



Sydney Desalination Plant 2017 Price Reset

Review of Operating and Maintenance Costs

21 October 2016

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Executive Summary

Advisian was engaged by Sydney Desalination Plant Pty Ltd (SDP) to review on the operation and maintenance component of SDP's opex and capex forecast to be submitted by SDP to IPART for the Price Reset process for 2017-2022.

We were requested to review the following systems and data to support our review of the opex and capex forecasts:

- The operation and maintenance contract
- The asset management systems, plans and processes
- Care and maintenance activities
- The procurement strategy for operation and maintenance
- Benchmark operation and maintenance costs where available

We completed the review through a desktop study and a physical inspection of the site, and found:

- (a) The plant was generally in very good condition, consistent with its age and operating environment before the Kurnell tornado on 16 December 2015 ("tornado").
- (b) The plant has been in a 'care and maintenance' state since June 2012 resulting in an increasing uncertainty in relation to the risks relating to a restart of the Plant.
- (c) During the current regulatory period, the level of implementation of processes and systems for managing the SDP assets has been appropriate and adequate to provide confidence that when the processes are implemented the associated costs reflect prudent and efficient expenditure.

Procurement strategy findings

SDP has in place three existing Operations & Maintenance service delivery contracts, one each for the desalination plant (the O&M Contact), the Drinking Water Pumping Station (DWPS) and the water delivery pipeline.

The desalination plant O&M Contract was comprehensively competitively tendered along with the plant Design & Construct contract in 2007. The DWPS Deed was exclusively negotiated with Veolia Water Australia in 2009, and benchmarked against an internal Sydney Water cost comparator. The water delivery pipeline contract was exclusively negotiated with Veolia Water Australia in 2013.

SDP has a limited number of options for procurement of its operating and maintenance delivery services in the 2017-2022 period of the price determination. These include continuing with the existing arrangements or approaching the market for a re-tendering process with the possibility of a new operations contractor.

Given the risk allocation in the existing O&M contract and the procurement process undertaken for the three contracts, it is considered prudent to continue with the procurement of services via the existing arrangements and considered that the resultant costs are efficient. This is particularly the case because re-tendering for the O&M services for a plant whose prospects for return to full operation during the regulatory period are limited and that has been damaged by a tornado, is unlikely to result in lower overall opex expenditure.



Asset management findings

The processes and systems that support the asset management framework for managing the Plant assets are appropriate and adequate to provide confidence that when the processes are implemented the resulting actions would be prudent and are an appropriate basis for substantiating that the O&M expenditure forecasts are prudent. This conclusion is based on an appropriate sample of processes, onsite findings and a review of findings of previous audit reports.

Our review of SDP's asset management framework, plans and supporting processes and systems found that:

- (a) the asset management plan appropriately describes the management of the Plant;
- (b) the supporting processes reflect an efficient and effective approach to managing plant assets, taking into account the operational environment of the Plant, that is, there was no evidence of excessive expenditure and any maintenance activities that were re-scheduled were done so in order to achieve efficient use of resources without any loss of plant integrity;
- (c) the supporting asset management systems are well established within plant operations and do record appropriate historical information to support the efficient ongoing operation of the Plant; and
- (d) Overall, the asset management framework, management plans, processes and systems reflect contemporary asset management practices and are considered to support efficient management decisions.

On this basis, Advisian concludes that the Asset Management framework, management plans, processes and systems are effective (i.e. fit for purpose). The framework, plans and resulting actions are consistent with good industry practice, and as such represent what a prudent operator in the industry would be expected to deliver. Accordingly, the framework and systems are an appropriate basis for the purpose of substantiating that SDP's O&M expenditure forecasts are prudent.

Proposed O&M Charges expenditure findings

Advisian has comprehensively reviewed the details of the O&M charges contained within the SDP opex forecast. Our review has addressed the application of the Service Fee under the O&M Contract, the forecasting of escalation indexes required for the calculation of the Service Fee and the likelihood that the capped amount of periodic maintenance will be underspent.

Our review of SDP's O&M expenditure forecast has found that:

- (a) the O&M expenditure forecast has been calculated via applying the correct interpretation of the Service Fee under the O&M Contract;
- (b) the SDP opex forecast draws upon the contracted O&M Charges where appropriate; and
- (c) each assumption made in the preparation of the SDP opex forecast is appropriate and likely to lead to the incurrence efficient costs.

Our review has also identified that efficiencies in the delivery of the O&M Services are incentivised via several gain/pain share mechanisms under the Service fee arrangements and that various positive impacts arise to customers of SDP via the incurrence of the O&M expenditure.



Proposed non- O&M Charges expenditure findings

SDP needs to include asset maintenance costs not captured in the contracted O&M Charges in its opex forecast because the plant is nearing the end of the 5 year time limit on a “mothball” shutdown as proscribed in the O&M Contract. Under the O&M Contract, if the plant is not restarted by June 2017, either:

- SDP must restart the plant, thereby increasing maintenance cost allowances back to their normal operating levels; or
- A portion of risk under the O&M Contract, particularly the increasing risk of asset failure or low performance at plant restart (re-start risk), transfer back to SDP.

Advisian has comprehensively reviewed the details of the SDP opex forecast where costs have been drawn from outside the O&M Charges due to the expected extended water security shutdown. Our review has examined the asset management processes applied to identify the necessary periodic maintenance tasks, considered the appropriateness of including each maintenance item and sampled a selection of maintenance item costs.

Our review of SDP’s O&M expenditure forecast drawn from outside the contracted O&M Charges has found that:

- (a) the O&M expenditure forecast has been developed by applying appropriate asset management processes considering the increased risk of asset failure or low performance at plant restart and is therefore considered to be prudent expenditure; and
- (b) the maintenance items examined are calculated according to good process, by experienced personal and are within reasonable expectations of efficient values.

Our review has also identified that a positive impact of continued water security arises to customers of SDP via the incurrence of this portion of the O&M expenditure.

Benchmarking findings

Benchmarking efficient operating costs between desalination plants is challenging because of the limitation on the statistical certainty due to the small sample size as well as the significant differences in operating environment factors, regulatory regimes and commercial arrangements. It should be acknowledged that it may not be possible to consistently correct for these factors.

There does not exist sufficient publically available operating expenditure or operating performance data that would enable worthwhile comparisons to the SDP opex forecasts, nor to key metrics of the SDP facility. Further, in any attempt to benchmark the operating costs of SDP, there are several factors that limit the usefulness of benchmark/s identified, such as the reliability and inclusiveness of the data and the significant number of variables to be controlled for. This will likely require a larger sample size than may be available.



Conclusion

Our review found that SDP's opex forecasts can be considered to be prudent and efficient on the following basis:

- *Prudence* - The Operator's asset management system, including documented plans and procedures, ensures the Operator undertakes the operation and maintenance activities which any prudent operator would undertake.
- *Efficiency* - The values in the operation and maintenance charges from the O&M contract represent efficient costs.

The SDP opex forecast contains the likely operation and maintenance charges to be incurred over the 2017-22 period in real \$2016/17, and represents prudent and efficient expenditure.



1 Introduction

Advisian was engaged by Sydney Desalination Plant Pty Ltd (SDP) to review the operation and maintenance component of SDP's opex and capex forecasts to be submitted by SDP to IPART for the Price Reset process for 2017-2022.

IPART sets the prices for the SDP to charge its customers for supplying drinking water and also the making available of assets to supply drinking water. The assets include the Sydney Desalination Plant, the Drinking Water Pumping Station and Drinking Water Pipeline (the Plant). This report outlines our assessment and conclusions provided to SDP about the forecasts to be submitted.

1.1 Advisian Scope

Advisian was engaged by SDP to review and advise on the appropriateness and robustness of the operation and maintenance components of the SDP opex forecasts, in particular to test that the forecasts represent the most efficient and prudent level of expenditure in the operational context.

We were requested to review the following systems and data to support our review of the opex and capex forecasts:

- The operation and maintenance contract
- The asset management systems, plans and processes
- Care and maintenance activities
- The procurement strategy for operation and maintenance
- Benchmark operation and maintenance costs where available

We completed the review through a desktop study and a physical inspection of the site.

1.2 Structure of this Report

This report covers our assessment of the supporting systems and data used to develop the SDP opex and capex forecasts. The report is structured as follows:

Section 2 describes the Sydney Desalination plant, including the pricing arrangements, operating scenarios, major systems and current condition and management of the asset.

Section 3 reviews the procurement strategy for the O&M contract with Veolia and comments on the efficiencies that have been realised.

Section 4 reviews the asset management framework for the plant and comments on the appropriateness and relative maturity of the supporting systems and processes

Sections 5 & 6 review the proposed operations and maintenance expenditure considering the structure of the Veolia charges, the supporting plans and the efficiencies embedded in the forecast.



Section 7 presents our benchmarking assessment, including high level cost benchmarks and specific consideration of the inherent differences in operating environment that need to be taken into account when making benchmarking comparisons between desalination plants.

Section 8 summarises our conclusions on the operating and maintenance costs for SDP over the period covered by the 2017 Price Reset



2 The Sydney Desalination Plant

This section summarises the existing state of the Sydney Desalination Plant including the plant history, regulatory environment, operating scenarios, the key assets, management processes and overall condition of the plant.

2.1 Plant history

SDP holds the long term lease of the Sydney Desalination Plant (the Plant) in Kurnell. The Plant was built and initially operated as a wholly owned subsidiary of Sydney Water Corporation. A brief timeline of the Plant is in the following table.

| Date | Event |
|------------------|--|
| 18 July 2007 | Design and construct contract (Vol 1-3) awarded to Blue Water Joint Venture Operation and maintenance contract (Vol 4-5) awarded to Veolia Water Australia for 20 years |
| Jan-June 2010 | Plant commissioned and 2 year proving period starts |
| 9 August 2010 | Network Operator and Retail Supply licence granted under Water Industry Competition Act 2006 |
| 6 May 2011 | SDP declared a monopoly supplier under Water Industry Competition Act 2006 |
| 30 May 2012 | Long term lease entered into for 50 years |
| 1 June 2012 | Water Supply Agreement between SDP and SWC for 30 years signed |
| 1 July 2012 | The Plant placed in Water Security Shutdown (mothball) and now is kept under 'care and maintenance'. IPART's first 5 year price determination of SDP P/L commences |
| 16 December 2015 | Kurnell tornado occurs |
| 1 July 2017 | IPART's revised price determination commences |

The Kurnell tornado on 16 December 2015 has significantly damaged the Plant. The rectification works being planned and completed under insurance are outside the scope of this engagement. Where relevant, we have outlined the assumptions we have made to address the complications introduced by the tornado and subsequent rectification, which is currently underway.

2.2 IPART Price Regulation

In August 2010, SDP was granted a network operator licence for the Plant. The Minister for Finance and Services then declared the operator a monopoly supply under section 51 of the *Water Industry Competition Act 2006* in 2011. As a monopoly supplier, SDP prices for water supply and water security services are set by IPART, under section 52 of the *Water Industry Competition Act 2006*.



The first price determination commenced in 2012 whilst SDP was under Sydney Water Corporation control. The Terms of Reference issued to IPART for the determination included the following principles of note:

- The structure of the prices should encourage SDP to be financially indifferent as to whether or not it supplies water. As such the structure of the prices should comprise separate charges for the different water supply services of supplying drinking water and the making available of the Plant to supply drinking water.
- The charge for the making available of the Plant to supply drinking water should be a periodic payment and should reflect fixed costs including, return on assets, return of assets and the fixed component of operating costs.
- The charge for supplying drinking water should reflect all efficient costs that vary with output, including variable energy, labour costs, and maintenance costs.

Points of interest from IPART's first determination include:

- IPART set an abatement mechanism to reduce the daily water service charge applicable in that day's full operation mode if the average production of the preceding 365 days where the plant has been classified as 'Available' is less than (250ML/day). There is no capacity in this mechanism to 'catch up' or recover foregone fixed charges once SDP has been penalised.
- In determining the efficient level of costs, IPART assumed that in a water security shutdown (greater than 2 years), there are no variable costs and a range of other costs are greatly reduced or avoided entirely. These other costs include reduced fixed labour costs, deferred membrane replacement, reduced periodic maintenance and avoided fixed costs associated with water monitoring and testing.

2.3 Operating Scenarios

Under Sydney's water security plan¹, the Plant provides the following water supply services:

- (a) The supply of non-rainfall dependent drinking water; and
- (b) The making available of the Plant to supply non-rainfall dependant drinking water.

When operating ("Operating and Maintenance" mode), the Plant will be *available* to supply and also *will supply* drinking water. SDP is entitled to both a variable and fixed charge during this time.

When it is shutdown ("Care and Maintenance" mode), the Plant is only *available* to supply the drinking water, it *does not supply* any drinking water. During this mode, SDP only receives a fixed availability charge. The availability charge varies according to the length of the shutdown period².

In both cases, customers are provided with water security assurance because the water supplied from the plant is partially not dependent on rainfall.

¹ Metropolitan Water Plan 2010

² There are 4 shutdown periods specified in IPART's price determination and the Operation and Maintenance Contract: short term shutdown – 2-10 days; medium term shutdown – 11-90 days; long term shutdown – 91 days to 2 years; water security shutdown – more than 2 years.



2.4 Desalination Plant and Associated Infrastructure

This section describes the key components of the desalination plant and comments on the known condition. This is not a comprehensive audit of the condition of the Plant, rather it is a high level review for the purposes of identifying emerging issues for each of the key systems within the plant. Each section of the plant is described in terms of its process function and its condition, whilst in care and maintenance, inclusive of major tornado damage, noting that SDP is working with its insurers to return the plant to its pre-tornado state.

