SDP Capital Works Project Summary

Project Title / Asset	RO Sampling Panels
Project Driver	Safety / Availability

Purpose

The purpose of this document is to provide a high-level overview for major projects, further detailed information is available on request. Major projects have been defined as any capital expenditure that includes the addition of new assets to the Sydney Desalination Plant (Plant).

Information/justification on other elements of the proposed capex program (e.g. refurbishments and replacements of existing assets) are available on request.

Project Background

The Plant utilises a total of 20 Reverse Osmosis (RO) membrane trains. During normal operation, the conductivity level of the permeate water is measured remotely on a train or 'system' basis as a surrogate for salinity. This measurement is a key indicator as to the effectiveness of a train's desalination performance, i.e. higher conductivity suggests deteriorating membrane performance or a feedwater leak into the permeate. Such incidents of increased conductivity, once numerous or individually significant enough, can require additional treatment processing and higher energy usage, increasing the manufacturing cost of the product water. In significant cases, production volume of the Plant may be decreased. There are various points in the system that may contribute to increased conductivity levels, such as the membranes themselves, O-rings, and adaptor tubes.

Once a critical conductivity level is reached, there are several ways to narrow down the search area. These are presented below as Steps 1 – 4 at increasing levels of granularity:

- Step 1 Each RO train is monitored for turbidity remotely. However, this does not identify which of the 259 pressure vessels or 2,072 individual membranes per train may be contributing to the increased conductivity.
- Step 2 Currently, a "mini sampling panel" is in place per train, however, this can only narrow down to which dropper or broad area (which contains 28 vessels, or 224 membranes) is affected and will not always identify an issue in one of the vessels.
- Step 3 To identify which individual vessel (which each contain 8 membranes) is at fault, each vessel needs to be sampled individually. This activity requires elevated work platforms (EWPs), multiple site technicians, work permits, barricading, all whilst in front of an operational train sampling from a vessel with pressures in excess of 60 bar.
- Step 4 Once the problem vessel(s) is identified, the final step is to identify which of the 8 individual membrane location is at fault. An invasive sampling method called probing is used by inserting a tube down the centre of a vessel. This activity requires EWPs, multiple site technicians, work permits, barricading, all whilst in front of an operational train sampling from a vessel with pressures in excess of 60 bar.

Generally, when the steps above are called on, it is good practice to sample the entire RO train individual vessels to act as a "screenshot" of the RO train's health at that moment in time. This information can be useful for also narrowing down future leaks by indicating likely "at fault" locations. It is also good practice to sample entire RO trains individual vessels from time to time to keep a record of the health of a train and track its condition and performance.

The sampling in Step 3 required to identify the exact location of a leak must be conducted on an operating RO train. This introduces 2 undesirable issues:

1. The sampling person is located directly in front of the pressure vessel end cap. In the unlikely event that the end cap should fail, the force of debris aimed directly at the sampling person would be catastrophic.
2. To reach all sampling points, multiple persons, paperwork, procedures, and an EWP are required. This process is labour intensive, equipment reliant and introduces potential damage (e.g. EWP collision) to the existing equipment, and 'working at heights' risks including falls or falling objects.

To allow individual vessel permeate sampling as described in Step 3 to take place at ground level and from outside the 'line of fire' of the vessel end caps, it is proposed to install a permeate sampling panel beside each RO train. The sampling panel would comprise a labelled valve for each RO vessel connected to the existing sampling point by a 6 mm flexible line. Only if an issue is identified in an individual vessel, will further probing be required as per Step 4.

Individual RO vessel sample panels have become an industry norm for desalination plants. The majority of large scale desalination have these types of sample panels installed to reduce OH&S risks associated with operating and maintaining a high pressure system like RO membrane desalination.

Asset Details

Asset	All first and second pass Reverse Osmosis Units
Asset durability/ design intent/ asset management Strategy	Mechanical assets: 25 years Minor routine maintenance will be required on the new assets but will be incorporated into existing RO train inspections with negligible impact. The new assets are intended to operate in conjunction with the RO train for the remainder of that train's operational life. The new asset is completely mechanical (e.g. no electrical components are involved). Corrosion resistant materials and components will be utilised, and it is not expected that the new sampling panel will require any significant amount of maintenance but should be routinely checked for leaks.
Asset Function/ Subsystem/ System	The primary function of the proposed new asset is to allow operators to identify internal RO train leaks and problematic membrane elements safely and efficiently.
Asset Failure and its consequence	Individual component failure would require the associated permeate sample point to be isolated. The consequences would be minor, as repair works could be completed promptly without shutting the RO train down. Complete failure would require resumption of current RO membrane mapping practice with the associated consequences of two operators placed in the line of fire while working at heights and increased labour requirements.

