



## LESSONS LEARNED FROM ADELAIDE DESALINATION PROJECT

**Tarek Omar and Moncef L. Nehdi, Ph.D., P.Eng.**

*Department of Civil and Environmental Engineering, Western University,  
London, Ontario, Canada*

**Abstract:** The Adelaide Desalination Project (ADP) received many prominent awards, such as the 2013 PMI project of the year. This global award distinguishes the most successful project globally and recognizes exemplary application of project management principles and processes. Indeed, the project has effectively delivered its promised objectives and outstanding results to its customers and to the community. In this study, a categorization and description of some lessons learned from the ADP are provided. This includes procurement and risk management, integration management, quality management, time management, cost management, scope management, human resource management, and communications management. The impact of each lesson on the success of the project is presented and recommendations are made for consideration in future projects. This should assist construction stakeholders achieving project objectives and avoiding to fall behind project schedules.

**Keywords:** ADP, PMI competition, management principles, lessons.

### 1 INTRODUCTION

Desalination is a secure water source that does not rely on rainfall. As a result of the water supply crisis during the severe 1997-2009 drought, state governments around Australia began building desalination plants that purify seawater using the reverse osmosis technology. Due to relatively high energy consumption, many of these plants have included in their overall cost the building of renewable energy sources such as wind farms. Australia's first working desalination plant was the Kwinana plant in Perth, which was completed in November 2006. A second plant on the Gold Coast began operations in February 2009. The Kurnell desalination plant in Sydney was opened in January 2010.

The Adelaide Desalination Project (ADP) is the largest infrastructure project (\$1.824 billion) ever completed in South Australia. The project vision was to build a long-term, sustainable and cost-effective infrastructure capable of producing 100 billion litres of desalinated drinking water per year. This represents about 50% of the drinking water supply for the South Australian capital city of Adelaide, home to more than 1.2 million people (Milind 2013). The location and a perspective view of the Adelaide desalination plant is shown in Figure 1. The project's scope includes reverse osmosis desalination plant and marine works, power supply infrastructure, transfer pumping system, pipeline and connection works, preliminary site works and ancillary works, and project development and land (IPM 2013).

The project was scheduled to complete by 31 December 2012, subject to the contractor meeting milestones. The main works package was implemented under a "DBOM" (design, build, operate, maintain) structure, with the winning consortium providing a "whole of life" service including a 20 year O&M term. The project was delivered 19 days ahead of the original approved completion due date. This included a full and final resolution of all issues between parties prior to project handover within the original approved budget (Mauro 2013). The project successfully overcame numerous challenges associated with geotechnical conditions and weather through a highly effective governance structure and issue resolution process. With delivering the project ahead of schedule, within budget, outstanding build quality and superb environmental features, the project has set a new standard for desalination plants around the world in terms of project planning and scheduling, project development, project procurement management, project communication management, and environmental management performance.

Since falling behind schedule is an unfavourable event that often occurs in construction projects. This paper highlights some of the facts behind the success of the ADP project and presents some lessons learned. It should provide useful guidance to managing construction projects in the future.



Figure 1: Perspective and plant site of ADP (*PMI Newsletter. Nov.2013*).

## 2 LESSONS LEARNED

The project management institute (PMI) defines lessons learned as the learning gained from the process of performing a project. It is very important to ensure that the lessons learned are covered in the initial stages of the project planning. The reason for this is that a methodology along with an appropriate set of tools could be established to capture these lessons throughout the project's lifecycle (PMD 2014). Moreover, the lessons learned should not only describe what went wrong during a project and suggestions to avoid similar occurrences in the future, but it should also describe what went well and how projects may benefit from this information as described below for the case of the ADP.