2.4.1 Seawater Intake and Pre-treatment

PROCESS: The intake and pre-treatment area takes seawater from the ocean, then screens, doses and filters the seawater to prepare it for the next step of reverse osmosis.

CONDITION: The penstocks, screens and pumps in this part of the Plant are operated and maintained regularly during shutdown to ensure they are maintained when not in operation. The area is clean and in good condition with little sign of corrosion.

The chemical tanks have been drained, except the sulphuric acid tanks, which are being appropriately maintained. The chemical dosing systems are housed under one roof and are in good condition despite tornado damage, such as roof damage and broken cable trays and dosing pipework.

2.4.2 Reverse Osmosis Units & Permeate Storage

PROCESS: The filtered water is fed through the 1st pass reverse osmosis trains at high pressure, then a portion is stored in the intermediate permeate tanks until fed through the 2nd pass trains, whilst the remainder is discharged direct to the remineralisation system.

CONDITION: The building housing the reverse osmosis units and the equipment itself are in good condition, except for the lack of a roof after the tornado. The high pressure pumps have been rebuilt as part of defect rectification works and will be recommissioned when the plant is restarted.

The membranes in the reverse osmosis units are in sodium bisulfate preservation fluid. This means the majority of valves and associated assets are regularly operated to replenish the fluid via the Clean In Place (CIP) system which was adapted by the operator for this purpose during the shutdown to maximise the effectiveness of the membrane preservation.

The state of the membranes is presently unknown after a large amount of the preservation fluid was lost after the tornado and the CIP was damaged. Advisian understands that SDP is working through a process with the insurers to agree on the extent of damage to the membranes.

The intermediate permeate tanks have been very badly damaged by the tornado and will be replaced under the rectification works.



2.4.3 Remineralisation

PROCESS: The permeate is remineralised by dosing with lime and carbon dioxide, then further treated with chlorine, fluoride and ammonia, to become drinking water.

CONDITION: Prior to the tornado, the assets were in water security shutdown, they had been emptied and cleaned out. There has been some damage to parts of the remineralisation system that will be either replaced or repaired under the rectification works. The building containing the fluoride system was condemned following the tornado and we did not inspect the system.

Aside from this damage, the equipment is likely to require an overhaul before the restart, even though it has been maintained. This is because of the nature of the chemicals involved, and recommissioning lime systems that have been shut down for extended periods of time is known to be problematic, even though the system has been emptied and cleaned.

2.4.4 Residuals Treatment

PROCESS: The waste streams from the treatment processes go through various steps of dewatering before disposal either to the ocean or landfill. The processes include Lamella thickeners, centrifuge and neutralisation.

CONDITION: The treatment area has been drained and desludged for the shutdown. Some sections of the waste wash water tanks and pumps are operated regularly to drain stormwater and pumped to the return flows chamber.

2.4.5 Control System

PROCESS: The Plant is controlled by a PLC/SCADA system.

CONDITION: Prior to the tornado, the control system was functional and had various upgrades since the plant was first commissioned. The computer server room in the administration building was flooded during the tornado so it is possible the servers will be replaced under the rectification works. After the tornado the system still loads up but some of the PLC cards fail.

2.4.6 Electrical

PROCESS: The Plant is powered through a 132kV switchyard and a backup 11kV supply.

CONDITION: Prior to the tornado, the electrical systems on site were in good condition and in use regularly just to maintain the Plant in water security shutdown.

Two of the three 132V transformers were damaged in the tornado. 132kV switchgear in HV switchyard was damaged in the tornado. Current power to the site is through the back up 11kV supply which is sufficient to power the site in shutdown mode.

Most of the LV power cables, control and communication cables were laid in cable ladders, which were either installed indoors or outdoors but covered. They are now exposed to the sun in many areas, which will slowly damage the cable insulation material and shorten the cable design life. However the impact will be beyond the next five year period so it has not been considered in this assessment.



Either directly or indirectly affected by the tornado, much of the electrical equipment and its associated protection and control devices, instruments, PLC and communication components have suffered from excessive moisture, salt-laden air, high ambient temperatures and UV rays. Even though these effects have been largely mitigated now, their impact will shorten the design life of the assets. Additional monitoring and testing in the future maintenance program may be required to check asset condition.

2.4.7 Drinking Water Storage

PROCESS: The drinking water is stored in the tank prior to reaching the drinking water pumping station.

CONDITION: The storage was drained and in satisfactory water security shutdown condition prior to the tornado. The roof of the storage was damaged during the tornado and will be repaired. Aside from this damage, there is no evidence of degradation, other than some minor corrosion on the entry porthole.

2.4.8 Drinking Water Pipeline and Pumping System

PROCESS: The drinking water is pumped into the water delivery pipeline that goes across Botany Bay and discharges to Sydney Water's drinking water distribution system in Erskineville.

CONDITION: All assets are in good condition. The drinking water pumping station lost the roof in the tornado but it has since been replaced. The pipeline has not been damaged by the tornado.

2.5 Existing state of the Plant

The Plant is currently in a water security shutdown state and also still has damage from the tornado. In a water security shutdown state there are still significant asset management activities at the Plant. Operation and maintenance activities are replaced by care and maintenance activities. These activities are designed to ensure the Plant is preserved ready for an efficient start-up, so SDP can fulfil its water security objective.

There is currently no precedence for a plant of this size to be in water security shutdown for an extended period. As a result there is uncertainty about the operational capability of the assets when restarted. Even excellent care and maintenance cannot mitigate the risk of operational issues arising when the Plant is restarted as assets continue to degrade over time, even if they are well maintained.

Presently, the damage to the Plant is still being rectified following the tornado on 16 December 2015. As the timing and extent of the rectification under insurance is yet to be fully identified, it is not known for certain what the status of the Plant will be on 1 July 2017 although it is likely that the repairs will still be in progress.

To address this uncertainty, we used the following principles to assume the status of the plant in July 2017 for the purposes of this review/assessment. We have assumed:

- the assets will be in a functional but water security shutdown state, and the assets are being managed in accordance with the systems in place prior to the tornado;



- the assets will be the same assets as prior to the tornado, except where the asset was replaced or repaired; and
- The replaced and repaired assets will have the same maintenance regime as the original assets, except where new equipment is not exactly the same as the previous asset due to changes in technology or standards since 2010.

2.6 Conclusions on the Existing Plant

Advisian's review of the existing SDP assets, after spending time on site, found:

- (a) The plant was generally in very good condition, consistent with its age and operating environment before the December 2015 tornado.
- (b) The plant has been in a 'care and maintenance' state since June 2012 resulting in an increasing uncertainty in relation to the risks relating to a restart of the Plant.
- (c) During the current regulatory period, the level of implementation of processes and systems for managing the SDP assets has been appropriate and adequate to provide confidence that when the processes are implemented the associated costs reflect prudent and efficient expenditure.



3 Review of Procurement Strategy

3.1 Objectives

The objective of this section is to assess the SDP procurement strategy for the current O&M contracts in order to establish whether the existing service delivery arrangements and associated costs represent an efficient outcome.

This objective is achieved by firstly describing and reviewing the historical procurement strategies implemented for the O&M contracts covering all SDP assets. SDP's present procurement options are examined before reaching a finding on the selected procurement strategy for the O&M services for the determination period 2017-2022.

3.2 Efficiency of Historical Procurement Process

The assets controlled by SDP and captured with the price determination were delivered under two separate contracts during the period 2007 – 2010. The contracts under which SDP procures its operate and maintenance service delivery are so structured as a result of procurement strategies implemented by the original ultimate owner of the assets, Sydney Water Corporation, in 2006-2007. The following sections outline these procurement decisions and the operation and maintenance service delivery procurement that arose from them.

3.2.1 Desalination Plant DBOM Contract

The desalination plant, including the intake and outlet tunnels and marine structures, were procured under a design and construct (D&C) contract between Sydney Desalination Plant P/L (wholly owned by Sydney Water Corporation) and the Bluewater Joint venture, comprising John Holland Group P/L and Veolia Water Australia.

The assets captured under the desalination plant D&C contract extended from the marine intake and outlet to a discharge pipe from the drinking water storage tank. Revenue flow meters captured under the plant contract were installed downstream of the drinking water pumping station, however the pumping station itself was not delivered under the plant D&C contract.

Simultaneously with the design and construct contract, an operate and maintain (O&M) contract was awarded to Veolia Water Australia for a 20 year term. This design, build, operate and maintain (DBOM) approach was selected to significantly transfer the risks associated with operating the desalination plant, as designed and delivered by the D&C Contractor, to the plant operator, who captured this risk in its fixed price. A DBOM approach ensured the joint venture maintained focus on the long term operating demands of the process and equipment it delivered in order to achieve the plant's functional requirements. Advisian is of the view 20 years is an appropriate operating term duration as it is a suitable minimum duration to ensure plant operational risk is adequately addressed, but does not tie the asset owner to a single procurement decision for an excessively long timeframe.



Together, the D&C and O&M contract elements comprised a 6 volume agreement commonly referred to as Sydney’s Desalination Project – Design, Build, Operate and Maintain (DBOM) Contract. The various volumes are:

- Volume 1 – Design & Construct Contract
- Volume 2 - Design & Construct Contract/Company’s Requirements
- Volumes 3A , 3B & 3C - Design & Construct Contract/Contractor’s Proposal
- Volume 4 – Operate and Maintain Contract
- Volume 5 - Operate and Maintain Contract/Company’s Requirements
- Volume 6 – Other project documents (including Interface Deed, Independent Verifier Deed)

The establishment of both the D&C and O&M Contracts followed a comprehensive procurement process aligned with the NSW Government Gateway process, to ensure a genuinely competitive outcome was achieved for Sydney Water and through them, for the NSW Government. The procurement timetable was as follows:

- December 2006 – Issue of Expression of Interest (EOI)
- February 2007 – Issue of Request for Tender (RFT)
- February to May 2007 – Tender period
- April 26 2007 – Submission of Technical tender information
- May 10 2007 – Submission of Commercial Tender information
- May/June 2007 – Evaluation of tenders and requests for information period
- June 2007 – Notification of Preferred Tenderer
- July 18 2007 – Execution of D&C and O&M contracts

The contract documents executed on 18 July 2007, included the following scope and contract prices

| | Scope | Contract Price AUD (2007) |
|-----|--|---------------------------|
| D&C | The development and completion of the design and engineering, obtaining any required approvals, procurement, manufacturing, factory testing, transport to Site, erection, construction, commissioning and performance testing of a Plant sized for the average production of 250 ML/day of Drinking Water. | \$1,000,470,306 |
| O&M | The services which the Operator is required by the O&M Contract to perform, including the operation and maintenance of the Plant, Changes and any rectification work. | The O&M Service Fee |

To maximise future operating mode flexibility and achieved cost savings when the plant is not required to supply water, the O&M Services provide for the plant to be placed into short term,



medium term, long term and a mothball shutdown. The mothball mode is limited to a shutdown between two and five years duration.

The level of costs under the O&M Service Fee for each mode that are of a fixed nature, is related to the duration of the shutdown, with cost savings increasing relative to the On mode as the shutdown duration increases from the shorter duration modes to the long term mode and eventually to the mothball or water security mode.

SDP undertook a competitive market procurement process for the 20 year operating contract and the approximately \$1B construction contract to ensure that the prices agreed with the successful tenderers were efficient.

Risk allocation

The allocation of risk between the asset owner and the contracting parties was a carefully considered feature of the D&C and O&M contracts. Broadly, three categories of risk can be considered and the key features of the risk management approach integral to the desalination plant contracts are discussed below.

Between D&C Contract and client

All design construction risk was transferred to the D&C contractor, except for some geotechnical risk related to latent conditions in the area of the intake and outlet tunnels. The client also retained the interface risk between the desalination plant and the water delivery infrastructure.

Between D&C Contract and O&M Contract

Through the Interface Deed, which was part of the DBOM documentation, the O&M contractor was obligated to review all aspects of the D&C Contractors scope, from design and procurement, through to construction, commissioning and testing. This gave the O&M contractor a degree of control over the construction of the plant which enabled the O&M Contractor under the O&M Contract, to provide an indemnity against defects in the plant, thereby meeting the Company's Requirements of the D&C contract.

Between O&M Contract and asset owner

The Operator's price for delivering the O&M Services over the 20 year term is captured by the Service Fee of the O&M Contract, which includes prices based in \$2007. Each component of the Service Fee is escalated annually in line with nominated applicable fractions, typically CPI and average weekly earnings. Two notable risk transfer mechanism of the O&M contract were:

- (a) As no publically available index is available for the basket of chemicals used in RO desalination plants or for RO membranes, the contract provided for regular market testing by the Operator of both a list of chemicals and RO membranes matching those installed under the D&C contract, to enable the creation of bespoke indices.
- (b) Periodic maintenance and membrane replacement are treated on a cost pass through basis, however both are subject to a total 5 year cap, enabling the Operator to optimise these costs over that 5 year period. The risk of the work quantity and unit rates remain with SDP, but this exposure is limited to the 5 year capped amount. Under-run of the cap for both these



components is split between the Operator and owner equally, providing an incentive for the Operator to look for and deliver cost savings opportunities.

