotors and casings were fabricated in precision ceramics, which are immune to corrosion and highly resistant to wear. A small amount of water flows from high to low pressure through the narrow end gaps and the narrow annulus that surrounds the PX device rotor, creating a nearly frictionless seawater-lubricated hydrodynamic bearing. There is no shaft or shaft seal. Each PX device is limited in size to 220mm diameter, but unlimited capacity is achieved by arraying multiple devices in parallel.

In practice, the lubrication flow through the PX devices is approximately 1% of the brine flow to the array and together with the transient mixing in the passages leads to an increase in salinity of the seawater fed to the membranes of about 2.5%

A total energy transfer efficiency of up to 98% is possible, and efficiency is nearly constant over a wide range of flow and pressure variations.

Potabilisation

The potabilisation treatments includes remineralisation using CO2 injection and lime (saturated lime water), and injection of fluoride and chlorine to meet the Water Corporation requirements.

Concentrate discharge

The PSDP treatment line includes a full backwash water facility based on clarification/thickening and sludge dewatering using centrifugation. The clarified backwash water is mixed with the reverse osmosis brine before discharge. The brine discharge was subject to a specific design, based on a scale model testing study performed by the Water Research Laboratory (School of Civil and Environmental Engineering Technical, University of New South Wales) under the direction of Worley Parsons specialist engineers.

To ensure that the environment is protected, a series of marine monitoring studies were commissioned prior to and as part of the environmental approvals. These included; Whole Effluent Toxicity testing on simulated brine and actual seawater concentrate at commissioning and 12 months after commissioning, sediment oxygen demand tests, international literature review of dissolved oxygen levels, ecological investigations, cause effect models, and an intensive baseline investigation commissioned to document water quality and macrobenthic fauna present prior to operations.

Before and during operations a real time monitoring system, located at three points within Cockburn Sound feeds data back to the plant constantly. At one-minute intervals, temperature and conductivity is being recorded at 1-2m intervals through the water column, and dissolved oxygen is recorded at the bottom of each monitoring buoy and at mid-depth. Management responses have been agreed with the regulator in the event agreed trigger levels are reached.

Baseline water quality monitoring and testing in the discharge area as discussed above was undertaken many months before plant commissioning. This baseline monitoring included the following parameters:

- light intensity,
- salinity depth profile,
- temperature depth profile,
- dissolved oxygen depth profile,
- turbidity,
- Secchi depth,
- nutrients concentration (phosphorus, nitrogen, ammonium, nitrates and nitrites),
- metals,
- phytoplankton.

Western Australia’s environmental regulator, the Environmental Protection Authority (EPA) set strict criteria for the concentrate discharge, requiring the salinity within 50 meters of the discharge point to be within 1.2 ppt of background levels. By the time the discharge is one kilometre offshore, salinity must be within 0.8 ppt of background levels. Extensive modelling revealed that salinity represents the most constraining water quality parameter.

The plant's true environmental standing was confirmed by field campaigns which, included tracing an environmentally benign dye added to the plant discharge, which showed that the desalination discharge rapidly mixes with the surrounding waters. Stratification in the sound is mostly drive through temperature, not salinity gradients.

As the plant is fully automated specific care has been taken in relation to instrumentation to ensure reliable and safe operation of the plant. Analytical panels assess information from sensors installed at the intake, pre-treatment, first pass RO feed second pass RO and potable water systems. These incorporate hydrocarbon monitors, turbidimeters, pH meters, ORP, on-line SDI, conductivity and temperature as required. Residual chlorine and fluoride are also monitored for the drinking water. Parameters such as dissolved oxygen and ORP are also monitored in the discharge water back to the sea to ensure that strict environmental guidelines are adhered to.