### 2.1 Lesson Learned # 1: Accelerated Master Planning Can Reduce Project Duration

In the ADP, the project planning, environmental impact statement and concept design were undertaken in a compressed program (IPM 2013). For example: (i) early site works and early program initiatives (second shift and night shift) were implemented to decongest the site and build program float, (ii) maximise early completion of buildings and covered areas was considered to reduce inclement weather impact, (iii) early involvement by commissioning and O&M operator was implemented in the design and planning process, (iv) an independent verifier was appointed to undertake progressive surveillance of oversee equipment and overseas posting of key resources, and (iiv) air freight decision for critical equipment was taken. These accelerated planning decisions that lead to meeting project milestones in terms of duration and cost (IPM 2013). Therefore, a clear and feasible planning of the various management stages in all projects is essential to reduce the level of risk and avoid scope-creep (Milind 2013). This mechanism was applied and demonstrated in the ADP as described above, which led to delivering the project as planned. Project managers are encouraged to consider accelerated master planning as a key success item, especially in large infrastructure projects similar to the ADP.

### 2.2 Lesson Learned # 2: Building Close Working Relationships between Multiple Stakeholders is a Benchmark for Safe Delivery Project

In the ADP, the South Australian (SA) Government appointed the lead agency responsible for the project and the government supplemented this with a whole of government approach to secure the major development approval (Milind 2013). As part of this approach, a senior steering committee, comprising chief



executives of the key government agencies, was appointed by the Government to provide strategic guidance to the project team and ensure 'single window' process for stakeholder engagement. An early contractor involvement process was used to initiate critical works by the successful tenderers before contract award. This included early commitment of long lead items and separate procurement of the power and transfer pipeline infrastructure. In addition, project planning, development approvals and major contracts were awarded within 12 months of project announcement. The strong collaborative nature of the relationships between SA Water, the project partners and their subcontractors was fostered by having multidisciplinary teams fully engaged from the outset. Moreover, the O&M operator being part of the project team from inception brought operability, operational performance and durability perspectives early in the design & build process. These actions and through full engagement of all project parties resulted in nearly zero lost time due to the co-shared leadership at all levels that created a culture where the project team actively engaged with each other and with the project stakeholders and workforce in a spirit of genuine collaboration to create a "One Team" approach, which has been an outstanding feature and crucial to the success of the ADP (Wittholz 2012). Therefore, building close working relationships between the multiple stakeholders was recognised as essential for the safe delivery of this complex and is recommended for other large infrastructure projects in future projects.

### **2.3 Lesson Learned # 3: Keeping Positive Communications with Local Community Enhance Project Success**

The ADP represented a key strategy in its ability to meet and secure the owner customers' needs (Mauro 2013). A secure water supply means reduced water restrictions, positively impacting the community by ensuring availability of high quality drinking water for general household use, gardening and recreation as well as commercial horticulture and industry. Throughout the project, the local community has been engaged. Approximately 15,000 people have attended sessions at the on-site temporary visitor centre and off-site at various presentation sessions, where they have been able to view the scale and size of the project and /or speak to key project staff (Tan *et al.* 2012). Consultation and feedback from the community visitors about the project has been outstandingly positive, especially towards the commitment made and delivery of the target compliance insurance policy against future droughts and to reduce reliance on rainfall and River Murray for Adelaide water supplies, thus improving overall health (Bolto 2012). These continuous communications led to providing many environmental benefits and employment opportunities for the local community. At its peak, the ADP employed some 1,850 people and in all, around 10,000 people worked on the project in its different stages, resulting in a net benefit to South Australia's gross state product. It is therefore strongly recommended to keep positive communication with the local community throughout the lifecycle of a project.