A further incentive for the Operator to strive for lowest cost operation exists via a pain/gain share of savings/costs from energy use. A baseline specific energy usage value (MWh/ML) exists which varies depending on the increment of design capacity applicable, membrane age, seawater salinity and seawater temperature. Where the specific energy use of the plant exceeds the value calculated from the pre-agreed formula, a portion of the additional energy costs caused by the over-run is debited from the monthly service fee. Where an under run occurs, the savings accrued to SDP from lower energy costs are partially shared with the Operator via an addition to the monthly service fee. Together with an abatement mechanism, these mechanisms incentivise the Operator to optimise the total cost of production.

Finally, after 4 years and three months duration in mothball shutdown, the contract allows for a transfer of risk back to the asset owner and the payment of compensation to the O&M Contractor, although it does not specify the exact process, the extent of the risk transfer or level of compensation. The current mothball shutdown under the O&M Contract will reach five years in July 2017 i.e. broadly at the commencement of the 2017-22 regulatory period.

3.2.2 Water Delivery Alliance

The Water Delivery Alliance (WDA) was an alliance contract established between a series of private sector parties and Sydney Water Corporation for the delivery of the water delivery pipeline between Kurnell and Erskineville and the drinking water pumping station (DWPS). The private sector parties developed a Target Out-turn Cost (TOC) which was reviewed by an Independent Estimator, in a process typical to previous Sydney Water Alliance contracts. The private parties would participate in a pain/gain share arrangement, based on performance against budget and a range of non-financial targets.

Beyond commissioning, the WDA agreement did not include any operate and maintenance services. This resulted in the need for Sydney Water to procure O&M services for both the DWPS and the water delivery pipeline. Each of these service delivery procurement decisions are discussed below.

A. DWPS

In mid-2009, Sydney Water began exclusive negotiations with Veolia Water Australia (VWA) to add the necessary operate and maintenance services for the DWPS to the already contracted desalination plant operate and maintenance services.

VWA did not have any input to the design or build of the DWPS. As a result, the warranties and indemnities provided by VWA under the plant O&M Contract were not able to be replicated for the DWPS and a separate O&M Deed was established, rather than the plant O&M contract being varied.

A key aim of the DWPS Deed was to maintain the risk allocation established in the Plant O&M Contract. The DWPS Deed ensured that VWA retained all risks allocated by the Plant O&M Contract in the event of any failure within the DWPS.



Sydney Water developed a procurement plan for the DWPS services, which included exclusive negotiation with Veolia Water Australia and the development of a service cost comparator by internal Sydney Water asset management. The Service Fee for the DWPS Deed closely replicated the plant O&M Contract, including all relevant components and some additional items relevant for the DWPS, such as document establishment and critical spares.

The DWPS Deed for the operation and maintenance service delivery of the DWPS was executed by Sydney Water and Veolia Water Australia in late December 2009.

B. Water Delivery Pipeline

After handover of the DWPS and water delivery pipeline from the WDA to Sydney Water in January 2010, Sydney Water began internally delivering maintenance services for the water delivery pipeline.

Upon the expiration of an interim maintenance agreement between SDP P/L and Sydney Water following the refinancing in June 2012, SDP procured a separate pipeline maintenance contract with Veolia Water Australia. The value of this agreement was benchmarked against the interim pipeline agreement previously in place. The costs were found to be immaterial relative to SDP's overall cost base. The potential for cost reductions which could be achieved through a competitive procurement process was considered too small to justify the time and cost that would be required and unlikely to exceed the efficiencies obtained from contracting with the on-site plant operator.

3.3 Assessment of 2017 - 2022 Procurement Options

For the procurement of the operate and maintenance service delivery for the three main assets, being the desalination plant, the DWPS and the water delivery pipeline, SDP has two procurement options moving forward from the existing arrangements. These are discussed in turn below with the benefits and disadvantages associated with each option, briefly discussed.

3.3.1 Business as usual under existing contracts

Both the desalination plant O&M Contract and the DWPS Deed have operating terms that extend 20 years from the initial completion of the assets, being February 2010. The existing contracts will therefore continue for the full extent of the 2017-22 price period, unless any termination clauses are enacted prior. Together, these two contracts comprise greater than 80% of SDP's operating costs when the plant is in production and around 55% when it is in water security mode.

The existing contract for maintenance services for the water delivery pipeline is a five year agreement, which terminates 30 June 2018. However it can be extended annually up to 2062.

Proceeding with this option protects the indemnities and warranties that the Operator has provided to SDP under the O&M Contract and associated Interface Deed with the D&C Contract. It also continues the incentives of pain/gain share and abatement within the O&M contract for efficient operation via the sharing of energy cost over-run and underrun against the pre agreed specific energy formula and prudent decisions in regard membrane replacement and periodic maintenance.



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3.5 Conclusions on SDP's Procurement Strategy

SDP has in place three existing O&M service delivery contracts, one each for the desalination plant, the DWPS and the water delivery pipeline, established in the period 2007 to 2013.

The desalination plant O&M Contract was comprehensively competitively tendered along with the plant D&C contract in 2007. The DWPS Deed was exclusively negotiated with Veolia Water Australia in 2009, and benchmarked against an internal Sydney Water cost comparator. The water delivery pipeline contract was exclusively negotiated with Veolia Water Australia in 2013.

[Redacted content]



Given the risk allocation in the existing O&M contract and the procurement process undertaken for the three contracts, SDP's procurement strategy is considered to be prudent and the associated costs are considered to be efficient.



4 Review of Asset Management

This section presents Advisian's review of the asset management approach established for the Plant, including a review of the asset management framework, supporting processes and systems and comments on the relative maturity of the overall approach. It seeks to test whether the resulting actions represent what a prudent operator in the industry would be expected to deliver and therefore whether the framework and systems are an appropriate basis for substantiating that the O&M expenditure forecasts are prudent.

Under ISO 55000 Asset Management Standard, effective asset management is essential to realise value through managing risk and opportunity in order to achieve the desired balance of cost, risk and performance. An effective and robust asset management approach will ensure that strategic objectives and investment priorities for capital and operational planning are aligned.

The review included a desktop review of the systems and processes, as well as an on-site review. The relationship between the desktop and on-site review is as follows:

- The desktop review tested whether the asset management approach represents an effective and robust planning framework, and hence will result in prudent and efficient investment decisions if implemented.
- The on-site review aimed to demonstrate the rigour with which the asset management approach is applied in practice at the Plant.

4.1 Asset Management Framework

Under the WICA Network Operator's licence, SDP is required to have an Infrastructure Operating Plan that captures the intended approach to asset management. SDP's Infrastructure Operating Plan references Veolia's Integrated Business Management System (IBMS)³. The management of assets at the Plant is outlined in the Asset Management Plan section (Chapter 9) of Veolia's IBMS Manual.

The IBMS aligns with the principles in the standard for asset management (ISO 55 000) and the IBMS is certified under ISO 9001, as a quality management system. Being certified under ISO 9001 means the system has demonstrated that it adequately monitors and manages the business and assets to achieve consistent and adequate performance and service. This includes regular audits, review and continual improvement processes.

4.2 Overview of Supporting Processes and Systems

This section provides an overview of the systems and processes that support and provide confidence in the framework for managing the SDP assets.

³ The IBMS is also implemented to meet the management plan requirements under the O&M Contract.



4.2.1 Systems assessed

To assess the adequacy of the supporting systems and processes under the IBMS, we reviewed a sample of management plans, procedures and work instructions. The systems under the IBMS that relate most directly to asset management are:

- Maximo – a computerised maintenance management system (CMMS) database with an asset register, maintenance schedules, procedures and work instructions;
- Critical Asset Renewal Management System (CARMS) – a Veolia database for forecasting asset renewals and replacement based on criticality and condition of the asset;
- Experience Centred Maintenance System (ECM) – a database that collates the information gathered from operators, suppliers and management in workshops where the criticality and condition of major assets are assessed. This information is then fed either into CARMS or Maximo, depending on the outcome of the workshop; and
- Membrane Management System – a tool for managing the membranes at the plant.

The sample of procedures and work instructions which we assessed included:

- PR-KDP-22- 850 Conducting Preventive Maintenance
- PR-KDP-21-856 Asset Creation Renewal and Disposal
- PR-KDP-21-854 Asset Condition and Risk Assessment procedure
- PL-ANZ-21-383 Developing and Maintaining an Asset Replacement Plan
- PR-KDP-19-5071-1 Plant Mothball Procedure
- WI-KDP-19-5067 Intake and outlet area mothball work instruction

The purpose of assessing the systems and associated documentation was not to conduct a comprehensive audit of the system to ensure it was compliant with any standard or regulatory requirement, but rather to confirm that the approach manages risk to optimise production (or capacity for production), so the water security objective for the plant is met as efficiently as possible.

The procedures and work instructions that we reviewed:

- Were chosen specifically to investigate the process supporting decisions on large cost maintenance and renewal items;
- Adequately used a risk management approach aiming to minimise costs while accepting an appropriate amount of risk;
- Included continual improvement where appropriate. Continual improvement was explicitly included in the procedures, and fed data back into the CARMs and Maximo for altering future preventive maintenance or adapting work orders
- Integrated the planning process for maintenance with the budgeting cycle by timing the periodic reviews onsite to feed information such as emerging risks into the asset renewal decisions and other strategic level processes.



4.2.2 Previous Audits

Under the *Water Industry Competition Act 2006*, SDP is required to have independent audits to test that SDP still meet the requirements under their network operator's licence. This includes testing that the Infrastructure Operating Plan and supporting systems (in this case the IBMS) manage assets in accordance with good industry practice.

The previous audits⁴ found the supporting processes and systems under the IBMS were adequate to meet the requirements of the WICA licences. These audits verified the processes were adequate to achieve safe, reliable and continuous performance, as per the legislative requirements.

The most recent auditor commented that "SDP and the operator are to be commended for the appearance of the site and the condition of the infrastructure, particularly the programs to maintain electrical equipment and monitor, repair and prevent corrosion."⁵ There were no recommendations from the most recent audit that indicate there should be any concern relying on the systems in place to obtain efficient and prudent costs.

The audit reports were accepted by IPART, so demonstrate that the systems which passed the audit support prudent management decisions to meet legislative requirements.

4.2.3 On-site findings

During the site visit of 24-26 May 2016, Advisian found evidence that the documented asset management approach has been implemented with rigour at the SDP facility. Key examples are:

- The Plant (those components not tornado damaged) was in a clean and well-maintained condition. All evidence was that the Plant was being maintained in a proactive manner;
- Continuous improvement (leading to increased efficiency) was demonstrated in all aspects of the care and maintenance routines that were sampled. The following examples demonstrate this:
 - The replacement regime for the membrane preservation fluid was changed over the water security shutdown period. In consultation with the manufacturers, the operator reviewed how often the fluid had to be replaced and gradually increased the time from every 6 months to every 9 months, to improve the efficiency of the preservation regime.
 - The recoating of the internal sludge thickener concrete surfaces was brought forward in the maintenance schedule to utilise the scaffold that was set up for scraper maintenance, as the scaffold is a major part of the maintenance cost.
- Some major renewal works have been delayed until the plant is restarted. These decisions have been made as a result of the risk assessment process inherent in CARMS. For example, the overhaul of the sludge centrifuges has been delayed as the centrifuges are not critical to the Plant during shutdown and following the overhaul will need to be recommissioned by a specialist technician;

⁴ *Audit of the Adequacy of the Sydney Desalination Plant Infrastructure Operating Plan & Water Quality Plan, Cardno, September 2013; and Operational Licence audit for Sydney Desalination Plant, Risk Edge, July 2015*

⁵ *Operational Licence audit for Sydney Desalination Plant, Risk Edge, July 2015*



- Use of the Maximo software, which we interrogated via a random selection of items, gave us confidence in the integrity and thoroughness of the maintenance activities undertaken during the Shutdown period.

Maintenance costs under Water Security Shutdown conditions are not necessarily less than when the Plant is operational. Under the care and maintenance regime, significant sections of the Plant remain operable and require similar resources to be maintained. Some aspects of the Plant require more manual attention than when the plant is operational. For example:

- Assets that are covered by statutory requirements (i.e. some pressure vessels and electrical equipment)
- Many of the pumps are regularly rotated by hand rather than operating regularly.
- Some checking has to be done manually rather than by reviewing the output of the instrumentation (SCADA) while the plant is operating.

4.2.4 Tornado Impact

The tornado is impacting nearly every aspect of the care and maintenance of the Plant. While for the purposes of the price reset, this impact is not taken into account, it is impacting the operator's capacity to continue the care and maintenance activities. There was considerable evidence that the operator is constantly adapting the care and maintenance activities to minimise the impact of the tornado, however, will not be able to completely mitigate that impact. For the purposes of this review, we have assumed that any damage will be rectified through the insurance rectification process.

Assets which may be reset to Year 0 in their lifecycle at the start of the next price path, due to replacement after the tornado, include the following higher cost items. This is not a comprehensive list nor does it reflect final outcomes of the rectification process. The list only includes larger cost items, because we assumed that the smaller cost items will not impact the opex forecast.

- 2 of the 11 transformers
- Fluoridation building
- Fluoridation dosing equipment
- Air conditioning systems for switch rooms
- Intermediate permeate tanks
- RO building roof / walls / roller doors / vents
- RO building ducted ventilation system
- Seawater pumping station roof / walls
- Drinking water pumping station roof / walls
- Maintenance building roof / walls
- Fire System
- Administration building
- HP pump motors – (partial only)
- Compressed air system (possible)
- Filter Air scour blowers (possible)



The operator has identified a reduction in maintenance costs due to the replacement of assets damaged in the tornado. This is discussed in further detail in sections 5.6 and 6.4.