Plant commissioning

Seawater first flowed through the plant intake in October 2006. Product water from the plant began flowing into Perth's municipal water supply on November 7. By December, the first six first-pass racks were running. By the end of February 2007, the entire plant was in operation. During the construction period, the supply of filtration media and chemicals were finalized. Some pilot tests were performed to verify the quality of the inorganic coagulant as well as the coagulant aid. Ferric sulphate was finally selected and implemented on the full-scale plant. During the commissioning, Degrémont standard quality control was applied to the filter media loading and commissioning and during the filter start-up, allowing fine-tuning of the backwash and maturation phases, and of the water conditioning.

The SWRO trains were commissioned and started up two at a time with the corresponding HP pump isolated on the high-pressure manifold. Start-up followed a thorough flushing of each train with pretreated seawater at design flow rates to remove any residual construction debris. Plant start-up went according to schedule despite several unplanned incidents which could be considered normal in the context of a large plant start-up. Perhaps the most worrying was that most of the PX devices in the plant were exposed to excess high flow at least once, including one incident where flows rose to 81 kL/h in each PX device (62% higher than the maximum rated capacity) for six hours. These events occurred while the plants automated control systems and many of the process alarms were suppressed.

In addition, fibreglass construction debris stopped the rotors of several PX devices. However, the devices suffered negligible damage. The general comment of the commissioning team was that the start up of the SWRO trains with the PX devices was very easy and the devices are quite flexible and robust.

For the first stage RO, with 97% energy recovery, the specific energy consumption (SEC) of the HP pump and the booster pumps is 2.4 kWh/kL with the high pressure flow rate being trimmed by a highpressure control valve. The specific energy consumption (SEC) for the second reverse osmosis pass, and post-treatment can be as much as 1.4 kWh/kL, depending on full or partial second pass operation. The seawater supply pump and reject brine discharge consume about 0.3 kWh/kL. Currently, with new membranes and operating at nominal capacity with an overall water recovery rate of 42%, the plant itself consumes less than 3.9 kWh/kL including pre-treatment, both RO passes, post-treatment, and all electrical losses. This is a remarkably low SEC for a seawater desalination plant.

While the pre-treatment was partially commissioned, reverse osmosis first pass and second pass were gradually started, as well as the potabilisation treatment, allowing the first drinking water production to start in November 2006. In terms on energy recovery, the ®ERI installed on the first pass reverse osmosis performs in the design value: the first energy recovery figures are within the 94% energy recovery guaranteed on this plant.

Major environmental issues

Energy

Desalination is an energy intensive process. Reverse osmosis requires significantly less energy than that of thermal distillation. The energy often comes from fossil fuels, so as well as the expense, there is the disadvantage of CO2 emissions. Critics say desalination could worsen climate change, by adding to greenhouse gases, and contribute to water shortage. Ironically it is what will solve water shortage.

As SWRO technology improves, energy inputs and hence CO2 emissions will decline, particularly in relation to large-scale desalination plants. The use of reverse osmosis membrane technology (essentially filtering water through a membrane under pressure) rather than distillation (boiling and condensation) lessens the energy requirement because the water does not need to change state from liquid to vapour.

High energy use and consequent high greenhouse gas emissions are an aspect of desalination that needs to be addressed from an environmental perspective. A plant similar to Perth's, even with energy recovery devices (ERD) connected, will consume about 24 megawatts of electricity to produce about 45 GL of water per year. This represents about 185 GWh/year (which is 21.1 MW average) of energy per year which equals the amount of electricity needed by about 30,000 households. The opportunity to use renewable energy arose for PSDP and this plants energy is supplemented with energy injected into the grid from a new wind farm constructed north of the city.

Proposing offsets such as carbon offsets (tree planting) can be expensive and can lock up water reserves if not planted in carefully chosen locations (e.g. catchment thinning proposals). The nuclear energy debate and solar-thermal technologies in Australia continue to develop. However, as the ongoing need for large-scale water sources increase, energy sources will continue to be key part of the desalination equation, and must be thought through carefully during planning.

The energy required to permanently produce 17% of Perth's water supply, i.e. enough water for over 300,000 people and their homes and gardens, is about the third of the energy of one Boeing Jumbo Jet flying continuously. A Jumbo uses 80 MW of power for take-off and 65 MW of power to cruise as apposed to 21 MW of power for PSDP.

