ENG4112 – Research Project Part 2 &
ENG4111 – Research Project 1

Improving Project Delivery: Through the Application of Project Management Techniques

Submitted By: Aron Molloy
Student Number: 0061021071
Submitted On: 13/10/2016

DECLARATION: I declare that:

- No part of this assignment has been copied from any other person's work or from any other source except where due acknowledgment is made in the assignment, and
- No part of this assignment has been written for me by any other person except where such collaboration has been authorized in writing by the course examiner concerned.

ABSTRACT

Substantial investment was made in Australian water infrastructure in the post war period in the 1950's and 1960's. Much of this infrastructure is now reaching the end of its usable life and will need to be replaced in the near future. However, in the preceding years a shift has occurred in the water industry from a government subsidized industry to user pays businesses (Coombs & Roberts 2007).

Many regional centers have also seen decreases in population. The infrastructure that was needed to supply water to a large population is now being used to supply only a fraction of the users for which the supply network was designed (Hicks & Woods 2010). However, the outer edges of the supply network have not changed, water is pumped from a source to be treated, distributed, collected as waste water and treated at a waste water treatment facility.

The infrastructure owned by water authorities is diverse in nature, spanning Civil (pipelines), Mechanical (pumps), Electrical (control systems), Chemical (water treatment) and Environmental (waste water) Engineering disciplines (Rokstad, M, Ugarelli, R 2015). Each discipline knows intrinsically well the importance of their own field of expertise, however, this can often be hard to convey to a colleague in another field.

In this business environment of falling revenue and population bases, diverse and aging infrastructure profiles it is necessary that Capital Expenditure (CAPEX) projects are delivered on time and on budget. Furthermore, managing projects over a diverse range of fields can be a complex proposition which can lead to failed project delivery and increased project costs.

To deliver projects in a timely manner it is important that organisation's undertake their project work using proven project management techniques. Tracking the progress of the project through the use of 'Key Performance Indicators' (KPI's) and 'Project Dashboards' will ensure that the project is delivered on time, on budget and meet the expectations of the organization.

University of Southern Queensland

Faculty of Health, Engineering and Sciences

ENG4111/ENG4112 Research Project

LIMITATIONS OF USE

University of Southern Queensland

Faculty of Health, Engineering and Sciences

ENG4111/ENG4112 Research Project

CERTIFICATION

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

Aron Molloy
0061021071

ACKNOWLEDGEMENTS

I would like to acknowledge and thank all the people whom have given guidance, support, assistance and their advice to aid in the completion of this dissertation. The completion of this dissertation has been made, at times, an almost enjoyable task through the input of numerous people.

To my supervisor Mr Bob Fulcher, a sincere, thank you. Your guidance throughout this process has been outstanding. Your understanding and knowledge of the topic has been greatly appreciated. Furthermore, the time you have given to helping me outside of this project is proof of your genuine concern for students' wellbeing.

To Mr Chris Snook I echo the sentiments that I forwarded to Mr Bob Fulcher. The understanding that you have shown, also shows the genuine concerns that you have for the wellbeing of your students.

To the Management Team at AUSWater FW, thank you. The mentoring that you have all given me throughout the entirety of my studies has been second to none. Thank you as well for the all the time you have given pointing me in the right direction to complete this project.

To my family, my wife Sarah and my children Grace, Scarlet and Olive thank you for the love and support that you have all given me throughout my study. You all have made it possible for me to achieve my educational goals.

NOMENCALTURE

AC	Actual Cost
ACWP	Actual Cost of Work Preformed
AT	Actual Time
AWFW	AUS Water FW
BCWP	Budgeted Cost of Work Preformed
BCWS	Budgeted Cost of Work Schedule
CAPEX	Capital Expenditure
CPI	Cost Performance Index
CV	Cost Variance
EA	Engineers Australia
EF	Earliest Finish
ES	Earned Schedule
ES	Earliest Start
EV	Earned Value
EVM	Earned Value Management
EW	Essential Water
IA	Infrastructure Australia
IPART	Independent Pricing And Regulatory Tribunal
IT	Information Technology
KPI	Key Performance Indicator
LF	Latest Finish
LS	Latest Start
NWC	National Water Commission
OBS	Organisational Breakdown Structure
OPEX	Operational expenditure
PMO	Project Management Office
PACl	Polyaluminium Chloride
PV	Planned Value
SPI	Schedule Performance Index
SPI(t)	Schedule Performance Index over Time
SV	Schedule Variance
SV(t)	Schedule Variation over Time
WAMP	Water Asset Management Plan
WBS	Work Breakdown Structure

PREFACE

The research project has been written using seven chapters to present the completed work for this dissertation. The chapters are structured as follows:

Chapter 1 – Introduction

This chapter has a brief introduction to the topic of interest and clear presentation of the aims and objectives of the dissertation

Chapter 2 – Literature Review

This chapter presents an extended literature review to the reader, which forms the basis of this research. The topics of urban water supply, project management and the obstacles to effective project delivery are researched.

Chapter 3 - Methodology

The chapter describes and justifies the methodology to be used to collect the data needed to examine the effectiveness of the project delivery at a regional water business.

Chapter 4 – Analysis

In this chapter the authority's past performance on project delivery is investigated. Gaps in the expertise of the organisation are identified with the aim of this information to aid in the development of the Project Management Suite.

Chapter 5 – Development

In this chapter the design of the project management tool is document. Information gather in the analysis phase has been utilised to tailor the tool to the organisation's needs. The logic behind the tools features are explained in detail.

Chapter 6 – Testing, Discussion and Recommendations

In this Chapter the results that the tool during testing are discussed, and recommendations are given on how to improve the organisations project delivery with its continued use.

Chapter 7 – Conclusions and Further Work

In this Final Chapter further work to prove the usefulness of the tool is proposed and conclusions are drawn on the validity of this research in furthering the collective knowledge of Project Management.

Table of Contents

Table of Figures

List of Tables

1 Introduction

1.1 Background

Substantial investment was made in Australian water infrastructure in the post war period in the 1950's and 1960's. Much of this infrastructure is now reaching the end of its usable life and will need to be replaced in the near future. However, in the preceding years a shift has occurred in the water industry from a government subsidized industry to user pays businesses (Coombs & Roberts 2007). Many regional towns during this time have also seen decreases in population. The infrastructure that was needed to supply water to larger populations is now being used to supply only a fraction of the users for which the supply network was designed (Hicks & Woods 2010).

In this business environment of falling revenue and population bases, diverse and aging infrastructure, it is important that water businesses spend their Capital Expenditure (CAPEX) budgets prudently. When it is necessary to replace an asset, a robust and transparent methodology must be used in both, selecting a suitable replacement and managing the process of asset renewal.

1.2 Idea Initiation

This topic arose from initial discussions with Mr Stephen Bastian (Steve), Civil Engineer and Department Manager of 'Planning and Design' at AUS Water FW. Mr Bastian, who has extensive experience in the Water Industry in NSW has been involved in developing previous IPART submissions for AUS Water FW. Steve has identified the need for AUS Water FW to develop a transparent system of managing CAPEX projects that form the basis of EW's IPART submission. The process needs to be transparent as it will be scrutinised by IPART and the Broken Hill community to determine if previous projects have been completed cost effectively.

Mr. Bastian suggested investigating the application of a 'Suite of Project Management Tools' to address AUS Water FW's needs. In the suite, Mr Bastian suggested to include tools to track the project throughout all stages from project initiation and justification, project delivery, handover and project review. Furthermore, Steve also suggested that as AUS Water

FW would be left to manage these assets throughout their lifecycle, hence, consideration would need to be given to the ongoing costs of any new infrastructure, for example cost of electricity and ongoing maintenance.