There are also assets which have been damaged by the tornado (and during the following period until rectification is finalised) but are likely to be repaired rather than replaced.

4.3 Relative Maturity of Asset Management framework

Our findings evidence that the asset management framework implemented at the Plant is mature and leads to efficient outcomes through continuous improvement.

A central demonstration of this is that the preventive maintenance for the Plant is regularly recalibrated through workshops between the operators, equipment suppliers and operations managers on site. This process involves inputs and outputs to the asset maintenance database (Maximo) as well as the critical asset management system (CARMS). The condition and the criticality of the assets are reviewed and where appropriate, options for different maintenance regimes considered. Any changes are then fed back into the various systems.

Further, the response after the tornado demonstrates the relative maturity of the asset management approach at the Plant. Considering the extent of the event and the difficulties in site access afterwards, the plant was in good, although damaged, condition at the time of the site visit. The maintenance work orders had been amended and multiple workshops had been undertaken to address the challenges presented by the event, via application of the asset management systems already established.

The Advisian team considers this demonstrates that the asset management systems are robust and adaptable to even an extreme event. It is our opinion that only a mature and well administered asset management approach could achieve such a result in such challenging circumstances.

4.4 Conclusions on SDP's Asset Management

The processes and systems that support the asset management framework for managing the Plant assets are appropriate and adequate to provide confidence that when the processes are implemented the resulting costs would be prudent. This conclusion is based on an appropriate sample of processes, onsite findings and a review of findings of previous audit reports.

Our review of SDP's asset management framework, plans and supporting processes and systems found that:

- (a) The asset management plan appropriately describes the management of the Plant;
- (b) The supporting processes reflect an efficient and effective approach to managing plant assets, taking into account the operational environment of the Plant - there was no evidence of excessive expenditure and maintenance activities that were brought forward or delayed have been done so to ensure efficient use of resources without any loss of plant integrity;
- (c) The supporting asset management systems exhibit a focus on continuous improvement, are well established within plant operations and do record appropriate historical information to support the efficient ongoing operation of the Plant; and



- (d) Overall, the asset management framework, management plans, processes and systems reflect contemporary asset management practices and are considered to support efficient management decisions.

On this basis, Advisian concludes that the Asset Management framework, management plans, processes and systems are effective (i.e. fit for purpose). The framework, plans and resulting actions are consistent with good industry practice, and as such represent what a prudent operator in the industry would be expected to deliver. Accordingly, the framework and systems are an appropriate basis for the purpose of substantiating that SDP's O&M expenditure forecasts are prudent.



5 Review of Proposed Operations and Maintenance Expenditure – O&M Charges

This section presents Advisian’s review of the O&M expenditure drawn from the O&M Charges only, included by SDP in its opex forecast. The review has included the following main steps:

- Confirmation that the Service Fee provisions of the O&M Contract, being the basis of the O&M expenditure forecast, have been interpreted correctly and identify any exceptions;
- Confirm that the SDP opex forecast draws upon the O&M Charges where appropriate; and
- Review and test each of the assumptions made in the preparation of the SDP opex forecast and confirm that they are appropriate and likely to lead to the incurrence of efficient costs.

5.1 Proposed Expenditure

The tables below presents the SDP proposed opex (real 16/17) for each mode across the individual financial years of the regulatory price period. The Fixed and Variable costs shown below are drawn from the O&M Charges (apart from the exception discussed below in regard water security mode), whilst the Corporate cost values are provided in order to provide a total cost value and have not been reviewed by Advisian.

| Mode | Cost (Real\$16-17) | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 |
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| Mode | Cost (Real\$16-17) | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 |
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Source: Extracted from 'SIR Summary', SDP REG OPEX MODEL FINAL.xlsm

The water security mode fixed cost values include some elements that are not drawn from the O&M Charges. These elements are assessed in Section 6.

The Shutdown and Restart values shown below are drawn from the O&M Charges.

| Mode | Cost (Real \$16-17) | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 |
|------|------------------------|---------|---------|---------|---------|---------|
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Source: Extracted from 'SIR Summary', SDP REG OPEX MODEL FINAL.xlsm

The pipeline operating expenditure values shown below are drawn from the pipeline asset management review completed by KBR.

| | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 |
|--|---------|---------|---------|---------|---------|
| | | | | | |

Source: Extracted from 'SIR Summary', SDP REG OPEX MODEL FINAL.xlsm



5.2 Veolia O&M Contract Charges

A summary of the Operator's proposed charges in accordance with the Service Fee under the O&M Contract and the DWPS Deed is provided in Appendix A. One table is provided per mode of operation for as follows:

- On;
- Short Term Shutdown;
- Medium Term Shutdown;
- Long Term Shutdown; and
- Water Security.

Each table presents the anticipated value of each component of the Service Fee across the price determination period. Fixed and variable costs of delivering the O&M Services are clearly identified.

It can be seen from the tables of Operator's proposed charges that the fixed costs are rolled back from the 'On' mode scenario as the length of the shutdown duration increases from short term shutdown to water security mode.

5.3 O&M Charges Escalation

The O&M charges were set in real terms as at 1 July 2007. All components of the O&M charges are therefore subject to regular (typically quarterly) escalation in order to calculate the monthly Service Fee. SDP has applied actual values of the relevant indices in the O&M Contract to escalate all values to \$2016/17.

Forecasts of SDP opex were derived in part from the O&M charges, therefore need to include an allowance for the future movement in the particular escalation indices defined under the O&M Contract used to calculate the monthly Service Fee. These indices are either publically available indices or bespoke indices calculated solely for the purposes of O&M contract.

A. Publically Available Indices

- Consumer Price Index (CPI)
- Average Weekly Earnings (AWE)
- US Producer Price Index

B. Bespoke Indices

- Chemical Price Index
- Membrane Price Index

In its review of the SDP opex forecast, Advisian has found that an escalation forecast equivalent to CPI has been applied to both publically available and bespoke indices. The opex forecasts are shown in real 2016/17 dollars and under IPART's guidelines, will be escalated by CPI during the regulatory period. Since each of the indices applied in the O&M Contract could reasonably be expected not to track precisely in parallel with movements in CPI, other than CPI itself, it is necessary to examine the appropriateness of the use of CPI in each instance and the likelihood that



such an assumption will be within a reasonable margin of the actual value and accordingly the resultant opex forecast represents efficient costs. It is important to acknowledge that forecasts of future movement in the bespoke indices are inherently difficult to reliably prepare and include uncertainty.

In each case, Advisian’s research of past historical movements and our assessment of likely future movement in either the publically available index or the primary constitute factors of the bespoke indices, leads us to conclude that CPI is an appropriate proxy for the actual index and unlikely to materially differ from the index’s future movement.

Advisian has calculated the long term trend movement in both the chemical price index as calculated under the O&M Contact and a proxy index for the O&M contract membrane price index based on publically available US Producer Price Indices. When the long term trend is considered over 15 and 9 years respectively, the annual movement is calculated between 3% and 3.75%. With compound annual increase in CPI (All Groups, Sydney) over the last 15 years being 2.3% , Advisian views the use of CPI as an outcome more likely to under compensate SDP for the actual movement in both chemical and membrane prices over the 5 year regulatory period than over compensate.

Advisian has also calculated the movement the in average weekly earnings over the last 9 years and found it to be 3.4% p.a. When allowing for the likely movement in wages over the near term, as represented by Enterprise Bargaining agreements in the electricity, gas, water and waste services sector of 2.5% and the longer term trend, Advisian again views the use of CPI as an outcome more likely to under compensate SDP for the actual movement in Average Weekly Earnings over the 5 year regulatory period than over compensate.

On the basis described above, Advisian concludes that the forecasts in index movements are likely to be within a reasonable margin of error of the actual value and that the resultant opex forecast values calculated by applying these forecasts represents efficient costs. Application of CPI for all escalation indices also leaves the volatility risk of movement in the bespoke indices residing with SDP.

5.4 Incorporation of O&M Efficiencies

Several components of the O&M Charges incentivise the Operator to seek out and achieve efficiencies in the delivery of its operate and maintenance services under the O&M Contract. This feature of the O&M Contract is vital to ensure that the Operator is continually seeking increased efficiencies and that the O&M charges represent efficient expenditure. These incentives are described below and the respective values incorporated in the forecast O&M Charges are also presented.

A. Electricity Adjustment

[Redacted text block]

[Redacted text block]



B. Periodic Asset Maintenance

[Redacted text]

C. Membrane Replacement

[Redacted text]

5.5 Impact on Water Customers

It is important that the opex submitted by SDP is prudent and efficient as these costs are passed through to water customers, namely Sydney Water Corporation and all its water service customers.

Various positive impacts arise to SDP customers through the expenditure of the proposed operating costs. The primary impacts that occur are discussed below.

5.5.1 Water Security

A significant portion of the fixed costs component of the O&M charges is contained within the fixed labour cost item. This item captures the cost of the operator’s on site management team, including the senior asset maintenance personnel. Not only does this team manage the asset maintenance by which the individual plant assets stay in a state able to produce drinking water in the applicable timeframe following a restart notice, the senior management also oversee implementation of the operator’s management system and would recruit and train the additional staff required were the plant be required to restart and switch to an operating mode.

The routine asset maintenance costs are incurred in undertaking the preventative and corrective maintenance required to keep the originally installed assets in suitable condition to produce drinking water when required.



5.5.2 Efficiency benefit pass through

[Redacted]

[Redacted]

5.5.3 Shutdown mode savings

[Redacted]

[Redacted]

5.6 Advisian Review of Key O&M Issues

The forecast expenditure on periodic maintenance in all modes other than mothball is assumed to be the contract value for the cap of periodic maintenance in the O&M contract indexed from 2007 prices. The forecast whilst the plant is in water security/mothball mode is assessed in Section 6.

We consider that this forecast is appropriate in all modes other than mothball and that there is unlikely to be savings under the cap for periodic maintenance because:

- The significant duration of the water security shutdown the Plant has experienced increases the uncertainty about the condition of the assets under operational conditions. There is no precedence with such a long shutdown to provide the operator or owner with any data about the reliability of assets when the Plant is restarted. Hence it is possible there may be more periodic maintenance required after the restart, than was allowed for in the contract. In this case, the cost of any additional periodic maintenance is captured under the existing O&M Charges
- Some periodic maintenance has been deferred until the Plant is restarted. The deferrals have been decided via the application of the criticality and condition assessment processes which supports the CARMS process. This process is appropriate to manage risk and opportunity to achieve the desired balance of cost, risk and performance under the Asset Management



standard ISO 55000. Therefore, the deferrals of periodic maintenance are appropriate under good industry practice of asset management,

- As a result of the tornado reinstatement, there will be a certain number of sub components replaced and their maintenance demands will likely reduce to that of a new or near new asset, as listed in Section 4.2.4. However, a significant majority of these items were not due for periodic maintenance in the 5 year period of this price determination assuming the plant was not in mothball mode. Therefore, the replacement of these sub components following the tornado will not materially impact on the periodic maintenance allowance under the contracted O&M Charges during the 2017-22 regulatory period.

5.7 Conclusions on SDP's Operations and Maintenance Expenditure – O&M Charges

Advisian has comprehensively reviewed the details of the O&M charges contained within the SDP opex forecast. Our review has addressed the application of the Service Fee under the O&M Contract, the forecasting of escalation indexes required for the calculation of the Service Fee and the likelihood that the capped amount of periodic maintenance will be underspent.

Our review of SDP's O&M expenditure forecast for all modes has found that:

- (a) the O&M expenditure forecast has been calculated via applying the correct interpretation of the Service Fee under the O&M Contract;
- (b) the SDP opex forecast draws upon the O&M Charges where appropriate; and
- (c) each assumptions made in the preparation of the SDP opex forecast is appropriate and likely to lead to the incurrence efficient costs

Our review has also identified that efficiencies in the delivery of the O&M Services are incentivised via several gain/pain share mechanisms under the Service fee arrangements and that various positive impacts arise to customers of SDP via the incurrence of the O&M expenditure.



6 Review of Proposed Operations and Maintenance Expenditure – other than O&M Charges

This section presents Advisian’s review of the O&M expenditure drawn from outside the O&M Charges captured in the O&M Contract, included by SDP in its opex forecast. This category of expenditure is only applicable to the Asset Maintenance component of the opex forecast during an extended water security shutdown (greater than 5 years).

SDP needs to include asset maintenance costs not captured in the O&M Charges in its opex forecast because the plant is nearing the end of the 5 year time limit on a “mothball” shutdown as proscribed in the O&M Contract. If the plant is not restarted by June 2017, either:

- SDP must restart the plant, thereby increasing maintenance cost allowances back to their normal operating levels, but only for as long as the plant continues to operate; or
- A portion of risk under the O&M Contract, particularly the increasing risk of asset failure or low performance at plant restart (re-start risk), transfer back to SDP.

SDP has decided that it is not prudent to direct a permanent restart of the plant in the absence of the need to do so for water supply purposes under the water supply agreement with Sydney Water, which is governed by the SDP operating rules of the Metropolitan Water Plan. Given the availability of comparatively cheaper water from storage dams which are presently at very high levels, restarting⁶ the plant would not represent value for money for customers. Therefore an extended water security mode is required to be addressed by the SDP opex forecasts. As a result of the risk transfer back to SDP that would exist in such a scenario, the total costs incurred by SDP during an extended water security shutdown are not captured in the existing O&M Charges provided by the O&M Contract.