### **2.4 Lesson Learned # 4: Cost Management is a Key Factor in Project Investment**

In the ADP, significant cost efficiency has been achieved by constructing the first 50GL/a plant and the expansion works concurrently, saving on mobilisation costs if the decision to build the second 50GL/a plant was deferred (Wittholz 2012). In addition, the design incorporates features that provide full flexibility of operation of plant in 10% capacity increments, with the owner only paying for the water produced and electricity used (Dixon *et al.* 2012). Other cost efficiency measures include: highly efficient use of energy, reducing consumption through the use of energy recovery devices and high efficiency pumps, installation of solar panels to main buildings and passive design methods such as the selection of high thermal capacity materials and use of natural light; use of a pre-treatment process, which reduced energy and chemicals needed; and durability (material selection for long life) in the design and construction of key components of the plant, which reduced future maintenance over the life of the asset. Cost analysis to complete tasks was performed on a monthly basis to avoid cost overruns. All such actions resulted in delivering a cost-efficient project (Milind 2013) and was part of the cost management and control management applied.



**2.5 Lesson Learned # 5: Early Tracking of Learned Lessons is a Benefit to Project throughout its Lifecycle.**

A methodology along an appropriate set of tools was established and lessons have been captured and tracked in the initial stages and throughout the project construction. They have been used to inform each project phase and improve the successor phases (IPM 2013). For example, comprehensive management learnings in all aspects from the first constructed 50GL/a plant were used to inform workers on the second 50 GL/a plant, ensuring efficiency and further reducing risk. In addition, the project staff from all parties has also delivered knowledge sharing seminars on various aspects of the project including power supply infrastructure, tunnelling works, transfer pumping system, desalination processes and environmental and marine management (Tan *et al.* 2012).. The collaborative client-contractor-operator relationship has also ensured that key learnings have been shared amongst all parties and this process also continued through the 24 month warranty phase of the project (Mauro 2013). Therefore, capturing lessons learned should occur throughout a project's lifecycle to ensure that all information is documented at earlier stages and in a timely and accurate manner to improve further project phases and similar future projects.

**2.6 Lesson Learned # 6: Dispute Resolution Agreement before Starting Project Delivers Beneficial Outcomes for all Project Parties**

An agreement was reached between the owner and contractor before starting the project on the methodology and approach of dealing with claims and disputes resolution (Milind 2013). The contractor submitted claims to the owner to cover unanticipated costs they encountered in design and construction. The owner also claimed money from the contractor. Under the agreement all commercial issues and claims were resolved. This meant that neither party will be suffer costly disputes or legal action. The chief executive of the owner stated that the agreement delivered beneficial outcomes for all parties, including the most important outcome of all – the Adelaide Desalination Project completed on time and budget. The owner and the contractor worked closely to resolve their disagreements relating to the design and construction contract, and milestone payments. He indicated that “we have reached a mutual agreement before the project completion that all claims and disputes are off the table and that South Australian taxpayers are not exposed to any unexpected costs and the project delivered within the overall approved project budget of \$1.824 billion”. This resolution resulted in reaching the delivery of major milestones ahead of schedule. Such applied approach in the ADP is recommended for future projects since it maintains a collaborative relationship between the contractor and owner based on win-win principles.

**2.7 Lesson Learned # 7: Risk Management Minimizes Exposure to Unpleasant Outcomes**

The ADP has been able to achieve optimum management of project risks by adopting the Design Build Operate Maintain (DBOM) delivery model (Clarke and Kampf 2013). This contracting methodology is cost-effective, with the owner only paying the fixed lump sum costs of the plant and retaining ownership of the critical water security asset. The DBOM contract model has early involvement and input from the O&M operator during the design, procurement and construction phases, which provided vital input to further improving the durability and operability of the plant. This approach enabled an optimum allocation of risks between the owner and the private sector, providing the owner with an optimised value for money outcome (Milind 2013). As example of managing risk in the project, a robust contract change control process was established upfront, which comprised a multidisciplinary review of proposed changes. The original business case for the project estimated an overall project budget of AUD 1.960 billion. Taking account of risk assessments, risk quantification and robust processes to manage the key risks, the board of the owner and Cabinet agreed to approve a lower budget target of AUD1.824 billion as part of the Cabinet approval process (Dixon *et al.* 2012). A fully auditable cost control process, which incorporated scheduling and recording of all expended funds, analyzing projected capital spends and managing changes to forecasted works, together with input from the independent verifier, ensured rigorous monitoring and control of the project budget against works as they progressed and resulted in the contractor ability to deliver the project





within the approved budget (Tan *et al.* 2012). Therefore, it is recommended as one of the key project management principles to manage the risk from the design stage through construction and operation phases of the project. The contractor should consider contingency in the total program cost estimate. In addition, keeping open communications with sponsors and key stakeholders at a level that allows the project manager to reach out to them as needed is a paramount advantage.