Justification

The primary need for this project is to significantly reduce the amount of "hazard facing" time for technicians associated with RO train mapping and to reduce the amount of time required to analyse

the whole (or part of a) train. The proposal for inclusions of sampling panels are for the following reasons:

- RO treatment of seawater is the fundamental process that allows the Plant to generate drinking water from seawater.
- The existing method for identifying failures or issues in membranes adversely consumes Plant resources and operations time, which increases downtime risk, availability and our ability to respond to changes in production.
- RO sampling panels are widely becoming an industry standard with RO trains, as they allow fast, accurate and safe ways to identify trouble areas in RO membrane arrays.
- Currently, this task requires at least 2 operators, a scissor lift, and a conductivity probe for typically 3 hours to locate membrane issues on any given train. Use of an RO sampling panel could reduce the investigation time down to 1 operator and approximately 15 minutes allowing the Plant to maintain our reliability and availability in line with the new operating environment.
- The inclusion of RO sampling panels will remove high risk work activities and decrease downtime when RO membrane issues are identified.
- The increased convenience of sampling a train can more quickly and more often lead to identification of poorly performing vessels which can ultimately leads to lower cost or higher volume of water production for ultimate customer benefit.

SDP has approved the implementation of a sampling panel onto a single, first pass, RO train. This will allow a better understanding for the effectiveness of the solution, allow testing of market pricing and allow staggering of the capital cost required to facilitate a whole Plant upgrade.

Options Considered

The use of RO sampling panels is common across the industry. Quotes were obtained by multiple contractors who have recently installed similar panels at other sites. Given the same functionality and durability requirements, the main consideration of options was based on price.

It is proposed to complete the design, supply and installation of a sample panel on a single first pass RO train, then review the effectiveness of the solution and use the information collected from the use of the first installation to competitively market the installation of the remaining RO trains (19).

Proposed Scope

The proposed scope includes:

1. Purchase of one (1) 280 array RO sampling panel, including:
    a. Design works and AutoCAD drawings for the sample panel and components. Drawings will be issued with dimensioned layouts before fabrication.
    b. Fabrication and supply of the sampling board. All sample holes will be fit onto one large panel, via butt welding of sheets together if required.
    c. Labels on the sample board for each sample tap, to allow for easy identification, including letters across the top and numbers down the side of the panel. A large sign is also to be added on top of the panel to identify the specific RO train.
    d. Fibreglass (FRP) or stainless-steel frame mounting of the sampling board, with a drip tray and 2” drain fitting.

   e. Offsite fabrication of the sample board and board components
   f. Freight of sample board to site.
   g. Note, the array of the sample panel shall be suitably designed for a full RO rack (14 ports x 20 ports).
2. Purchase of connections for routing the array of sample taps to the array of RO vessels, including:
   a. Two hundred and fifty-nine (259) sampling taps.
   b. Three thousand (3000) meters of polyethylene tubes.
   c. Tube connections and adapters, including two hundred and fifty-nine (259) ½' to 6mm thread to tube adaptors, and other adapter types. The connections shall be plastic compression fittings where possible.
   d. Manifold connections, including pipe clips and 316 stainless steel UniStrut brackets, to allow integration of the sampling panel to an existing first pass RO panel.
   e. Note, all material is to be suitable for a corrosive environment (PE/PVC/GRP), with SS316 fixings where required.
   f. Spares of the above for issue to the site store.
3. Installation of the above-mentioned sampling panel and hardware as required to allow full function of the sampling panel. This includes the hire of:
   a. Two (2) mechanical fitters, one (1) skilled tradesperson, and one (1) supervisor.
   b. One (1) scissor lifts for a duration of one (1) week, for access and installation of the RO sampling panel.
   c. Note, none of the work shall interfere with removing the end cap of the vessel, to ensure RO membranes can still be changed as required.
4. Integration and commissioning of the sampling panel.
5. Supervision of installation and commissioning.
6. Change management comprising:
   a. Change Management Form
   b. Risk Assessment
   c. Update of relevant documentation and drawings as follows:
      - O&M manuals
      - Datasheets
      - Piping and instrument diagrams for the associated RO train.
      - Revision of any relevant work instructions or procedures associated with operation and maintenance of the new instruments, approval by SMEs from O&M team.
   d. QA review and wrap up
   e. SDP site walk
   f. Document package submission, including but not limited to the ITPs, drawings and lengths of sample lines from each vessel.
   g. Subcontractor supervision
7. Training by Original Equipment Manufacturer (OEM) in the operation and maintenance of the new sampling panel.

Cost Estimate

Costs have been defined based on quotes from preferred suppliers. Veolia Water Australia (SDP's operator) completed pricing due diligence on equipment hire, materials, and components offered by two proponents - [redacted]. Based on the review, the most economical options was

for Veolia to purchase the fabricated sample panel from [redacted], then separately purchase the remaining items from [redacted] and utilise [redacted] for assembly and installation.

The estimated budget price for the works is [redacted], which includes installation on all 20 RO trains.

- Estimated costs for Mod 2 Pass 1 Train 6 (first train): [redacted]
- Total price for all 20 trains (including M2P1T6 above): [redacted]

Please note, it is hoped after the initial installation that savings can be identified, and if the remainder are rolled out as a single package, further savings can be achieved through economies of scale (e.g. reduced mobilisation costs).

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Proposed Layout (Example from another SWRO plant in Australia)