The contract risk was limited in this way to enable the maximum fixed cost savings compared to the On mode, which accrue in shutdown modes, to be realised and be applicable in the first 5 years of any water security shutdown. Limiting this contract provision to the initial 5 years of shutdown was prudent in order to minimise costs to the customers while still ensuring the plant was available in shutdowns of less than 5 years duration.

The O&M Contract does not specify what the detailed commercial arrangements will be upon expiration of the 5 year time limit. The contract only proscribes that a reasonable transfer of risk from the Operator must occur. SDP’s opex forecast assumes that the cost of mitigation measures to address the plant restart risk transferred from the Operator, will be borne by SDP and that these costs are in addition to the existing O&M Charges. The transfer of this risk proscribed by the O&M Contract will result in SDP incurring asset maintenance costs additional to those incurred in shutdown modes of up to 5 years duration, which were assessed in Section 5 of this report.

The review of the O&M expenditure drawn from outside the O&M Charges has included the following main steps:

⁶ A partial plant test, separately proposed by SDP, does not constitute a restart of the plant in the context of this assessment



- Examine the specific periodic maintenance tasks proposed by the Operator and the process of their identification via the asset management systems applied at the plant;
- Challenge the Operator on their initial task identification and look for evidence that the Operator itself has challenged the asset management system outcomes for an extended water security shutdown context;
- Disaggregate the proposed periodic maintenance totals into categories of related assets and assess the proposed values for prudence on this basis, including a comparison to the O&M Charges’ of the operating term’s most applicable time period;
- Review the process of maintenance task cost estimation and sample review a randomly selected list of key tasks; and
- Assess any impact of the Kurnell tornado on the proposed periodic maintenance by examining a list of maintenance tasks omitted from the proposed total as a result of asset replacement under the tornado rectification works.

6.1 Proposed Expenditure

SDP and Veolia Water have developed forecast asset maintenance costs to address the plant restart risk not captured by the O&M Contract for the 5 years beyond the expiration of the initial 5 year water security shutdown, should this occur.

The table below presents the SDP proposed opex (real 16/17) in the context of an extended water security shutdown, across the individual financial years of the regulatory price period. The Fixed cost component below captures two elements detailed in Appendix A - Routine and Periodic Maintenance - that are not drawn from the O&M Charges and are assessed in this section.

| Mode | Cost | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 |
|-----------------------|--------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Water Security | Fixed | 10,308,352 | 13,047,488 | 12,985,426 | 22,329,225 | 21,462,939 |
| | Variable | - | - | - | - | - |
| | Corporate | 8,229,927 | 8,113,089 | 8,363,615 | 8,640,199 | 8,629,425 |
| | Total | 18,538,279 | 21,160,577 | 21,349,042 | 30,969,425 | 30,092,364 |

Source: Extracted from ‘SIR Summary’, SDP REG OPEX MODEL FINAL.xlsm

There is no five year period that provides an appropriate comparison between the forecast asset maintenance expenditure in an extended water security shutdown and those included in the O&M Charges. This is because whilst the O&M Contract captured the risk plant restart following a shutdown of up to 5 years duration, an extended shutdown (i.e. beyond 5 years) was not a scenario addressed by the O&M Charges.

6.2 Veolia’s Charges

A summary of the Operator’s proposed costs for asset maintenance in the context of a continuation of the water security shutdown is provided in Appendix A . These forecast costs include the additional asset maintenance costs incurred by SDP as a result of the risk transfer from the Operator if the water security shutdown exceeded 5 years. Development of the costs assumed that a plant re-start would occur in the first year of the 2022 regulatory period.



Costs for all other components of the operator's O&M Charges in an extended water security shutdown would remain the same as during a "normal" water security shutdown as they are fixed irrespective of mode. The exception is membrane replacement, however no membranes are replaced during shutdown.

6.3 Impact on Water Customers

All opex submitted by SDP, whether or not it is derived from the O&M Charges, must be prudent and efficient as these costs are passed through to water customers via Sydney Water's charges. As discussed above, adapting the maintenance regime to an extended water security mode, minimises total costs to customers, particularly compared to returning to an ongoing On mode of operation.

The ability to remain in water security mode reduces the Fixed Cost component under the O&M Charges compared to all other modes of operation. Whilst asset management costs of the Operator's senior asset maintenance personnel continues to be incurred, some other services captured under the Fixed Cost component are avoided and fixed cost savings are realised. In parallel, additional asset maintenance activities directed at mitigating the plant restart risk, are necessary during an extended water security shutdown. SDP customers are positively impacted by this arrangement via the continuation of water security availability at minimum overall cost.

Additional expenditure is incurred in an extended water security shutdown because preventative and corrective maintenance is required to overhaul and where necessary, replace the originally installed assets. More maintenance is required than in the initial 5 years of a water security shutdown because many of the assets:

- are continuing in active service, even whilst the main plant drinking water process systems are in shutdown; or
- were not designed to be kept in a shutdown state beyond five years, with only minimal routine maintenance.

If the additional maintenance activity is not completed during the extended water security shutdown, many plant components will deteriorate to an extent that would reduce SDP's compliance with its obligations under its WIC Act Network Operator's Licence. The lack of additional maintenance will also unacceptably raise the plant restart risk that is transferred from the Operator to SDP when a water security shutdown exceeds 5 years and jeopardise the ability of the plant to achieve the 8 month duration restart target under the Network Operator's Licence.

6.4 Advisian Review of Key O&M Issues

The additional asset maintenance forecast to be completed in an extended water security shutdown was not included in the originally procured O&M contract because the contract limited the operator's exposure to paying for maintaining assets in a shutdown mode to 5 years. After this time, either the plant is required to be restarted, with accompanying return of maintenance cost allowances to operational levels, or risk is transferred back to SDP. With the 5 year time limit to expire at the commencement of the 2017-2022 regulatory period, it is necessary to assess what is prudent and efficient to include in charges passed onto customers, in order to ensure the continuing availability of the plant.



The forecast expenditure on periodic maintenance during an extended water security shutdown has been assessed by Advisian to be prudent and efficient. We consider this to be the case due to the reasons provided below. A more detailed list of our findings is provided in Appendix D.

- The inclusion in the opex forecast of maintenance costs incurred during an extended water security shutdown in order to mitigate the risk to plant availability upon restart, is based on a reasonable interpretation of the limitations of risk transfer under the O&M Contract;
- Development of the forecast expenditure via the framework of the Operator's asset management system and particular application of the CARMS asset maintenance tool is appropriate and an industry accepted recognised process;
- The periodic maintenance items identified by the Operator through the CARMS tool, generally relate to previously scheduled maintenance on:
 - Critical plant systems that are operational even whilst the plant is a shutdown; and
 - Civil engineering and building assets that will have experienced up to 12 years physical deterioration by the end of the regulatory period.
- Further periodic maintenance items relate to:
 - Key plant process equipment that has not yet seen any significant maintenance as they have not operated since 2012, but on which the risk of reliable restart has increased beyond tolerable levels due to its age, such as: critical valves, turbidity and pH meters, and variable speed drives;
 - Assets where initial maintenance was not scheduled until after 12 years from plant commissioning, but for which being in a non-operational environment is causing an increased rate of deterioration, such as: permeate hoses and rubber expansion joints.
- A final category of prudent periodic maintenance items identified by the Operator relate to items that were not previously scheduled. These items were either excluded from the planned periodic maintenance intentionally (and the assumptions relied upon have proved incorrect) or they were inadvertently overlooked. In both cases, the risk of exclusion was addressed in the O&M Contract and therefore accepted by the Operator for the initial 5 years of water security shutdown. In an extended water security shutdown, this risk and associated costs transfers back to the Asset Owner;
- Where multiple items of the same high value and specialised asset exist within the plant, the Operator has proposed an approach of limiting inspection and regular maintenance in order to inform the condition of the total set, to a small sample only, thus limiting to a minimum prudent level, the cost and risk arising from mitigating restart uncertainty;
- After the tornado, there may be some assets that will be replaced and their asset age effectively reset to Year 0, as listed in Section 4.2.4. This replacement has been captured in the Operator's asset management system which has resulted in the Operator identifying periodic maintenance which is no longer required. This has been accounted for in the proposed expenditure, [REDACTED]
- As discussed in section 5.6, some periodic maintenance items scheduled for completion in the 2012-2017 period, have been deferred until the Plant is restarted. Unless these items would have again been required to be completed in the 2017-2022 regulatory period, it is not appropriate that the cost of those deferred maintenance items be included in the proposed additional expenditure, even if the items were to be actually undertaken during the future regulatory period. This has resulted in SDP excluding one maintenance item from the expenditure proposed by the plant Operator (valued at \$0.4 million);



- The sample of periodic maintenance item cost estimates reviewed indicates that:
 - The costing were prepared by experienced asset management personnel and were developed following an appropriate cost estimating process;
 - capture only a reasonable scope of work for the relevant periodic maintenance item; and
 - the individual task line items assessed in detail are within reasonable expectations of most likely values and appropriately account for risk in undertaking the maintenance item.

6.5 Conclusions on SDP's Operations and Maintenance Expenditure – other than O&M Charges

Advisian has comprehensively reviewed the details of the SDP opex forecast where costs have been drawn from outside the O&M Charges due to the expected extended water security shutdown. Our review has examined the asset management processes applied to identify the necessary periodic maintenance tasks, considered the appropriateness of including each maintenance item and sampled a selection of maintenance item costs.

Our review of SDP's O&M expenditure forecast drawn from outside the O&M Charges has found that:

- the O&M expenditure forecast has been developed by applying appropriate asset management processes considering the increased risk of asset failure or low performance at plant restart and is therefore considered to be prudent expenditure; and
- The maintenance items examined are calculated according to good process, by experienced personal and are within reasonable expectations of efficient values.

Our review has also identified that a positive impact of continued water security arises to customers of SDP via the incurrence of this portion of the O&M expenditure.



7 Benchmarking

7.1 Objectives

The objective of this section is to assess the availability of suitable benchmarking data for the Sydney desalination plant and where applicable, provide a reliable comparison of the relative efficiency of the Sydney plant using the available data. Benchmarking SDP's proposed opex to other plants has the potential to indicate if SDP's proposed opex may be considered efficient.

Benchmarking efficient operating costs between desalination plants is challenging because of the limitation on the statistical certainty due to the small sample size as well as the significant differences in operating environment factors, regulatory regimes and commercial arrangements. This section considers the data normalisation required in order for appropriate comparisons to be undertaken. It also identifies and discusses the operating and environmental factors that may influence the proposed opex and which need to be taken into account when making comparisons between different plants.

All benchmark comparisons should be considered in the context of these limitations and used with appropriate caution.

7.2 Approach

Comparing the operational costs of similar sized seawater desalination plants can, under specific circumstances, provide a reliable indication of the relative efficiency of different plants. However, when making comparisons it is important to consider the influence of operating environment factors as these can have significant impacts on operating costs and may not reflect underlying efficiency.

To benchmark the proposed opex for SDP, we firstly gathered and reviewed publicly available information. We undertook an extensive literature search and liaised with key organisations in the global desalination industry, including the International Desalination Association (IDA) and the National Centre for Excellence in Desalination in Australia.

High level indicative operating cost values are usually expressed as \$opex/kL of drinking water produced. This high level comparator has some significant limitations, as there are many operating and environment factors that will vary from location to location significantly. Foremost amongst these is whether electricity costs are included or excluded from the expressed value. The electricity costs are a significant proportion of the overall unit production cost of any RO desalination process. As the contract for providing electricity is outside the scope of this price reset, (as it was procured separately from the operate and maintenance services and under NSW government direction) the associated costs are not assessed in this review of the O&M component of SDP's opex forecast, however benchmarking of energy costs can still prove valuable.

We have identified these operating and environment factors and discussed in some detail their potential to impact on the ability to make a reliable comparison between different plants. Finally, we considered the caution required in the application of benchmarking findings and limitation on the statistical certainty due to the small sample size and number of cost drivers and complexity of assembling a comparable Australian or international data set.



7.3 Operating Environment Factors

The operating environment of desalination plants varies significantly depending on their location, design, commercial arrangements, ownership structure, operating profiles, configuration and technology. The following sub-sections consider a range of operating environment factors that should be considered in making benchmarking comparisons. It should be acknowledged that it may not be possible to consistently correct for these factors.

7.3.1 Differences in reporting framework

Desalination plants that are operated by regulated utilities, such as Water Corporation (Western Australia) or SEQ Water, also operate the water and wastewater systems to provide services directly to the end-users. As a result, the costs of operating the plants are not specified in the regulators' determinations, the costs are tied up in the overall operating costs of the utilities. Differences in ownership and regulatory framework mean that it is difficult to determine the degree to which publicly available information is comparable.

Some data is available on the Victorian Desalination Plant (VDP), whose costs are recovered under the regulated Melbourne Water, and the Adelaide Desalination Plant (ADP) a part of SA Water, which is regulated by ESCOSA.

While Melbourne Water is a bulk water supplier and provides more than just the desalinated water services, in the latest determination, the opex has been separated out from the other water services. This is because VDP has received the first order for water in 2016-17, and the associated contractual opex comes under a pass-through arrangement.

It is unclear in the publicly available literature whether the operating costs for ADP include membrane replacement and electricity costs, so it is not possible to confirm that these costs are comparable.