Upon these suggestions I conducted a detailed journal search in the 'Science Direct' database accessible from the University of Southern Queensland's Library homepage. This initial search returned very little in the way of journal articles that were written regarding specific challenges in project management or the methods used in the water industry. However, searching on the topic of 'Project Management' revealed a magnitude of information on project management techniques, tools and philosophies, all of which will be valuable in understanding contemporary project management theory.

Notable articles were written by Rokstad & Ugarelli 2015, and Deckro & Hebert 2011. The focus of Rokstad & Ugarelli research was applying Multi Criteria Analysis (MCA) in identifying grouped assets for replacement. For example a number of water mains with in a geographical close area with the aim of reducing cost on installation. While Deckro & Hebert suggest, that greater control can be achieved through the application of both new and old project management tools. In this paper the limitations of Microsoft Project are discussed and the authors turn to linear programming methods to resolve time/cost trade-offs.

However, the initial research demonstrated that there is little contemporary formal information on the project management practices of water authorities in Australia. The lack of documented evidence would suggest that the topic area has sufficient knowledge gaps to warrant further research as the basis of a student project.

1.3 AUS Water FW

AUS Water FW (AWFW) is a water business that supplies water and sewer services to its ten thousand customers throughout Far West of NSW in the towns of Broken Hill, Menindee, Silverton and Sunset Strip. To facilitate this AWFW has an extensive, though aging, infrastructure network which AUS Water FW is required to monitor, maintain and replace as needed to continue servicing its customers. All of which is achieved with only 80 employees which are spread over work groups and a large geographical location (Essential Water 2016).

Due to the isolation of the area in which AWFW operates the organization has a monopoly on supply of water. As a monopoly, the prices of AWFW's services have been set since 2006 by the 'Independent Pricing Authority and Regulatory Tribunal' (IPART) which ensures transparency in AWFW's pricing practices. This means that proposed Capital and Operational budgets are scrutinized to ensure that works are prudent and offer a benefit to the customer.

Traditionally AUS Water FW has operated as an 'Operation and Maintenance' organization, which enjoyed deficit funding from the state government to reconcile the short falls in revenue collection. However, AUS Water FW has transitioned to a user pays model as determined by IPART. To meet the requirements of IPART's pricing determination, AWFW is completing more CAPEX projects as a core business function.

To ensure that AUS Water FW's CAPEX projects are completed prudently and in a timely manner, a robust and transparent project management process needs to be employed. Developing 'In-House' project management tools will ensure that key stake holders will have a sense of ownership of the process and will be more likely to continue to use the tools after the completion of this dissertation.

1.4 Project Management

While it is apparent that there are projects which have been completed throughout human history, some of which have immense organization and planning, modern project management is a relatively new field. Modern project management can trace its origin to the early 1950's. By this time, many projects had become so complex in nature that standard management practices were no longer capable of keeping some projects under control.

Hence, 'Programme Evaluation and Review Technique' (PERT) and 'Critical Path Method' (CPM) were independently developed in the late 1950's (Nicholas & Steyn 2008). Since this time there have been many technological and philosophical changes that have occurred, which have continued to develop the field of project management (Nicholas & Steyn 2008).

However, no matter what the project, the quality outcome of the project management process is still constrained by the interplay of cost, time and scope. This is best described by 'Figure 1.1 – Project Triple Constraint', that shows these competing controls.

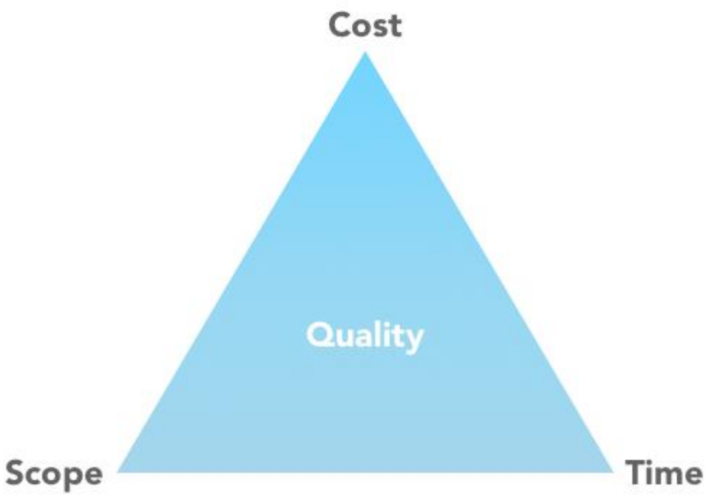


Figure 1.1 - Project Triple Constraint (Haughey 2016)

1.5 Project Management Tools

As previously discussed in Section 1.4 of this report, modern project management is ever changing, with new philosophies being developed to meet the needs of different projects, for example 'Agile' in the field of software development (Nicholas & Steyn 2008). While older, more established techniques such as PERT and CPM are still in use as they are proven effective methods of managing engineering projects.

The current project management software that Essential Water utilizes is Microsoft Project, which is mainly used at EW to develop project 'Gantt Charts'. Gantt Charts are a commonly used form of bar chart, which displays tasks against time taken to complete them. Microsoft Project is a standard, though powerful tool, that allows the user to visualize the interconnectedness of tasks in visual manner. The Microsoft Project software also has the advantage of being able to display the same project information in a number ways. For example through changing the ‘View’ option a project can be displayed as a Calendar or ‘Arrow-on-Node’ (AON) precedence diagram (Deckro & Hebert 2011).

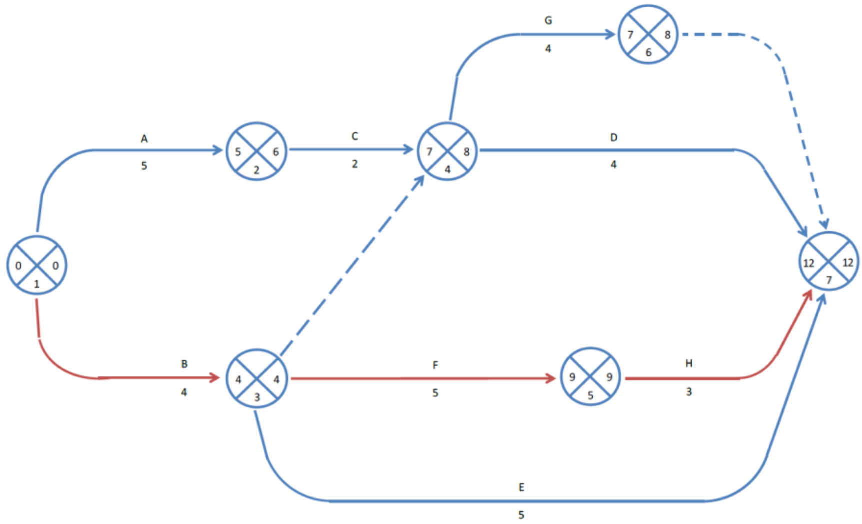


Figure 1.2 - Activity on Arrow CPM (Molloy 2014)

Precedence diagram easily display the critical path of a project, and form the basis of the Critical Path Method, which can be either ‘Activity-on-Arrow’ (AOA) as shown in Figure 1.2, or ‘Activity-on–Node’. In this method, the critical path is determined by activities that if not completed at the earliest time possible, will result in the project being delivered late. In their research, Deckro & Hebert have suggested that through using both Microsoft Project and more traditional linear programming methods, improved project outcomes can be achieved. As EW already utilises MS Project it is suggested that this this approach should be investigated further.

1.6 Project Aim

The aim of this research project is to review the effectiveness of the current project management techniques used at AUS Water FW and to develop a suite of Project Management tools that can be used by AUS Water FW to efficiently manage their projects.

In undertaking this research project, the key areas of focus will be on gaining an understanding of Australian Water Industry, Project Management techniques and the development of a suite of project management tools to be used in a regional water business.