Backwash material

The PSDP discharge products that have been carefully managed include; the seawater intake screen washings, clarified backwash effluent from the media filtration plant, reverse osmosis plant seawater concentrate stream, neutralised reverse osmosis plant chemical clean wastewater and reverse osmosis plant flushing water. The PSDP has been engineered to ensure that backwash materials (solids) are disposed to landfill. This decision was made due to the presence of ferric sulphate and poly DADMAC (an organic coagulant) added to coagulate particulate and colloidal material from the influent seawater, and concerns about possible discolouration of the white sandy beaches, should this backwash be discharged at sea. Solid wastes from the intake screens, media filters and lime system are captured in the wastewater treatment clarifier. The sludge from the clarifier is dewatered by centrifugation to a spadeable cake for disposal to landfill. Offsite environmental management considerations include the salt content of the sludge; the quantity of the sludge; and handling quality of the sludge.

Seawater concentrate discharge

In order to meet the strict environmental conditions, the seawater concentrate is returned 470 metres into the ocean via a 40-port diffuser, at a velocity of 4m/s through nozzles spaced at five metre intervals, to ensure total mixing of seawater concentrate within 50 metres of each side of the last 200 metres of pipeline.

Footprint

The Perth Seawater Desalination Plant is functionally laid out in an area of 6.5 hectares which can be regarded as its terrestrial footprint. Extensive computer modelling supported by a die test, as previously discussed, suggests that the diffuser with its 40 nozzles spaced at 4 metre intervals will ensure that the returning seawater concentrate is effectively mixed within an area of less than 2.5 hectares. It can then be argued that the spatial area of influence attributed to the plant on land and sea is only 9 hectares.

However to ensure that the total environmental affect of the plant is considered, we have to take into account the area attributed to the wind farm. The wind farm that has been constructed to inject the 185 GWh per year into the grid at Badgingarra, 200 km north of Perth and covers an area of 31 square kilometres, so with two thirds of its energy earmarked for the PSDP the terrestrial area attributed to power generation is 20 square kilometres. This area is still actively farmed as the only impact is the base of the 36 turbines (48 in total) which cannot be used for grazing. You will however find the farmers herds in lines in the shade of the turbines during the heat of the day.

Should we compare this plant to Perth's largest surface water supply source namely, Serpentine Dam, which when constructed in 1961 had an assured yield of 51 GL /year at 98% reliability. This dam has a catchment area of some 664 square kilometres which cannot be used for any other land use. It is now mostly a dry dam basin of 1067 ha. There are no fish ladders and no in-stream flow releases. Since 1961 the reservoirs yield has been de-rated on 3 occasions and the assured yield in 2005 was 15 GL /year at 98% reliability. In 2006 the reservoirs yield plummeted to 5 GL /year, almost a tenth of the PSDP yield at 100% reliability.

We can now also argue that Serpentine Dam and many other Western Australian and Australian dams have had other environmental impacts. In most cases fish ladders have not been provided to allow for migration of fish, inadequate or no in-steam flows occur which definitely has an affect on river ecology, both upstream and downstream. Further, there is an impoundment of silt and nutrients within the dam basin which once again affects river ecology upstream and downstream.

There is also the physical scar of the dam structure and the associated greenhouse gasses and carbon emissions that occurred during construction. When the total mass balance of all the environmental impacts are accounted for, a dam can have a massive environmental footprint.

It does not take much scientific deduction to work out which source has the largest environmental footprint. The one positive for the surface water source is that it has protected 664 square kilometers of re-growth native forest, had in been old growth forest this would have been prized.

The bottom line is that the cost of water from the PSDP is the true triple bottom line cost of water as all the environmental, social and economic aspects have been taken into the equation.

Technological improvements for future

We are all well aware of the great strides made in the advancement of reverse osmosis, be it new materials, membranes including reverse osmosis and ultra-filtration pre-treatment membranes, antiscalant, energy recovery devices and efficient pumps and electric motors.