7.3.2 Differences in Technology

Comparing costs between different technologies is challenging. For example, comparing the operating costs of a 10 year old plant against potentially lower operating costs of a recently commissioned plant does not demonstrate that the new plant is necessarily more efficiently operated. Efficient operating costs will reflect the operation of existing assets of the relevant technology, at a given plant, rather than the potentially more advanced technology used at other plants.

For example, significant variance in operating costs exists overall across technologies, such as thermal desalination technologies (i.e. multi stage flash [MSF] and Multiple -Effect distillation [MED]), and seawater RO (SWRO) as well as particular subsets of operating cost components. Whilst MED has a higher indicative operating cost than SWRO overall, if all energy costs are excluded the comparison switches around.

Further, large SWRO plants now typically incorporate energy recovery from the RO brine concentrate stream. Some recent large SWRO plant installations have adopted energy recovery systems using isobaric devices. Older plants use Pelton wheels or turbines for energy recovery and these devices provide lower energy recovery (80-82%) than isobaric devices (95-97%). Integrating



the design of the energy recovery device with optimised pumping costs can significantly reduce the energy and lifecycle costs.

Whilst appropriate comparisons can only be made between the same type of seawater desalination technology, incremental process improvements within the same technology, as a result more recent plant commissioning dates, can also make a significant impact and need to be accounted for in benchmarking comparisons.

7.3.3 Differences in Environmental Conditions

There are variations in raw seawater quality and characteristics which make it difficult to benchmark the operating costs and performance of desalination plants, even if they are similar sizes and in the same country.

The raw seawater salinity for the SDP ranges from a TDS of 35,000 mg/L to 40,000 mg/L. Due to this high variability of seawater salinity across the world it is difficult to benchmark the O&M performance of one large RO facility from another unless they are located in close proximity of each other.

Convention is that standard seawater total dissolved solids (TDS) is classified as 35,600mg/L. However, seawater TDS normally ranges between 35,000mg/L to 40,000 mg/L. There are exceptions found in other regions of the world such as in the Middle East where in the Gulf Region the raw seawater TDS can be as high as 55,000 mg/L.

Seawater RO membrane performance is temperature related, the higher the temperature the higher the membrane flux and the lower the membrane salt rejection. The raw seawater temperature for the Plant ranges from 14 to 24 degrees Celsius. Similar to variations of salinity, the high variability of seawater temperature across the world makes it difficult to benchmark the performance of one RO facility from another.

The physical, biological and mineral characteristics of raw seawater have a significant impact on the selection of pre-treatment systems. This impacts the operating costs, and as the characteristics of seawater, and hence the systems adopted are site specific, it is difficult to correct for these difference and benchmark operating costs in a meaningful manner. For example if a plant is located near shipping traffic the pre-treatment will need to include oil removal, but another plant will not require this technology. Access to detailed information regarding environmental conditions, particularly raw seawater characteristics, required to informal comparisons between seawater RO plants, is often difficult to achieve.

7.3.4 Differences in Operating Mode

There are variations in operating profiles which make it difficult to benchmark the operating costs and performance of desalination plants, even if they are similar sizes and in the same country. The use of incremental costs only, relative to other possible operating arrangements, provide a further complication, such as the recent ESCOSA decision for the Adelaide Desalination Plant.

Incremental costs incurred when a plant is producing water will depend on the contractual arrangements in place with the operator. For example, if the operator receives an allowance for membrane replacement as part of its fixed costs, then variable operating costs incurred when moving into an operating mode will be lower than for other operators who only receive membrane replacement during operating. Similarly, plants which are on "hot standby" and fully staffed will



have higher fixed costs than plants such as SDP which are in water security mode. However, the higher fixed cost base means that additional costs incurred in production will be lower than plants coming out of a water security shutdown. Consequently, it is difficult to readily compare operating costs without the detailed knowledge of the components of fixed and variable costs.

7.3.5 Differences in Risk Allocation

Desalination plants that are operated by regulated utilities, such as SEQ Water, SA Water or Water Corporation, also operate the water and wastewater systems to provide services directly to the end-users. This means the allocation of risk is different than for SDP, which provides services to one customer, Sydney Water.

The allocation of risk in the lease agreement and O&M contract, as well as the abatement regime in the determination, is unique in Australia. This risk allocation means that comparing opex directly between plants may be misleading. The allocation of which party bears risk related to plant availability, as well as plant handback condition at the end of a lease or operating period, can impact opex cost. Such risks may be priced differently by private and public sector organisations, or not priced at all if the potential liability is sufficiently distant. Such differences in the approach to the pricing of risk can make opex comparisons between plants unreliable.

7.4 Potential Desalination Benchmarks

Considering the many differences in operating environment factors described above, it is challenging to find reliable benchmarks. Some broad, generic operating metrics that could be used to assess the efficiency of the operation of a seawater RO desalination plant, include:

- \$opex/kL drinking water produced;
- specific energy use (kWh/m³ or MWh/ML); and
- measures of operations resourcing (i.e. a measure of staffing levels).

There are also more narrowly focused measures including:

- chemical usage;
- recovery rate (of intake water to drinking water) membrane replacement costs; and
- annual maintenance costs per value of capital asset.

We do not recommend using these metrics as these specific measures provide information for optimising the plant, but do not demonstrate the overall efficiency of the plant for benchmarking purposes. The measures are not directly comparable between plants because of the differences in operating environment factors discussed in the previous section. Only broad based operations metrics are practical measures for assessing overall efficiency of plant operations.

It is difficult to find reliable benchmarking data using metrics based on drinking water produced unless all the plants during the period are in continuous water producing mode. If one plant is operating for long periods at minimum capacity or ramping production up or down from shutdown modes, the efficiency metrics are not comparable.



7.4.1 Overall opex

Indicative overall operating cost values are usually expressed as \$opex/kL of drinking water produced. Table 7.1 outlines the operating cost benchmarks that are available from published literature and regulatory decision.

| Plant | Production (GL) | Operating Cost (\$M) | \$ opex/kL |
|------------------------------|-----------------|-------------------------------|--------------------|
| Victorian Desalination Plant | 50 | 27.2 ⁷ (\$2015-16) | 0.544 ⁸ |
| Adelaide Desalination Plant | 8 | 4.1 (\$2014) | 0.51 ⁹ |

The ADP value above is an incremental cost only compared to alternative sources of water. Also, it is unclear in the publicly available information whether the operating costs for VDP and ADP include membrane replacement and electricity costs.

For the reporting framework reasons mentioned above, as well as the differences in environmental conditions and potential differences in sub-component technologies, Advisian do not believe it is possible to make an appropriate comparison between the available VDP and ADP values and SDP in their present form.

7.4.2 Energy usage

The most commonly expressed metric for energy efficiency is kWh/m³. MWh/ ML is also regularly used. The use of specific energy usage metrics of this type eliminates the limitations associated with different electricity costs. However, it only demonstrates the efficiency of one aspect of the plant's operations, as it does not cover operating costs such as staffing, chemical or membrane costs.

The power consumption of large seawater RO plants is site specific and depends a series of environmental conditions, such as the actual range of the raw seawater salinity and the range of the raw seawater temperature; the design of the seawater RO plants, particularly the RO recovery targeted and the degree to which energy recovery devices included in the design. The location of intake and outlet facilities and the extent of pumping required to achieve both, can have a material impact on total energy use.

A further major driver of energy use is the relation between membrane age and energy efficiency. As membrane age can be reduced via advancing membrane replacement, improvements in energy efficiency can be accompanied and offset by higher operating costs elsewhere.

The industry standard for power consumption for large SWRO plants¹⁰ (with energy recovery), as cited by the National Centre of Excellence in Desalination Australia (NCEDA) is nominally 3.8kWh/m³. Although there are examples where lower power consumption are cited, examples of

⁷ This is incremental opex per kL not including the opex costs which apply regardless of whether the plant produces water.

⁸ Essential Services Commission, Melbourne Water Price Review 2016

⁹ Essential Services Commission of South Australia, SA Water Price Determination 2015.

¹⁰ "SWRO plant" refers to the entire desalination process, from intake to potabilisation, but excluding downstream drinking water distribution network.



materially below industry average power consumption should be treated with caution. Two examples of power consumption below the industry standard are discussed below.

A paper presented by Water Corporation at the IDA World Congress held in Perth in September 2011 entitled *Perth Seawater Desalination Plant, Five Years, 200GL, Australia's Operations and Maintenance Benchmark* (Ref: IDAWC/PER11-286), provided the following information:

- Energy efficiency was maintained at below 3.5 kWh/m³ (10% below target);
- Plant availability was increased to greater than 98%; and
- Actual costs averaged 8% below the target, resulting in savings to the alliance partners.

However, there are differences in the environmental conditions of the Perth and Sydney plants which Advisian considers warrants discounting use of a straight comparison of the raw data between the plants, particularly the seawater quality intake conditions that beneficially advantages the Perth plant. Further, the value quoted in the paper referenced above is from the first 5 years of operation, where membrane and asset life are contributing to above the longer term average performance and plant operational modes may not be that which is intended to be continued beyond the initial proving period.

The Al Ghubrah SWRO desalination plant, located in Oman, is one of the world's most recently completed SWRO plants, having achieved commercial operation in February 2016 after successful completion of the 30 day period acceptance tests. The SWRO desalination plant is designed to deliver a nominal capacity of 191 ML/day and it is claimed that it produces water at record low energy consumption at 3 kWh/m³ (for current drinking water standards). However, Advisian again considers comparison of this raw value to the Sydney plant is not appropriate, as it is likely that the plant was operating during the acceptance test in a manner that is not representative of longer term regular performance. Membrane age would also have been at its lowest possible level during this period. Further, the extent of energy recovery investment that has been included in the initial delivery costs is unknown at this time.

7.4.3 Staffing levels

Staffing requirements for large desalination plants can be compared for benchmarking purposes if the plants are of similar size and in the same mode of operation i.e. are they operating at or near full design capacity, or are they in a mothball shutdown, 'care and maintenance' mode only. To be a reliable comparator, staffing requirements should cover the number of direct operational staff and support staff, including those offsite. Staffing costs per person can differ significantly across the country, as proximity of the plant to labour markets and different costs of living will impact the remuneration of staff.

7.5 SDP Benchmarked Performance

In Advisian's opinion, there does not exist sufficient publically available operating expenditure or operating performance data that would enable worthwhile comparisons to the SDP opex forecasts, nor to key metrics of the SDP facility. Additionally, the relatively unique circumstances of a mothball shutdown where the plant is placed in a care and maintenance condition for an extended period of time, forecast to exceed 5 years during the 2017-2022 regulatory period, moves the plant further away from an operating context where sufficient data is available for a benchmarking process to provide reliable results.



Our view, which is supported by other industry experts¹¹, is that the essential need to normalize data for the effects of an extensive range of plant specific criteria, results in significant practical difficulties in developing accurate comparisons between seawater RO plants.

7.6 Limitations on use of benchmarking results

All benchmarking conclusions should be adopted with caution, and should always identify the limitations of the conclusions. In any attempt to benchmark the operating costs of SDP, there are several factors that limit the usefulness of benchmark/s identified:

- The reliability of the data may not have been independently assured;
- The inclusiveness of the data may not have been verified against a set of commonly applied definitions;
- The number of variables to be controlled for is significant. This requires a larger sample size than may be available;
- In the absence of a large sample size, the accuracy range from any benchmark will be so broad as to potentially not be useful and or misleading through overreliance on an inaccurate benchmark.

Putting aside issues of data reliability and inclusiveness, data quantity is a major issue. This could be explained by example and rules of thumb. Assuming a dataset of 13 plants in the same location with the same technology and the same operating conditions, but varying only in scale (plant capacity), then there may be enough information to form a reasonably reliable benchmark for any plant in the same location with the same technology and seawater characteristics inside the capacity range of the dataset.

Extending this example, if there are different technologies we would need add a variable to the benchmark calculation and increase the sample size in order to preserve the same predicative power (accuracy) of the benchmark. If variables are added for seawater salinity, seawater temperature, pre-treatment methodology, energy recovery etc. we quickly find the sample size required to preserve benchmark accuracy becomes very large. As a rule of thumb¹², we could assume 13 additional data points are need for each variable to be controlled in making the comparison. For a reasonably reliable desalination opex data set at least 100 reliable data points would be needed. The practicality and cost associated with getting a reliable dataset of this size makes quantitative benchmarking a major challenge. Further discussion of this issue is provided in Appendix E.

An alternative approach adopted by some regulators is to take a pragmatic view on the factor inputs costs and management practices used by an operator. Where the input cost is reasonably aligned with a competitive market and the management practices are aligned with good industry practice, there is reason to believe outturn cost is likely to be competitive.

¹¹ Nikolav Voutchkov, *Cost Estimating of SWRO Desalination Plants, the Middle East Desalination Research Centre, June 2013*

¹² *The actual data requirements to preserve benchmark accuracy would need to be determined after examining the variability of the raw data*



7.7 Conclusions

Advisian has considered the availability of suitable benchmarking data for the Sydney desalination plant and identified and discussed the operating and environmental factors that influence desalination plant opex and need to be considered when making comparisons between plants.

As described in this section of the report, there are many variables that influence desalination operating cost. As the number of operating variables increases, so does the number of data points required to preserve benchmark reliability. Within the commercial and data access limitations of this study, Advisian has not been able to gather sufficient quantities of reliable data to calculate and develop appropriate benchmark comparison for Sydney Desalination Plant. Further, Advisian is of the opinion, that securing reliable, consistently prepared and comprehensive data to complete a robust benchmarking study would require the willing participation of a large number (within a range of 50- 100, possibly more) desalination plant owners, which would need to comprise overseas facilities, to provide open access to their commercial and operational data.