The procedure and suite of tools that will be developed to monitor the effectiveness of AUS Water FW's project delivery. The information that will need to be displayed in the form of a 'Dash Board' will be developed in conjunction with the Essential Water Management group, as they are in the best position understand AWFW's needs. Therefore, the scope of the project will be limited to the development of the tool using these criteria. Criterion outside of this list will not be addressed as it will unviable to do so as it will not gain the needed support for successful application of the tool from inside AUS Water FW.

1.7 Project Objectives

The research investigation will focus on key objectives related to project management and efficient project delivery and will include:

- Research current best practices in 'Project Management', research to be presented in the form of extended literature review.
- Analyze the policies, procedures and culture that influence 'Project Management' practices at AUS Water FW.
- Develop through consultation with AUS Water FW's management team a suite of in-house project management tools to aid in project delivery.
- Develop a procedure for using the project management tools.
- Develop a set criteria for how the effectiveness of the tool and procedure will be evaluated.
- Implement a trial of the procedure and project management tools on a small sized project.
- Evaluate the effectiveness of the trial, through collecting feedback from staff and data collected from AUS Water FW's business systems.

2 Literature Review

As previously discussed in section 1.2 of this report it was found that there was very little research at present into water authorities in Australia's project management practices. Therefore, it was decided that it would be necessary to investigate various aspects of the topic area, so as to gain a better understanding of the issue as a whole.

To broaden my understanding of the chosen area of research it was decided to investigate the following topics:

- Urban Water Infrastructure in Australia
- Project Management
- Project Management Tools, and
- Factors Affecting Project Delivery

The following section of this report is the literature review that was undertaken to develop an understanding of the issues that will affect the outcomes of this report.

2.1 Water Infrastructure in Australia

The Australian water industry has long prided itself on the efficiency and reliability of its infrastructure. As a whole however, the industry has generally under invested in its assets. In a study completed by Engineers Australia in 2013 it was noted that historically the 'Capital Expenditure' on urban water infrastructure in Australia has, until recently, not kept pace with spending in other sectors. It observed in this study that, when compared to the electricity industry, investment in the water industry has been less than half of that invested in the electrical sector. In recent times there has been an increase in expenditure, which saw peaks in 2006 and 2011. However, this increase was in response to sever drought events. Furthermore, due to this lack of investment in the infrastructure that is not drought related, there is increased pressure on the remaining water infrastructure as population increases (Briggs et al 2014).

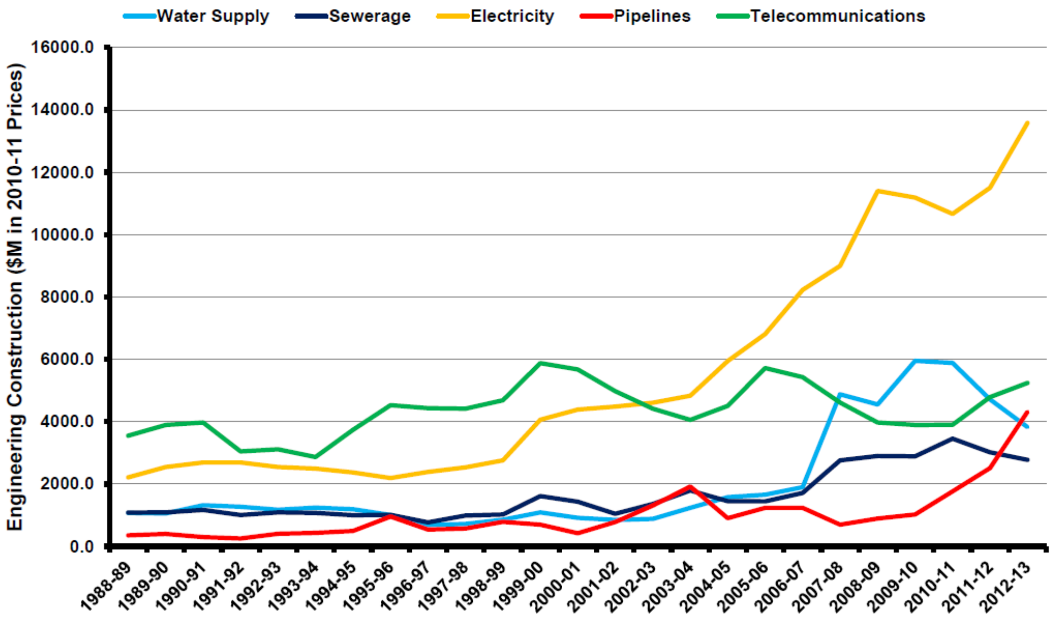


Figure 2.1– ***Historical Spending on Infrastructure by Type 1988 – 2013 (Kaspura, A 2013)***

In the research presented by Briggs, Joubert & Loke they assert that the biggest challenges to the Australian water industry are, population growth, increasing operating costs, transitioning from drought, increasing efficiency, developing industry partnerships and climate change.

The following section of this report is a detailed explanation of how the prescribed factors which are affecting the Urban Australian Water Industry. How these factors are affecting the industry in detail is as follows:

2.1.1 Population Growth

The 'Australian Bureau of Statistics' has projected the population of Australia to increase from a base of 22.7 million at 30 June 2012 to between 36.8 million and 48.3 million in 2061 (ABS 2013). The population is expected to increase predominately in urban areas, with the expected populations of capital cities shown in Figure 2.2.

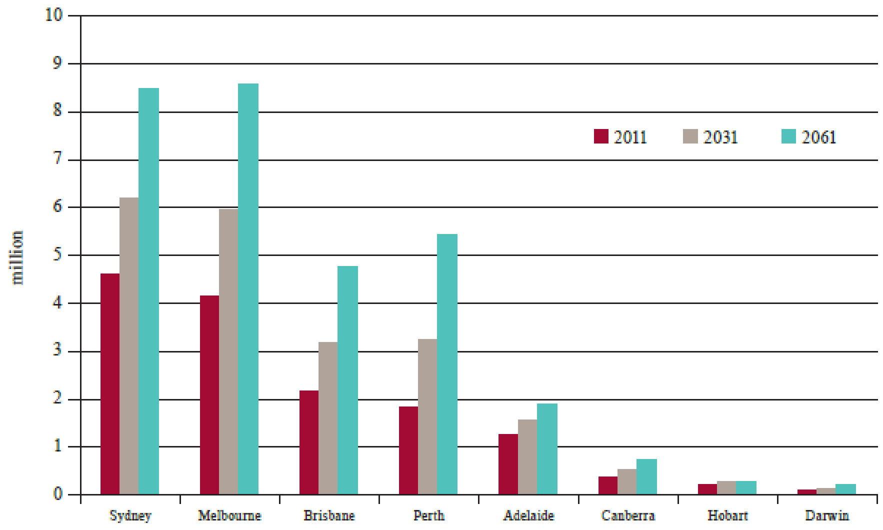


Figure 2.2 – Projected Population Increase 2011 to 2061 *(IA 2015)*

This expected increase in population will see increasing demand for reliable water and sewer services. Increasing demand will mean that there will be increased spending in water infrastructure to secure future water supply to meet this demand (Briggs et al 2014).

2.1.2 Increased Operating Costs

In the 'National Water Commissions' (NWC) report on the performance of urban water utilities 2012–2013, it is noted that increased operational costs are effecting the operational efficiency of water utilities. The NWC define 'Operating Costs' as the costs associated with running the day to day business of the utility, for example wages, fleet, energy, materials and legal fees.