In years to come, with all the latest components, such as large diameter - high rejection membranes, the footprint attributed to seawater reverse osmosis plants will reduce, making them by far the least environmentally intrusive water sources in semi arid regions such as Australia, Spain and California to mention a few.

New technologies such as forward osmosis (reverse-reverse osmosis, entropy recovery – osmotic power), may also become commercially viable. Forward osmosis utilises two sources of different salinity waters or liquids (e.g. seawater RO concentrate and wastewater) in combination with a semi permeable membrane, an energy recovery device (isobaric based), a booster pump and a Pelton impulse turbine. Utilising this equipment and the osmotic pressure that exists between these two liquids, energy can be recovered. This device has already been patented and prototypes constructed. A SWRO plant the size of PSDP located near a wastewater outfall can utilise the energy produced (5MW) from the osmotic pressure difference to power the associated desalination plant.

Taking the giant leaps that are occurring in creating freshwater from seawater, I know where I would invest if I had to invest in water infrastructure.

It's all about energy

The world's current global warming crisis is totally centred on mankind's insatiable appetite for energy. The world's climate change, which has occurred mainly due to the production of energy, has resulted in areas experiencing drastic and unprecedented water shortages. Ironically, the only way to create water in these areas is to use energy intensive means to produce water, such as desalination. This only results in higher energy demands and so the whole situation snowballs further out of control.

The only way to counter this is to produce unlimited clean energy, no matter what the cost. This can not only be done using renewable energy, no matter how attractive this may seem. It is highly impractical and unachievable.

This is where nuclear fusion comes to the fore. This will become mankind's saviour in the next 30 years. It is however this period where renewable energy and nuclear fission will reign supreme. The use of coal fired power stations has to be regarded as mankind's ultimate environmental vandalism. Not only does the burning of coal contribute to most of the world's carbon emissions, it also produces all of the mercury found in the oceans and to the acid rain that prevails. Wake up world.

Conclusions

- A clean unlimited energy supply is the key to most world problems, including water supply.
- The PSDP with a production of 143 700 cubic meters per day is currently the largest reverse osmosis plant in the Australasian region.
- During the commissioning period, the plant performances confirmed the design specifications:
- The pre-treatment composed of single stage dual media pressure filters is performing according to the pilot tests performed in 2004-2005,
- The reverse osmosis two pass design meets expected design parameters in terms of permeate salinity,
- The energy recovery device (PX) performances are within guaranteed values of the supplier and are operating at the highest efficiency ever reported for such devices at this scale.
- Plant performance is consistent with the design goals,
- the PSDP represents a significant milestone for the development of large-scale SWRO technology operating on renewable energy at a very low energy consumption level,
- The operators who commissioned the plant now operate the plant; this overlapping of functions has resulted in and increased level of operation ability and has allowed for a high level of optimisation of the plant operations for the 25-year operating Alliance contract,
- Desalination can have the smallest footprint of any source in Australia.

- A substantial component of Perth's water supply needs will be met by water reuse and seawater desalination in the medium to long term (2nd SWRO Southern Seawater Desalination Plant is almost at Contracting Stage).
- The PSDP is the most sophisticated and sustainable SWRO plant in the world, utilising the most up-to-date components, it will be the world's model plant and the only large plant using wind power.
- PSDP will be eclipsed by a more efficient plant, somewhere in the world within 3 years, but it may be many years before its wind power aspect is eclipsed.
- SWRO will still become more efficient with new High Rejection Membranes, Large Diameter Membranes and Membrane Pre-treatment.
- Forward Osmosis may become a new renewable Energy Source.
- State Governments are urged to undertake strategic forward planning in selecting SWRO desalination and wastewater treatment plant sites and associated corridors now. This should be projected for 50 years ahead.
- Water reuse and desalination are sustainable water sources that will contribute to solving Australia's water resource issues.
- New technology will substantially improve the efficiency of SWRO.
- It's all about energy.

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