We concluded that the combined impact of the following factors would result in attempts at benchmarking to be generally unreliable because of:

- Limited available dataset;
- Lack of transparency of relevant data, either due to commercial in confidence of private organisations or incomplete data reporting in publically regulated entities;
- Numerous operating and environmental factors that impact efficiency, such as:
 - Technology differences and related age of plant;
 - Environmental conditions such as feed water salinity and temperature and other physical and biological characteristics;
 - Operating mode differences; and
 - Differences in the approach to risk allocation between project parties.

Finally, we identified the reasons why results of any attempted benchmarking of the nature required for the SDP opex should be adopted with caution and always identify the limitations of the resulting conclusions. Our view is that the extent of these limitations makes the predictive power and therefore applicability of most benchmarking results to an assessment of whether the forecast SDP opex is efficient, unreliable.



8 Conclusions

Our review of the appropriateness and robustness of the operation and maintenance components of SDP's opex forecasts, found that the forecasts can be considered to be prudent and efficient. The SDP opex forecasts were assessed on the following basis:

- *Prudency* - The Operator's asset management system (including documented plans and procedures) ensures the Operator undertakes the operation and maintenance activities, which any prudent operator would undertake. The system ensures SDP will realise value through managing risk and opportunity in order to achieve the desired balance of cost, risk and performance, because the system is:
 - of a high quality, comparable to good industry practice or above, where relevant¹³.
 - being fully implemented at the Plant.
- *Efficiency* - The values in the operation and maintenance charges from the O&M contract represent efficient costs because;
 - the Operation & Maintenance Contracts were competitively tendered, with reasonable and justifiable exceptions;
 - if the contract was to be re-tendered with the Plant in its current state (in a water security shutdown and after the tornado) it is likely the tender prices would include a premium to address the uncertainties and associated risks;
 - the charges cover the risks inherent in consistently delivery drinking water from seawater RO processes; and
 - the charges do not include unnecessary contingency for risks the Operator is unable to manage, as risks of highly variable components are borne by SDP.

The SDP opex forecast is derived from:

- the charges in the O&M Contract, as amended in 2012;
- application of CPI for all escalation factors; and
- reasonable assumptions for remaining items (being those not fixed under the O&M Contract).

The SDP opex forecast therefore contains the likely operation and maintenance charges to be incurred over the 2017-22 period in real \$2016/17, and represents prudent and efficient expenditure.

¹³ There is no plant that has been maintained in a standby mode for such a long duration, which introduces uncertainty that cannot be removed by any identified improvements in care and maintenance activities.



Advisian

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Appendix A **Veolia O&M Contract Charges**





On Mode

| Service Fee Component | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 |
|-----------------------|------------|------------|------------|------------|------------|
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
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| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |

Source: Extracted from 'Veolia Summary', SDP REG OPEX MODEL FINAL.xlsm



Short Term Shutdown Mode

| Service Fee Component | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 |
|-----------------------|------------|------------|------------|------------|------------|
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |

Source: Extracted from 'Veolia Summary', SDP REG OPEX MODEL FINAL.xlsm



Medium Term Shutdown Mode

| Service Fee Component | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 |
|-----------------------|------------|------------|------------|------------|------------|
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | | | | | |
| [REDACTED] | | | | | |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | | | | | |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | | | | | |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |

Source: Extracted from 'Veolia Summary', SDP REG OPEX MODEL FINAL.xlsm



Long Term Shutdown Mode

| Service Fee Component | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 |
|-----------------------|------------|------------|------------|------------|------------|
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |

Source: Extracted from 'Veolia Summary', SDP REG OPEX MODEL FINAL.xlsm



Water Security Mode

| Service Fee Component | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 |
|-----------------------|------------|------------|------------|------------|------------|
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |
| [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] | [REDACTED] |

Source: Extracted from 'Veolia Summary', SDP REG OPEX MODEL FINAL.xlsm



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Appendix B **Plant Layout and Process Schematic**





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Appendix C **Advisian Procurement Experience**





Advisian Procurement Experience

Delivering major procurement and transaction management assignments, Advisian has supported private and public sector clients, nationally and internationally. Advisian's scope of services has included:

- Assisting clients developing procurement strategies.
- Advising on project procurement methods.
- Managing and implementing fully interactive tendering processes.

Providing optimal outcomes for clients, Advisian's approach includes:

- Developing negotiation and tender close processes which optimise competitive tension.
- Focusing on early identification and resolution of commercial issues to ensure swift progression from preferred bidder to contract close.
- Innovative thinking, through initiatives such as the accelerated design and construct (D&C) procurement approach, providing benefits such as earlier contract award and reduced bidder costs.
- Aligning with relevant guidelines such as NSW PPP guidelines 2012, National Public Private Partnership Guidelines and NSW Government Procurement Guidelines, and complying with probity principles.

Sample procurement and transaction management assignments include:

- New Grafton Correctional Centre PPP for INSW (2016)
- Barangaroo Reserve D&C Procurement and Contract Management for Barangaroo Delivery Authority (2011 – 2016)
- The Sydney International Convention, Exhibition and Entertainment Centre Precinct PPP for INSW (2012 – 2013)
- Northconnex D&C Procurement for Transurban (2013 – 2015)
- WestConnex Stage 1B (M4 East) and Stage 2 New M5 Main Works procurement and transaction management for Westconnex Delivery Authority (2014 – 2016)
- Kai Tak MPSC for the Hong Kong Home Affairs Bureau (2015 – 2016)
- Additional crossing of the Clarence River at Grafton - Project Management Support and D&C Procurement Management for NSW Roads and Maritime Services (2015 – 2016)
- PPP and maintenance contracting for Social Housing for the Dept of Treasury and Finance, Victoria (2014 – 2015)
- Contract strategy and procurement documentation for Sydney's Desalination Project – O&M Deed for Drinking Water pumping station (DPWS) (2009)
- Procurement strategy advice for the Sydney Desalination Plant for Sydney Water (2006)



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Appendix D **Maintenance Review**



Advisian

WorleyParsons Group

1. Introduction

This memo presents Advisian's detailed assessment of the asset management approach used to plan periodic maintenance during the Water Security shutdown period. This includes a review of the asset management framework, supporting processes and systems that were undertaken as part of the opex review for the 2017 Price Reset. Subsequent to this review, the reasonableness of the additional asset maintenance costs proposed in an extended water security scenario was reviewed, in order to assess its prudence and efficiency.



2. Background

Under the O&M contract, the budget for periodic maintenance expenditure is suspended while the Plant is in Water Security shutdown mode. However, the Plant still requires some items to undergo periodic maintenance even if no water is produced, to ensure that the plant can achieve full production within 8 months upon a restart request. This is particularly important for:

- Equipment that need compulsory statutory inspections;
- Equipment and infrastructure that is in partial use during the Water Security shutdown mode;
- Equipment and infrastructure that deteriorate regardless of the operational state of the Plant;
- Equipment that deteriorate faster in a mothball state (Water Security Mode) than in an operational state.



3. Infrastructure Operating Plan

Under the WICA Network Operator's licence, SDP is required to have an Infrastructure Operating Plan that captures the intended approach to asset management, and is in line with good industry practice. SDP's Infrastructure Operating Plan references Veolia's Integrated Business Management System (IBMS), in particular the Asset Management Plan section (Chapter 9) of Veolia's IBMS Manual.

Under ISO 55000 Asset Management Standard, effective asset management will enable the operator to manage risk and opportunity in order to achieve the desired balance of cost, risk and performance, within the constraints of contractual arrangements. This means the asset management system will minimise long-term and/or life cycle costs of the assets, while ensuring the assets perform adequately to meet the required production or address risks to an appropriate level.

The IBMS aligns with the principles in the standard for asset management (ISO 55 000) and the IBMS is certified under ISO 9001, as a quality management system. The ISO 9001 certification means that the system is proven to adequately monitor and manage the business and assets to achieve consistent and adequate performance and service. This includes regular audits, review and continual improvement processes. Changes to the timing or extent of periodic maintenance should be tracked through the continual improvement aspect of an ISO 55000 system.

To check the prudence and appropriateness of any changes to the periodic maintenance programs due to the Water Security shutdown, we reviewed a sample of management plans and procedures.



4. Integrate Business Management System (IBSM)

The IBMS systems that relate most directly to planning of periodic maintenance are:

- Experience Centred Maintenance System (ECM) – a database that collates the information gathered from operators, suppliers and management in workshops where the criticality and condition of major assets are assessed. This information is then fed either into CARMS or Maximo, depending on the outcome of the workshop;
- Critical Asset Renewal Management System (CARMS) – a Veolia database for forecasting asset renewals and replacement based on criticality and condition of the asset;
- Maximo – a computerised maintenance management system (CMMS) database with an asset register, maintenance schedules, procedures and work instructions;

The sample of procedures and work instructions which we reviewed included:

- PR-KDP-22- 850 Conducting Preventive Maintenance
- PR-KDP-21-856 Asset Creation Renewal and Disposal
- PR-KDP-21-854 Asset Condition and Risk Assessment procedure
- PL-ANZ-21-383 Developing and Maintaining an Asset Replacement Plan

The purpose of reviewing the systems and associated documentation was not to conduct a comprehensive audit of the system to ensure it was compliant with any standard or regulatory requirement, but rather to confirm that the approach manages risk to optimise production (or capacity for production). In this case, this means checking that planned periodic maintenance has been reviewed, and any changes made to the planned activity are in line with good industry practice.

In summary, the assessment was to check that the actions were in line with what a prudent operator would do to retain an effective and efficient plant to ensure a full production mode availability within 8 months. The procedures and work instructions that we reviewed:

- Were chosen specifically to investigate the process supporting decisions on large cost maintenance and renewal items;
- Adequately used a risk management approach aiming to minimise costs while accepting an appropriate amount of risk;
- Included continual improvement where appropriate. Continual improvement was explicitly included in the procedures, and fed data back into the CARMS and Maximo for altering future preventive maintenance or adapting work orders;
- Integrated the planning process for maintenance with the budgeting cycle by timing the periodic reviews onsite to feed information such as emerging risks into the asset renewal decisions and other strategic level processes.



5. Findings

5.1 Plan and Approach

Approximately 600 periodic maintenance activities are scheduled annually across the desalination plant and drinking water pumping station. To ensure continuous improvement the system is regularly recalibrated. Recalibration is done through workshops between the operators, operations team management, representatives of SDP, and equipment suppliers were relevant. This process involves inputs and outputs to the asset maintenance database (Maximo) as well as the critical asset management system (CARMS). The condition and the criticality of the assets are reviewed and where appropriate, options for different maintenance regimes considered. Any changes are then fed back into the various systems. The current system has approximately:

- 13,000 registered assets (Maximo);
- 1,600 registered critical assets (CARMS).

While the findings are not comprehensive of all periodic maintenance identified under the contract, we did find the following examples of how the assets were managed with regard to periodic maintenance:

- The replacement regime for the membrane preservation fluid was changed over the water security shutdown period. In consultation with the membrane manufacturers, the operator reviewed how often the fluid had to be replaced and gradually increased the time from every 6 months to every 9 months, to improve the efficiency of the preservation regime.
- The recoating of the internal sludge thickener concrete surfaces was brought forward in the maintenance schedule to utilise the scaffold that was set up for scraper maintenance, as the scaffold is a major part of the maintenance cost. The same approach was used in the planning of other periodic maintenance interventions that share similar resource requirements.
- Some major renewal works have been delayed until the plant is restarted. These decisions have been made as a result of the risk assessment process inherent in CARMS. For example, the overhaul of the sludge centrifuges has been delayed as the centrifuges are not critical to the Plant during shutdown and following the overhaul will need to be recommissioned by a specialist technician. The same approach was applied to the replacement of selective valves, instruments and pipe expansion joints.
- Periodic maintenance for rotating equipment in partial use (pumps, mixers, blowers, etc) has been delayed to the next price submission following 2022 because of "better than expected" equipment health as determined by the risk assessment process inherent in CARMS.
- Periodic maintenance for the rotating equipment in full shutdown mode presents a greater risk, because limited information is available for the CARMS system to determine the health of the equipment. As such, equipment of similarity was grouped and inspections planned for a representative portion of each group. The outcome would reflect the health of the group. This approach increases the reliability risk because each piece of equipment will not be inspected,



and/or budgeted for refurbishment/replacement. This approach is however more economical, and evidence that Veolia aims to maintain the plant in a cost effective manner.

- The electrical infrastructure will be inspected, and replacement of up to 16% of the parts is expected. The risk assessment process inherent in CARMS calculated the part replacement requirements for electrical equipment in partial use.
- Part replacement for electrical equipment in full shutdown mode was determined from actual replacement requirements identified from the regular routine asset maintenance (RAM) inspections and a risk allowance for the unknown.

Use of the Maximo and CARMS software gave us confidence in the integrity and thoroughness of the periodic maintenance activities undertaken during the Shutdown period.