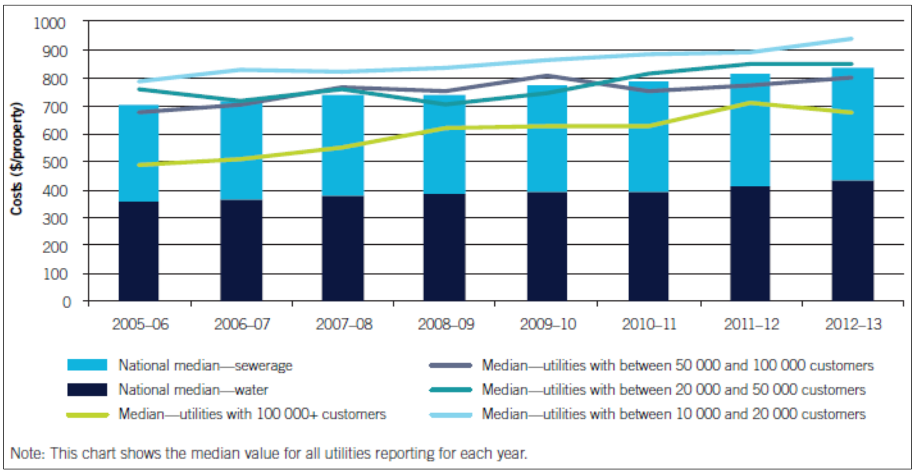


Figure 2.3 –Operating Costs Water & Sewer, Cost per property 2005-2013*(NWC 2014)*

Further to this, increases in operating costs are attributed to increasing, energy costs, chemical costs, utilisation of reverse osmosis/desalination plants, defined benefit superannuation payments, wages and IT costs. The steady increase in the cost of suppling water per property over the period from 2005 – 2013 is shown in Figure 2.3.

2.1.3 Increasing Efficiency / Productivity

The water industry has seen an overall decrease in productivity in the period 2006 – 2010, as determined by the National Water Commission. As seen in figure 2.4 the median efficiency during this time has decreased by 0.7%. The NWC has used a number of studies to benchmark this decrease, however it is suggested that this metric is difficult to measure. The effect of this decrease in real terms, increases the price for consumers through decreased earned value.

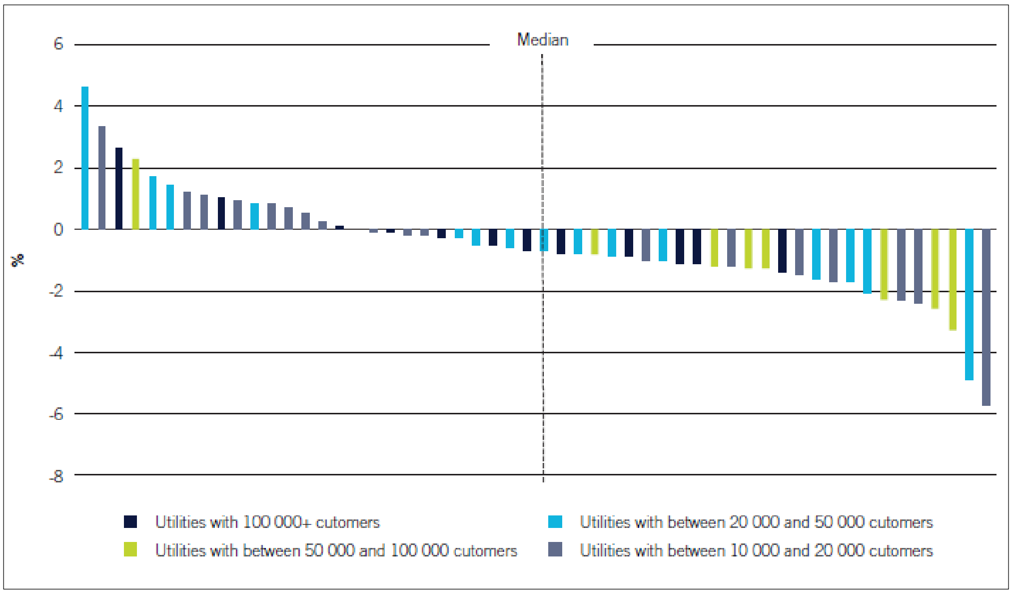


Figure 2.4 – *% Change in Productivity in the Water Industry 2006 -2010 (NWC 2014)*

2.1.4 Transitioning Out of Drought

As shown in Figure 2.1, Briggs, Joubert & Loke, attribute much of the increased spending which occurred from 2008 to 2010 in the water industry, to the building of infrastructure that was needed to give supply options during the last drought. For example desalination plants that are only needed when traditional supply options are unavailable. Briggs et al, identify the fact that the water industry now faces a transition period from the building phase of the last drought to the operating phase that the industry is now entering. In essence the asset base of utilities has increased while the overall user base has remained similar to pre drought numbers.

2.1.5 Climate Change

The bulk of Australia's urban water supply is drawn from surface water catchments, shown in figure 2.5. As climate change effects the seasonal weather cycles an increase in extreme drought and rains events is to be expected. Water Utilities will need to have flexibility in supply options to deal with the variability in both the quantity and the quality of supply (National Water Commission 2014).

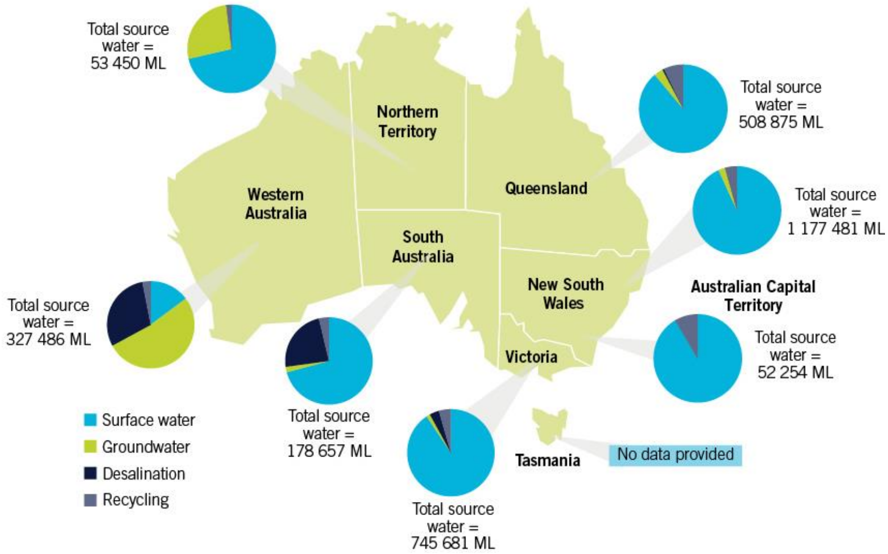


Figure 2.5 – ***Sources of Water Utilized In Australia in 2012 -13 (NWC 2014)***

2.1.5 Industry Partnerships

The final factor that is predicted to influence the water industry in the foreseeable future is an increase reliance on industry partnerships. Funding for water infrastructure has historical been sourced from public funding. However, as the population ages the pressure will be for governments to increase funding in the social welfare, retirement and health sectors (Infrastructure Australia 2015).

There are numerous models for private and public partnerships that can be explored. Though it is expected that increased competition in the water industry through these partnerships will deliver both improved efficiency and affordability for all stakeholders (Briggs et al 2014).

2.2 Project Management

'Project Management' has been described as managing the process of change management, as compared to 'Line Management' that is concerned with running a business with as little disruption as possible (Muller & Turner 2003). Project management is further defined as the process of reaching goals within a set time, to a set cost, and performance that is defined by the scope. These goals are reached through planning, monitoring, control and motivating individuals to complete specific tasks (Lester 2013).

2.2.1 The Three Constraints

It is widely understood that all projects are bound by the triple constrains of 'Cost', 'Time' and 'Scope or Performance'. These constraint will then align into a 'Natural Hierarchy' of driver, middle and weak constraint, depending on the needs of the project. The driver is the constraint that will most effect the project, for example, a short time frame will mean that time is the most important constraint placed on a project. The next that will determine how a project progresses is the weak constraint, or the most flexible constrain, for example, cost will increase if time and performance are important. Lastly, the middle constraint is as the name suggests, is in-between, it is not driving the project but it does not have the flexibility inherent in the weak constraint (Dobson & Leeman 2010).