## **2.8 Lesson Learned # 8: Health and Safety Management is Paramount for Project Success**

Throughout the ADP, health and safety management continued to be a core value for both the owner and contractor. The project involved approximately 8.9 million working hours with an overall Lost Time Injury Frequency Rate (LTIFR) of approximately 0.90 at the project end, which is an outstanding outcome compared with other similar infrastructure projects at the State and National levels (Bolto 2012). This was achieved through a continuous focus on safety improvements, lead indicators, including joint monthly safety themes to raise staff awareness of specific safety matters and investment in safety initiatives beyond normal practice including a higher level of hand and eye protection. For example, the construction workforce toolbox included: hearing protection, dealing with environmental spills, changes to road layouts, start cards, housekeeping, operational testing activities, exclusion zones, commissioning and permits, analysis of hazard reports and review of weekly incidents and hazard reports (Clarke and Kampf 2013). Actions or improvements have continued to be monitored at weekly project control group reviews. In general, the project specific health and safety plan was strictly implemented throughout the project lifecycle. Strictly applying such a strategy is strongly recommended for project managers to achieve highest standards of safety compliance with the aim of zero harm.

## **2.9 Lesson Learned # 9: Resource Management Is a Major Key for a Project Success.**

The right choice of the project team is very important task for the project manager to ensure that the required skill set to deliver the project's products is present. In the Adelaide Desalination project, market sounding and engagement with a broad spectrum of professional and experienced project team, subcontractors, and suppliers were in place (Clarke and Kampf 2013). As a very important secure, the best people in the team supported by the right technical specialists, commercial, legal and planning advisers in the team as the success of a project is largely dependent on the skills and strengths of the people involved. The policy of continuity of staff was implemented and was necessary for the project success. The frequent and often significant organizational changes were accompanied with continuous adjustments to the organization's structure in order to accommodate inherent dynamic changes. Consultation with the project team continued all over the project lifecycle. Motivation of the parties involved in the project was important to foster better collaboration and hence a greater awareness of each other's responsibilities (Mauro 2013). Therefore, Experienced and stable leadership team that brought personality, skills, knowledge and shared this widely and grew the capability and skills of the entire time of the project is an important factor that should be consider by each project manager. Together with leadership skills, the project manager needs to be aware of the strengths and weaknesses of his/her staff, so that the talents are harnessed and the shortfalls downplayed for the benefit of the project.

## **2.10 Lesson Learned # 10: Successful Management Increases Company Reputation**

Proper management of all project aspects leads to earning awards and enhancing company reputation (IPM 2013). The ADM has been recognized by many professional organizations, industry bodies and independent judges from around the world (McPhee 2013). Awards include:

- i. Project Management Institute (PMI), USA, Global Project of the Year Award 2013.



- ii. International Project Management Association (PMI), The Netherlands, Project Excellence Award, Gold Medal Winner in the category of Mega Projects 2013.
- iii. Project Management Institute (Australia), National Project of the Year Award 2013.
- iv. Water Industry Alliance Awards, Winner in the category of Planning and Delivery 2013.
- v. Engineers Australia (South Australian Branch), Engineering Excellence Award, Commendation in the category of Project Infrastructure 2013.
- vi. Global Water Intelligence, Desalination Plant of the Year, Distinction Award 2013.
- vii. South Australian Water Corporation, Certificate and Award for the Project Team and Individual Team Members - Overall SA Water Values Award Winner 2012.
- viii. National Electrical and Communications Association, National Excellence Award, Winner in Category 6 - Large Industrial 2012.
- ix. Australian Water Association (South Australian Branch), Winner in the category of Infrastructure Innovation 2012.
- x. Civil Contractor's Federation, Earth Awards, Winner in the category of Projects greater than \$75 million contract value 2012.
- xi. Master Builders Association (South Australian Branch), Excellence in Services, Category 6 Winner 2012.