5.2 Assumptions and Allowance

We grouped equipment of similarity and reviewed the appropriateness of the assumptions and risk management approach used to predict the required periodic maintenance. Our findings are presented in Table 1 below:

Table 1: Periodic Maintenance Assumptions and Allowance

| Group | Periodic Maintenance Base Assumptions & Allowance | Conclusion |
|--|--|---|
| Valves | <ul style="list-style-type: none"> ▪ An allowance was made to inspect and conduct minor refurbishment on all major valve groups prior to start-up. ▪ From current RAM inspections, and additional allowance was made to replace the disks of approximately 10% of the valves and < 5% of the actuators. | Periodic maintenance allowance is low, considering the risk of valve failures should the plant be required to start. Veolia has been very lean in their approach. |
| Rotating equipment, pumps, ERD's, VSD's, Mixers, screw conveyors, motors | <ul style="list-style-type: none"> ▪ Information received from current RAM inspections was used to calculate the PM requirements for equipment in partial use. ▪ An allowance was made to inspect and refurbish up to 15% of the high pressure pumps and ERD systems. ▪ An allowance was made to visually inspect the majority of the other pumps, mixers and screw conveyors, but refurbishment/replacement allowance was limited to 15% of the equipment to be inspected. ▪ VSD's were grouped and allowance was made to replace 100% of the VSD's smaller than 15kW, and refurbish 100% of those larger. From RAM | Periodic maintenance allowance is reasonable, considering the risk to maintain the plant at 8 month availability. |



| Group | Periodic Maintenance Base Assumptions & Allowance | Conclusion |
|--|--|---|
| | <p>inspections it is evident that roughly 60% will need immediate replacement/refurbishment and a further 20-30% within year 8-12. Allowance was made for 100% replacement/refurbishment because of available bulk discounts, which would make it more economical than to replace/refurbish 60 % immediately and the remainder as they fail.</p> <ul style="list-style-type: none"> For all rotating equipment replacement vs refurbishment is based on the most economical solution. | |
| Instruments | <ul style="list-style-type: none"> An allowance was made to replacement strategic instruments prior to start-up. These instruments have reached their end-of-life and are no longer in a working condition. | Periodic maintenance allowance is low, only a small portion of the site instruments will be replaced and no allowance was made to refurbish other instruments. |
| Vessels, Receivers, Compressors, AC, Lifting, Cartridges, Drum Filters, Penstock, Generator, IT, Anodes, etc | <ul style="list-style-type: none"> Equipment such as the air conditioners, IT systems, vessels, receivers, carnage, generators, anodes, etc. requires the same periodic maintenance irrespective of the mode the plant is operation in. The allowance was based on actual replacement needed and compulsory regulatory inspections. The drum filters is partly in use and the periodic maintenance allowance was based on RAM inspections and actual replacement needs. An allowance was made to inspect the cartridge filter vessels and conduct minor refurbishments. No allowance was made to replace a filter vessel should it be needed. | Periodic maintenance allowance is low, limited equipment replacement was allowed for. |
| Buildings, Bunds, General Site, Tanks, Security, Tele, Fire System & SWI | <ul style="list-style-type: none"> Buildings, bunds, tanks, security/telephone/fire systems, sea water intake and general site need to be maintained irrespective of plant's operating mode. Periodic maintenance allowance was based on RAM inspections and actual replacement needs. An allowance was made to inspect of all major areas and conduct minor repairs on up to 13% of the areas. | Periodic maintenance allowance is reasonable and consists of mostly minor refurbishments. There is a risk associated with hidden cracks on the concrete tanks and excessive |



| Group | Periodic Maintenance Base Assumptions & Allowance | Conclusion |
|--------------------------------|---|--|
| | <ul style="list-style-type: none"> It should be noted that concrete and other tanks need additional maintenance when not in use (empty). Concrete tanks are more conducive to cracks in the dry/warm/empty conditions and glass-fused-to-steel (GFS) tanks more to corrosion. | corrosion/damage to GFS tanks and bunds, because there is no allowance made for major repair/replacement. |
| Transformers, UPS, switchgear | <ul style="list-style-type: none"> An allowance was made to inspect and clean all panels and switchgear, and to replace up to 17% of parts. Estimation is based on current RAM inspections and knowledge of equipment condition. Switchgear not in full operation is more conducive to corrosion, because switchgear in operation generate heat which prevents moisture from condensing on the circuits. If not in operation condensation leads to a higher rate of corrosion despite MCC rooms being air conditioned. An allowance was made to replace all of the batteries and chargers on the site's UPS system. This is needed since the system is in full operation and reaching its end of life. No allowance was made for refurbishment or part replacement on transformers. No allowance was made for a major technology upgrade of electrical infrastructure. | Periodic maintenance allowance is low given the risk of not allowing for the replacement of entire MCC panels complete with circuitry, should part replacement exceeds 17%. No allowance was made for transformer refurbishment or electrical infrastructure technology upgrade. |
| RO vessels and permeate piping | <ul style="list-style-type: none"> An allowance was made to replace all of the RO permeate piping. Although not yet at the upper limit of their end of life, the pipe deteriorated faster than expected because of the prolonged exposure to the preservation liquid. Allowance was made to replace 2 defective ERD pressure vessels. No allowance was made to replace RO pressure vessels. Allowance was made to inspect all RO pressure vessel end caps and replace up to 30%. The estimate was based on current RAM inspections. | Periodic maintenance allowance is reasonable. |
| Metallic infrastructure | <ul style="list-style-type: none"> An allowance was made to replace all of the rubber expansion joints. They have deteriorated faster than expected due to the shutdown mode. The rubber requires cool/wet conditions | Periodic maintenance allowance is reasonable. |



| Group | Periodic Maintenance Base Assumptions & Allowance | Conclusion |
|------------|--|------------|
| and piping | <p>to ensure their prolonged life.</p> <ul style="list-style-type: none"> An allowance was made for corrosion protection work to be conducted on specific areas within the RO building, the estimate is based on RAM inspections. | |

5.3 Item Cost Estimate

Each periodic maintenance intervention had a breakdown of tasks. In the case of the \$197 543 SWI Drum Screen 1 intervention planned for year 10, the task schedule consisted of 23 individual priced tasks. We reviewed a sample of interventions and conclude that the estimated costs were prepared using a combination of first principle estimates, rate estimates and formal and informal requests for tender prices from industry and suppliers. The schedule of tasks for each intervention is reasonable and provides enough evidence to support the identified value. .

5.4 Estimate Sensitivity

We conducted a basic sensitivity analysis on the estimate, the results of which are presented in Table 2 with the assumptions applied listed in Table 3 below.

Table 2: Price Sensitivity

| Description | Price | % |
|-------------|--------------|--------|
| Maximum | \$24,836,402 | 16.8% |
| Requested | \$21,269,159 | |
| Minimum | \$19,871,105 | (6.6%) |

Veolia is conservative in their estimate and we believe they are more likely to overspend than underspend.

Table 3: Sensitivity Analysis Assumptions

| |
|---|
| Assumptions used to determine the upper limit was: |
| Increase RO pressure vessel end-cap replacement by 10% this would also allow to replace an additional RO pressure vessel should it be necessary. |
| Increase selective pump and motor replacement/refurbishment cost by 40%. The additional allowance is to cater for unforeseen refurbishments needed. |
| Increase building expenditure by 5%, to allow refurbishment of more structural issues than anticipated. |



Assumptions used to determine the upper limit was:

Increase tank and bund expenditure by 15%. RAM identified proof of refurbishment needed, but the extent of the work is unknown. The 15% allow for more extensive repairs than anticipated.

Increase safety shower expenditure by 15%. The estimate only allow for repair, paint and instrument replacement. The additional 15% will allow the replacement of a couple of entire shower assemblies if needed.

Increase site lifting equipment and weighbridge expenditure by 15 – 25 % and air-conditioned by 10%. The additional allowance is to cater for unforeseen refurbishments needed.

Increase drum screen refurbishment by 25%. Drum screen refurbishment is a large task and can take up to 3 weeks; the additional allowance is for project overrun and to cater for some unforeseen associated costs.

Make provision for the replacement of an ERD and RO cartridge filter vessel for each group. No provision was made to replace a filter vessel.

Increase PLC expenditure by 60%, general site electrical by 5% and selective high and low voltage switchgear by 25 - 40%, The estimate allows for inspections and the replacement of up to 17% of the switchgear, the additional allowance is to cater for unforeseen refurbishment/replacement of circuitry.



Assumptions used to determine the lower limit was:

Decrease RO pressure vessel end-cap replacement by 10%, if less than anticipated needs replacement and to make allowance for procurement gain.

Decrease VSD replacement/refurbishment allowance by 10-20 %, depending on the group. Make provision for the replacement/refurbishment of no more than 80-90 % depending on the group, whilst still maintaining the procurement gain.

Decrease selective centrifuge, mixer, fan, and blower refurbishment cost by 15%, selective screw conveyor costs by 10% and selective submersible pumps by 30%. Assume less refurbishment needed than anticipated.

Decrease building, tank and bunds expenditure by 5%. Take into consideration a procurement gain.

Decrease safety shower expenditure by 10%. Allow for the re-use of some flow meters.

Decrease site lifting equipment and weighbridge expenditure by 10 - 15% and air-conditioned by 10%. Assume less refurbishment needed than anticipated.

Decrease drum screen refurbishment by 15%. Assume less refurbishment needed than anticipated.

Decrease expenditure of selective switchgear, general site electrical works and UPS by 5%. Take into consideration a procurement gain.

5.5 Tornado Discount

Veolia reviewed the intended scope of the Kurnell Tornado reinstatement work and calculated a reduction to the additional periodic maintenance value. To calculate the discount Veolia:

- Assumed that the plant's assets will be rectified to no worse than their pre-Tornado condition, via the reinstatement works;
- Adjusted the periodic maintenance schedule by removing some items, to allow for equipment being replaced as part of the Tornado reinstatement works.

Overall, Veolia estimated that 74 planned periodic maintenance items would not be required. Table 4 below presents the discount offered by Veolia over the first 5 years of an extended water security shutdown:



6. Conclusions on SDP's Asset Maintenance in water security

We conclude that the asset management framework implemented at the Plant is mature and leads to appropriate outcomes through continuous improvement. We did not find any evidence of negligence, or inappropriate deferral of maintenance.

The processes and systems that support the asset management framework for managing the Plant's assets are appropriate and adequate to provide confidence that when the processes are implemented the actions would be in line with good industry practice and not represent negligence.

The **\$21,269,159** gross value for periodic maintenance across the first 5 years of an extended water security shutdown, is reasonable and reflect the actions of a prudent operator to manage the risk of plant restart within 8 months. Based on a basic sensitivity we believe that Veolia is more likely to overspend than underspend.



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Appendix E **Benchmarking discussion**



As discussed in section 7 of the report, there are many variables that influence seawater RO desalination operating cost. As the number of variables increases, so does the number of data points required to preserve benchmark reliability. Although it is not possible to determine the exact number of data points required to provide reliable benchmarks until the data variability is well understood, it is estimated the likely figure is not less than 50 and quite possibly more than 100 data points.

The feasibility and challenges of large scale data gathering was tested using Australian seawater RO desalination plants as a pilot group. The pilot effectively tests issues such as data protection because of commercial in confidence matters of private organisations or incomplete data reporting in publically regulated entities. If reliable data for Australian plants could be readily retrieved, pursuit of a larger international sample would be worthwhile. If data for Australian plants was not readily available, an alternate approach to assessing SDP competitiveness would be used in lieu because:

- A benchmarking approach without data from Australian plants would leave open the question of applicability of international data to the Australian context.
- Advisian experience is that the utility of published data is dependent on the purpose for which it is supplied. Additional data validation would need to be performed for international plants.

This appendix describes the results of the investigation into Australian seawater RO desalination plants that Advisian undertook as part of this opex cost review.

There are only six metropolitan utility scale plants desalination plants, five comparators to SDP. This small sample could potentially be used to calibrate models built on a larger sample of international plants so long as there is high data recovery for each Australian plant over a number of operational years.

During the data collection process we found data availability for Australian seawater RO desalination plants is patchy. In many cases the plant has not been in steady state operation for a significant time¹⁴ –there is limited longitudinal data for most Australian facilities. In all cases comprehensive (all variables) data sets were not readily available. Where the data is available, in various instances it is prepared and presented on a completely different basis and would need significant and careful treatment to align with other data before a valid comparison could be made.

A key finding is that that although much of the data sought is reasonably expected to exist, there are significant commercial barriers to getting a usable dataset – both in gaining access to the data and the cost of forensic analysis required to normalise the supplied data. Finally even if these obstacles were overcome in Australia, similar or greater obstacles would be met in international plants.

¹⁴ Many Australian plants are running on membranes installed during initial construction and are yet to demonstrate long term operating costs.



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In summary it was determined that a reliable benchmarking model was not practical to create because:

- Comprehensive longitudinal data for Australian seawater RO plants is not sufficiently available.
- The cost and effort to gather for Australian and international plants is large and not easily justified in the context of this benchmarking review for one operator. Were a study to be conducted it would need active and willing participation from a large number of plant owners.



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Appendix F **Team Members**





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Advisian Team Members

Members of the Advisian team for this review of the operation and maintenance component of SDP's opex and capex forecasts were:

| | |
|------------------|--|
| David Beckett | Engagement Principal and procurement strategy review |
| Michael Quinnell | Review co-ordinator and opex assessment |
| Carly Price | Asset Management system review and report writer |
| Steve Roddy | Asset management procedures review and benchmarking |
| Ian Fergus | Asset management procedures review and benchmarking |
| Daniel Wood | Asset management procedures review |
| Jandro Paxton | Asset maintenance and opex assessment |
| Michel Lesnie | Opex assessment and benchmarking |
| Adam Teusner | Opex assessment |