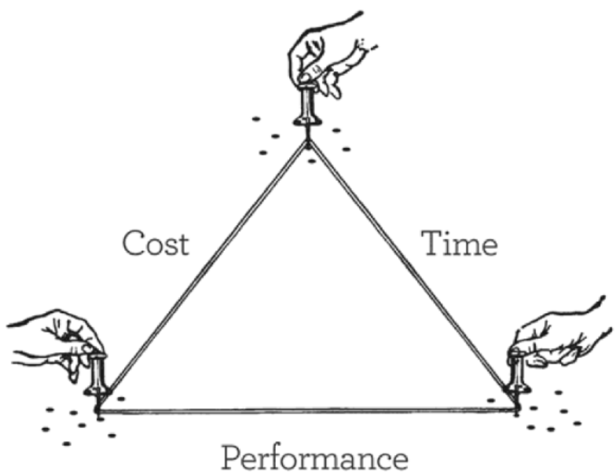


Figure 2.6 – The Dynamic Nature of the Three Constraints (Dobson & Leeman 2010)

The three constraints of time, cost and scope are described as follows:

2.2.1.1 Time

The characteristic that defines a project when compared to other endeavors is that it is finite, there is always an endpoint that is being worked towards. The time taken to complete a project will be specific to the project. Time may be measured in days, weeks, months or years, however, it must be measured.

2.2.1.2 Cost

As projects are usually conducted outside of the normal operation of the business the cost of the project needs to be budgeted.

2.2.1.3 Scope / Performance

The scope of the project relates to the outcome or the performance improvement that will be delivered by the project. For example, if a project is undertaken to increase the storage capacity of reservoir the scope will included how much of an increase is required and the standard against the success of the project will be measured.

2.2.2 The Project Management Life Cycle

Project Management is conducted over four distinct phases, definition, planning, monitoring/controlling and review. These different stages form ‘The Project Management Life Cycle’ (Westland 2006), as shown in figure 2.7 and describe in the following sub section of this report.

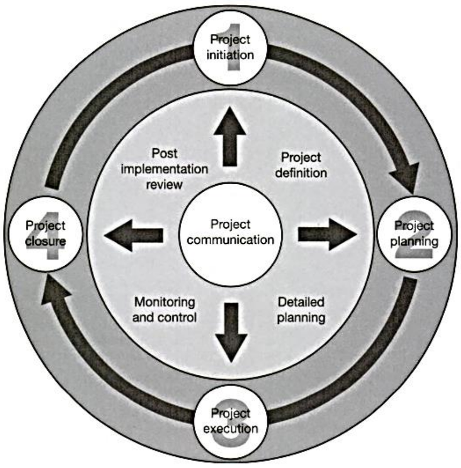


Figure 2.7 – Project Management Lifecycle (Westland 2006)

2.2.2.1 Project Initiation

This is phase where the issue or opportunity is identified. Once an issue is identified a 'Business Case' or 'Option Study' is developed to provide various solutions to the problem. After which, a 'Feasibility Study' is undertaken to ascertain which option is the most desirable solution. Once a solution is chosen it is then recommended to management for approval. If approval is gained for the recommended solution, a 'Term of Reference' for the project is developed. This will outline the objectives, scope, and structure of the project and the project manager is selected (Westland 2006).

2.2.2.2 Project Planning

In this second phase of the project life cycle the project will enter a detailed planning phase (Westland 2006). In this phase the following plans are developed:

- **Project Plan** – Activities, tasks, dependencies and time frames are identified,
- **Resource Plan** – Equipment, labour, and the materials required are identified,
- **Financial Plan** – The cost of the identified resources is evaluated,
- **Quality Plan** – The quality standards are identified, assurance and control measure,
- **Risk Plan** – Risks to the project are identified and mitigating actions developed,
- **Acceptance Plan** – Criteria for customer acceptance are listed,
- **Communications Plan** – How information will be conveyed to stakeholders.
- **Procurement plan** – Identifies all the materials that are to be sourced externally.

For further clarification on the construction of each one of these plans examples are provided in following chapter of this report.

2.2.2.3 Project Execution

At this stage of the project all plans that have been developed during the planning stage are applied. During this phase the project is monitored and controlled to ensure that the plan is on target. Changes are made to the project as risks or issues are identified. While the standard of the work completed is measured against the acceptance plan. Once execution of the project is completed project closure can begin (Westland 2006).

2.2.2.4 Project Closure

This is the last stage of the project, documentation and final deliverables are released, contracts are terminated, communication is closed and resources are returned to their roles. The final step is to complete a 'Project Review' where the success of the project is quantified and lessons are documented for use on future projects (Westland 2006).

2.2.3 The Project Stakeholders

Individuals or organisations that are actively engaged in delivering a project, or those whom will be affected in some way by the execution or completion of the project, are known as the 'Project Stakeholders'. A level of influence over the projects outcomes and objectives, may also be exercised by the stakeholders (Project Management Institute 2004).

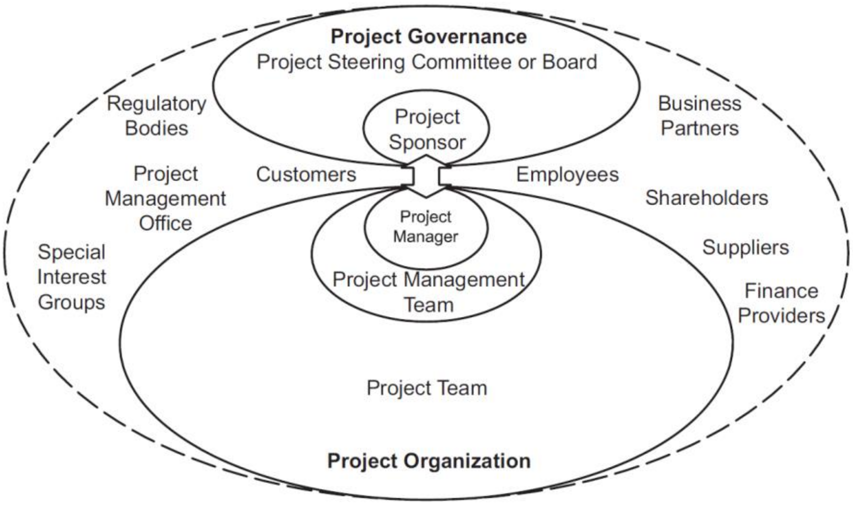


Figure 2.8 – Project Stakeholders (Australian Standards 2016)

The project stakeholders, can either internally influence the project delivery, such as the 'Project Organisation' and 'Project Governance', or have external influence, such as 'Regulatory Bodies' or 'Suppliers' as shown in figure 2.8. The level or involvement or influence the stake holders have, can range from active engagement in the decision making process or to being kept informed at a high level to the project performance and health (Flank 2015).

In AS ISO 21500:2016 the project stakeholders are divided into three distinct groups, these three stakeholders are discussed in the following section of this report.

2.2.3.1 Project Governance

Project Governance consist of the procedures and process that are enacted over the duration of the project to ensure that the project meets its expected budget, schedule and performance. Governance is defined by Flank, as the active process of monitoring the progress and performance of the project while making decisions to steer the project to a successful outcome (Flank 2015).

Project governance is provided by an individual, as the 'Project Sponsor', or a team, that is, the 'Project Steering Committee'. The roles that these play in the effective delivery of the project is as follows:

- **Project Sponsor** – the project sponsor is expected to be the owner and champion of the project. The sponsor may also provide financial support for the project. As such, the sponsor's approval is needed for any variation to the project scope, budget or performance.