#### **2.11 Lesson Learned # 11: Independent Financial and Management Audits are Beneficial**

The Australian National Audit Office has undertaken an independent performance audit in ADP (Milind 2013). This was included both financial audit to ensure cost effectiveness and comply with the approved budget and performance audit to ensure quality effectiveness. Assessment criteria that reflects the project objectives was finalized at the early start of the project and presented to all parties involved in the project execution. Monthly reports were regularly issued to highlight the compliance or any shortcoming on the previous period. This approach assist the project team to consider any corrective or mitigation actions immediately. Cost to complete evaluation was always positive indicating proper cost management while the performance in some areas was highlighted for corrective actions and environmental concerns were highlighted for mitigation. While this approach was very useful in this project, it may be difficult to apply in small projects but internal audit could play a major role in such cases.

#### **2.12 Lesson Learned # 12: Establishing Environmental Management and Monitoring Plans is Critical**

Considerable care has been taken during the design of the proposed desalination plant to ensure that any environmental impacts are minimised (Bolto 2012). The main focus was to ensure that safety, environmental and sustainability issues are addressed within the management plans that meet the needs and expectations of the wider and local community, relevant government agencies and local councils. The owner was informed that the proposed desalination plant will have some impacts, but these were to be managed and mitigated to ensure compliance with statutory requirements. A corresponding framework of management plans (systems) were prepared for the project. This framework of management plans provided the development of detailed construction and operation, environmental management and monitoring plans (Clarke and Kampf 2013). However, the management of project issues was underpinned by a series of performance objectives, which detail the minimum performance requirements to be achieved through all stages of delivery and operation. The objectives support specific performance criteria that address design, construction and operating requirements as well as their management, mitigation and monitoring measures (Tan *et al.* 2012). This was one of the key factors that led to the project success. Hence, it is recommended not only to study the environmental impact of any project, but also plan to avoid, mitigate, manage, and control any adverse effects, with full compliance with legislation, policies, and guideline requirements.



### 3 CONCLUDING REMARKS

Capturing the lessons learned is an integral part of every project, which serves several purposes (IPM 2013). While the finalization of a formal lessons learned document is normally completed during the project closeout process, capturing the lessons learned should progress throughout the project lifecycle to ensure all information is properly documented in a timely and accurate manner (PMD 2014). Construction projects normally present challenges with unanticipated events. It is not unusual for projects, let alone mega projects, to become bogged down in commercial issues, which can become a distraction from the main objective of delivering project outcomes. The Adelaide Desalination Project's Director stated: "this risk was recognised early by the project participants in the establishment of a robust governance process, which utilised features of 'alliance contracting' and resulted in the project being completed within the original approved timeline, within budget, and with a documented full and final resolution of all claims and issues between the parties". "Highly complex projects, like this one, require adept management of multiple stakeholders, highly effective communications, and talented project leaders," said the president and CEO of PMI. By leveraging strong, standardized project management practices, innovative ways to identify risks and overcome unexpected changes, and top-notch communication. The project managers should have a clear set of objectives such as time, cost, scope, quality, risk, benefits, and sustainability. The support and participation of stakeholders and interested parties is essential to ensure a controlled development of the project. Stakeholder input must be sought, and must be seen to be valued. Some lessons learned in this project are presented in this study and categorized by project knowledge area. These knowledge areas consist of: procurement management, risk management, integration management, quality management, time management, cost management, scope management, human resource management, and communications management. The lessons learned from the ADP are recommended as references for future projects. They can serve as a valuable tool for use by other project managers within organizations who are assigned to similar projects.

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