- **Project Steering Committee** – the steering committee is formed to monitor the project at a high level. The committee also provides guidance when needed to ensure the effective delivery of the project.

As described in the figure 2.8, communication must flow between the project sponsor and the project manager for governance of the project to be effective.

2.2.3.2 Project Management Team

The 'Project Organisation' is the institution whose employees have the most involvement in delivering the project (Project Management Institute 2004). The organisation includes the project manager, project management team and project delivery team. All the functions of delivering the project are covered by this organisation (Flank 2015). Each of the resources are described as such:

- **Project Manager** – this is individual who is ultimately responsible of the delivery of the project. The project manager is responsible for completing the project to schedule with the allocated resources. Further to this, the project manager must also facilitate any changes that are required to the project plan or schedule as required to keep the project progressing. The project manager finally, also has the responsibility of keeping the project sponsor informed on the projects progress (Project Management Institute 2004).

- **Project Management Office** – this is the grouping of professionals from both technical and business units that complete project tasks. The team member is only utilised by the project as required, in some cases this will be for the duration of the project, while in others it will be for the task that their expertise is required. Team member's responsibilities will be analogous to their position, for example an Engineer will provide technical support, where as a Business Analyst will be interested in Process improvement. There are many descriptions of the expected responsibilities of the differing team members contained in the literature, however, one thing is common; that is that the team members report to the project manager (Flank 2015).

2.2.3.3 External Stakeholders

External stake holders are those that are external to the project, however, they exert a level of influence over the project. External stake holders in the water industry, form a very broad group and can include the following groups:

- **Employees** - employees outside of the core project team are often called upon to complete work towards the completion of the project. If they do not fully understand the need for the project or have a level of resistance to the change to the organisation that the project will bring they can affect the timely delivery of the project. This situation highlights the need to keep the work force updated on all projects that the organisation is undertaking.

- **Customers -** customers also exert influence over the project delivery. A project is possibly being undertaken to meet the need of the customer, for example water mains renewal to ensure a more reliable supply. However, customers are often also paying for the project through higher prices, or rates in the case of a water authority, and often they are reluctant to do so. This situation then highlights the need to keep customers fully informed on the importance of required projects, so that they have a level of understanding as to prices they are being charged.

- **Regulatory Bodies** – projects are often undertaken to meet regulations imposed by the specific industry regulator. For example there may be a change to the regulations for minimum handrail height, which would require a project to change hand rails that are under this height. Furthermore, a regulator may impose a directive on the organisation. This a direct order to change something in the organisation that comes under their regulation. For example the EPA could audit a business and discover that waste products are being store incorrectly, a directive can be issued to fix the problem or fines will be applied.

2.3 Project Management Tools

Project management tools and techniques are defined as systems that aid in the delivery of the project to the triple constraints of time, cost and scope. They may be as simple as a to-do list, as seemingly complex as a Gantt chart developed using Microsoft Project (Wysocki 2009). As discussed in section 1.4 of this report, the modern profession of project management has been developing new methods to manage projects since the 1950's.

In their research Deckro & Hebert have identified that through the use both Microsoft Project and more traditional linear programming methods, improved project outcomes can be achieved. Further to this Pries and Quigley, have advocated, combing 'Scrum' an 'Agile' project methodology developed to deliver IT projects, with Microsoft Project and more traditional tools for increased efficiency.

This would suggest that traditional project management tools are as relevant as when they were developed. The following sub sections of this report outlines traditional PM tools and how they are applied to managing projects effectively.

2.3.1 Bar Charts – 'The Gantt Chart'

The most commonly used and simplest scheduling tool is the Bar Chart, which are more often known as 'Gantt Charts'. The Gantt chart is named after Henry Gantt who developed the chart in conjunction with the US Army to track the progress of munitions to the front line in World War One. During development of the chart, Gantt realised that the common element that all tasks shared was that they took a specific 'Time' to complete. Through tracking the status of the task with respect to time, a visual reference is produced that shows how the project as a whole is progressing (Nicholas & Steyn 2008).

The appeal of the Gantt chart is in the ease in which it can be created. The project is broken down into the elements that are necessary to complete the project and durations are estimated for each task (Wysocki 2009). These tasks are then listed down the y-axis in the approximate order that they will need to occur so that the project can be completed. As shown in figure 2.9, time forms the basis of the x-axis and the durations of the tasks are plotted to an appropriate scale for the project that is in days, weeks, months or years if necessary (Nicholas & Steyn 2008).

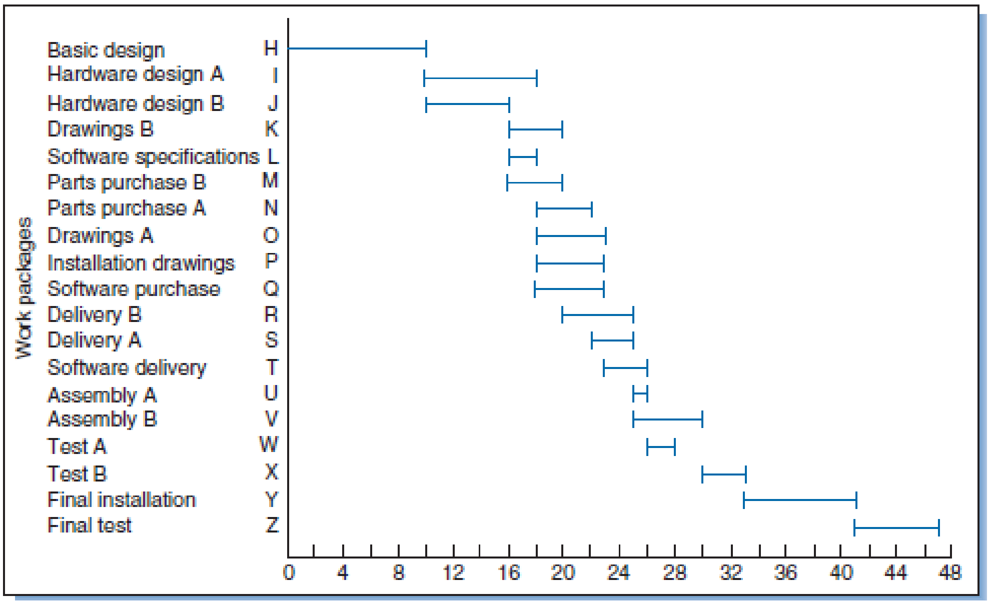


Figure 2.9 – Simple Gantt Chart (Nicholas & Steyn 2008)

The final step in creating the Gantt chart is to arrange the tasks along the x-axis to the time that they are likely to occur, for example a task may be reliant on another task being completed before it can begin. This pattern of tasks cascading across the chart takes on the appearance of a waterfall. The final tasks completion date gives the entire projects completion date (Nicholas & Steyn 2008).

The limitations of the Gantt chart is that it can be difficult to display complex dependencies that are easier described on a network diagram (Wysocki 2009). Programs such as Microsoft Project also allow for a clutter of distracting information. However, as stated in the research of Denko et al, they are useful tool that are still useful even with the multitude of other tools available.

2.3.2 Critical Path Method & Program Evaluation and Review Technique

As projects became more complex in nature during the cold war period of the 1950's it was necessary to develop more complex ways of controlling them. At this time and independently to one another the 'Critical Path Method' and the 'Program Evaluation and Review Technique' were develop by DuPont and the US Navy respectively to aid in delivering complex projects (Mantel et al 2011).

Both of these methods are almost identical, each use precedence / network diagrams to show the interconnectedness of the tasks required to complete the project. The network diagram consists of nodes and arrows, and can take the form of either an 'Activity on Arrow' where activities are shown on the arrow; or an 'Activity on Node' diagram, where activities are on the node. In figures 2.10 and 2.11, the activities from the table 1 are shown in both Activity on Arrow and Activity on Node form respectively (Nicholas & Steyn 2008).

Table 1 - Activities for 'LOGON' project from (Nicholas & Steyn 2008).

Activity	Description	Immediate Predecessors	Duration (Weeks)
H	Basic design	—	10
I	Hardware design for A	H	8
J	Hardware design for B	H	6
K	Drawings for B	J	4
L	Software specifications	J	2
M	Parts purchase for B	J	4
N	Parts purchase for A	I	4
O	Drawings for A	I	5
P	Installation drawings	I, J	5
Q	Software purchases	L	5
R	Delivery of parts for A	M	5
S	Delivery of parts for B	N	3
T	Software delivery	Q	3
U	Assembly of A	O, S	1
V	Assembly of B	K, R	5
W	Test A	U	2
X	Test B	V	3
Y	Final installation	P, W, X	8
Z	Final system test	Y, T	6

*Work packages from WBS, Figure 5-5.

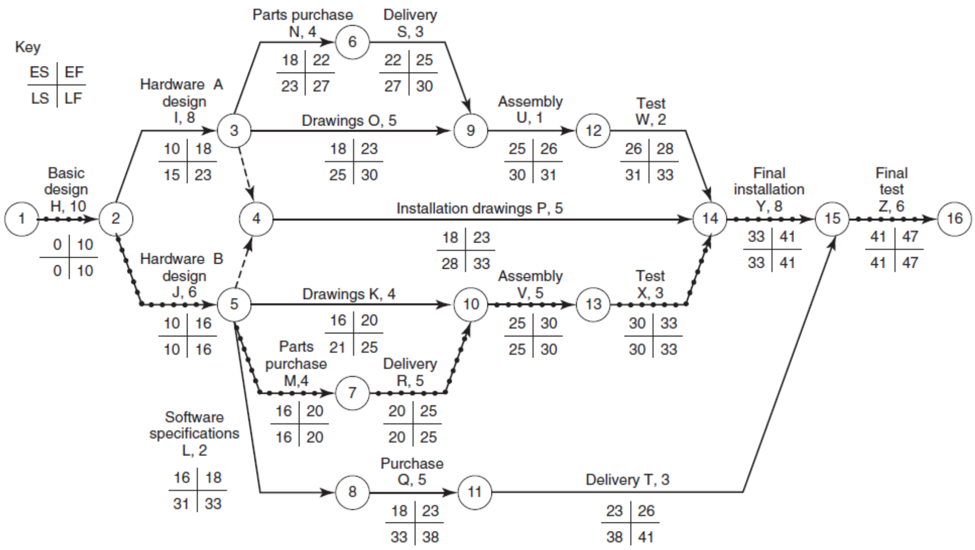


Figure 2.10 – Activity-on-Arrow (Nicholas & Steyn 2008)

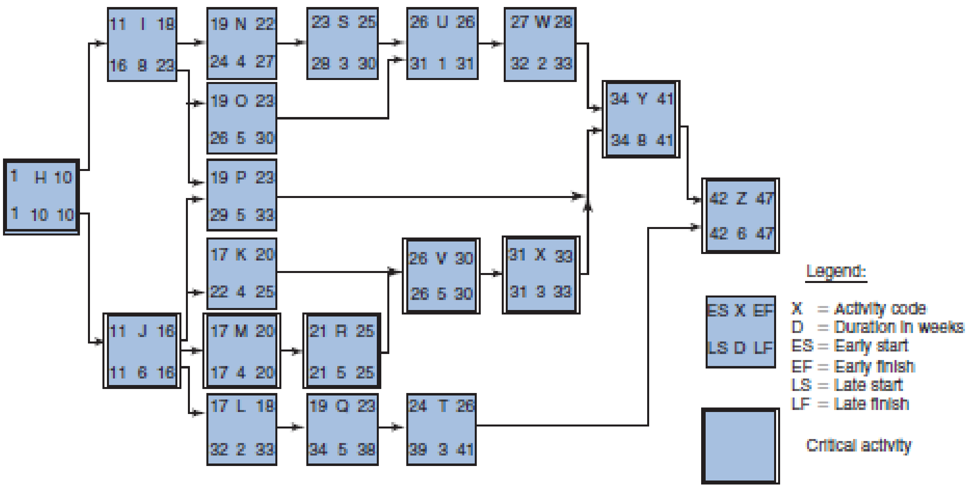


Figure 2.11 – Activity-on-Node (Nicholas & Steyn 2008)

To better understand the two methods it is first required to understand the terms that are used to describe them, Mantel et al, give the following definitions of the terms that are common to both the CPM and PERT when developing the network diagram:

- **Activity** – a task essential to complete the project that uses the projects resources and time.
- **Arrow** – a link between nodes in a network diagram. Represents either the activity needed or technical dependencies between activities. Arrows are always directed from predecessors to successors in the network.

- **Event –** a set point reached in the project through the full completion of one or more activities, none of the projects resources or time are consumed by a project event.
- **Milestone –** this an event that identifies that a significant progression point has been reached in the project.
- **Node –** visual representation of an activity or an event, that form the basis of the project network.
- **Network –** a diagrammatic representation of a project. The network consist of project nodes linked by arrows. The interconnectedness of the project activities and events are shown from start to finish of the project.
- **Path** – a set of connected nodes in the network which link events.
- **Critical Path** – a sequence of activities or events that run the full length of the project. The defining feature over other paths is that if one of the completion dates is delayed the entire project will be overdue.
- **Critical Time** - the time needed to finish every tasks on the critical path.
- **Slack** – the time that an activity can be delayed without affecting the critical path of the project.

As noted by Gray and Larson in 2011, the CPM and PERT methods are similar in application, however there are distinct differences between the two methods. Critical Path Method views each task as having a pre-determined length to completion, hence it is a 'Deterministic' method. Whereas, PERT accepts that there is a level of uncertainty attached to completing the task on time, it is therefore a 'Probabilistic' model. Hence each task has a statistical probability of being completed within a set timeframe. The following is a brief explanation of each method:

2.3.2.1 Critical Path Method

In the critical path method the tasks are arranged into either an AOA or AON diagram, ensuring that related tasks are connected. 'Earliest Start' (ES) times and 'Earliest Finish' (EF) times are calculated by doing a 'Forward Pass', a left to right evaluation on the network. After which a 'Backward Pass', a right to left evaluation is completed, to determine 'Latest Start' (LS) and 'Latest Finish' (LF) times for tasks. Tasks that are on the longest duration path and have identical ES and LS, and EF and LF times are on the 'Critical Path' (Wysocki

2009). The significance of this path is that a delay in any of these tasks will delay the project as a whole. To complete the process the Critical Path is then highlighted. Resources can then be assigned appropriately to ensure that the tasks are completed as required (Lock 2007).

If the project is required to be completed sooner than the determined project length, some tasks may be 'Crashed', this is assigning extra resources to a task to shorten its duration. However, crashing a task will also increase the cost to complete the task and effect the critical path, as other task may move onto this path. Hence, the critical path will need to be reassessed, as will the total cost of the project to ensure that the benefit is gained from doing so (Wysocki 2009).

2.3.2.2 Program Evaluation and Review Technique

Similarly to the CPM the first step to using PERT is establishing a task list, identifying connected tasks and developing a network diagram. Usually the AON method is used as this allows for clear display of the information. At this point the two methods differ, instead of a set time being allocated to the task, a probable length of the task is derived. To do this the three length s are assigned to the task, these are the 'Most Likely' (m) time, 'Optimistic' (a) time and 'Pessimistic' (b) time. From these three times the 'Weighted Average' (t_e) task time can be computed using the following formula (Wysocki 2009):

$$t_e = \frac{(a + 4m - b)}{6}$$

This weighted average task time follows a statistical distribution that is called a 'Beta' distribution, which allows for a skewed distribution, as seen in figure 2.12. Tasks represent work and as such when a task falls behind it is assumed it will always be behind, hence the use of beta distribution and not a normal distribution (Gray & Larson 2011).

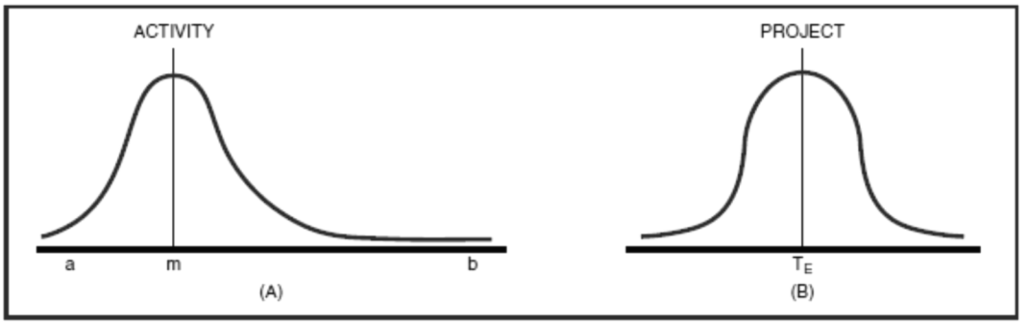


Figure 2.12 – Distribution of the Activity and of the Project (Gray & Larson 2011)

The standard deviation of the beta distribution is derived using the following formula (Gray & Larson 2011).

$$\sigma_{t_e} = \frac{(a-b)}{6}$$

The variance in the task is then found by (Nicholas & Steyn 2008):

$$Var = \sigma^2 = \left((a-b)/6\right)^2$$

Through adding the entire variances along the critical path the 'Critical Path Duration' (T_E) is found. Now the standard deviation of the entire project (σ_{T_E}) can be derived, which follows a normal distribution as shown in figure 2.12. The standard deviation of the entire project is found using the equation (Nicholas & Steyn 2008):

$$\sigma_{T_E} = \sqrt{\sum \sigma_{t_e}^2}$$

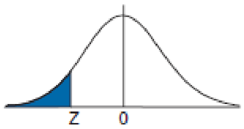
Once this is know the probability of completing a task is found using statistical data table, as shown in table 2, and the following equation (Gray & Larson 2011):

$$Z = \frac{T_S - T_E}{\sqrt{\sum \sigma_{t_e}^2}}$$

Where Z is the value used to derive a probability from table 2 and T_S is the 'Scheduled Time of the project (Nicholas & Steyn 2008).

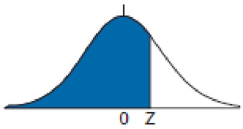
Table 2 – Normal distribution function of completing a project by time Ts (Nicholas & Steyn 2008)

(a)



Z Value	Probability	Z Value	Probability
0	.50	−1.2	.12
−0.1	.46	−1.3	.10
−0.2	.42	−1.4	.08
−0.3	.38	−1.5	.07
−0.4	.34	−1.6	.05
−0.5	.31	−1.7	.04
−0.6	.27	−1.8	.04
−0.7	.24	−1.9	.03
−0.8	.21	−2.0	.02
−0.9	.18	−2.1	.02
−1.0	.16	−2.2	.01
−1.1	.14	−2.3	.01

(b)



Z Value	Probability	Z Value	Probability
0.0	.50	1.2	.88
0.1	.54	1.3	.90
0.2	.58	1.4	.92
0.3	.61	1.5	.93
0.4	.66	1.6	.95
0.5	.69	1.7	.96
0.6	.72	1.8	.96
0.7	.76	1.9	.97
0.8	.79	2.0	.98
0.9	.82	2.1	.98
1.0	.83	2.2	.99
1.1	.86	2.3	.99

2.3.3 Earned Value Method – The S-Curve

'Earned Value Management, (EVM), is a project management methodology that is commonly used to control projects. EVM is popular, as the framework of the methodology incorporates cost, time and scope controls (Acebes et al 2014). In Brief, the EVM methodology relies on the depiction of the three key measures of 'Planned Value' (PV), Actual Cost (AC) and 'Earned Value' (EV) on a Cost vs Time graph as shown in figure 2.13. These three measures are described as follows by Acebes et al 2014:

- **Planned value** - of a project is the 'Budgeted Cost of Work Schedule' (BCWS), this is the forecast spend of the entire project.

- **Actual Cost** - of a project is described as, the 'Actual Cost of Work Preformed' (ACWP), which is the amount that has been spent from the start to date on the project.

- **Earned Value** - of a project is the 'Budgeted Cost of Work Preformed' (BCWP), which is the final cost on completion, or the forecast cost on completion of the project.

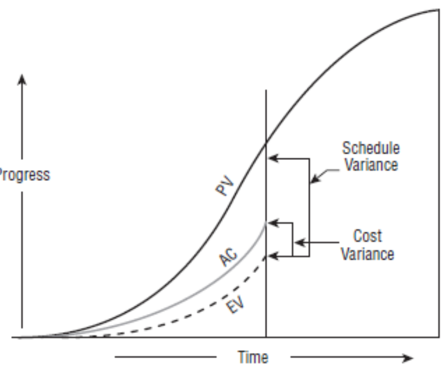


Figure 2.13 – S-Curve Cost verse Time with Variances indicated (Wysocki 2009)

Further to these three commonly used metrics it is also possible to derive a fourth key measure, the 'Earned Schedule' (ES) as proposed by Lipke in 2004, which is shown along aside the common metrics in figure 2.14 and is described as:

- **Earned Schedule** - is the date when the present EV should have been completed. This measure is found by superimposing the EV onto the PV line (Lipke 2004).

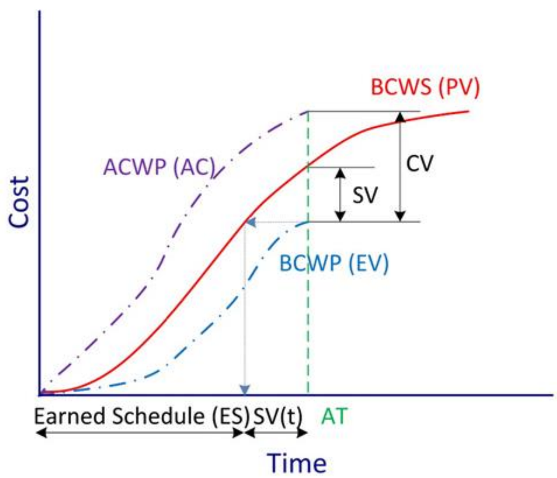


Figure 2.14 – S-Curve with Earned Schedule Superimposed (Acebes et al 2014)

From these four measures, the EVM 'Key Performance Indicators' (KPI) can be derived. The standard KPI's that are derived are 'Cost Variance' (CV) and 'Schedule Variance' (SV)

(Acebes et al 2014). The third measure as proposed by Lipke is 'Schedule Variance with respect to Time' (SV(t)). These KPI's are derived as follows:

- **Cost Variance –** is described by the equation CV = EV – AC. When a positive value is returned from this equation it indicates that the project is under budget. Conversely, if the project is over budget a negative value is returned.

- **Schedule Variance –** is derived using the equation SV = EV – PV. A positive value indicates that the project is ahead of schedule. Whereas, a negative value shows the project to be behind schedule.

- **Schedule Variance Time –** is found through the equation SV(t) = ES – AT, where AT is the 'Actual Time' the project has been running. In this KPI, a positive value indicates the time that has been saved in the project whereas negative values indicate time lost.

Finally it is then possible to derive a series of indices that allow projects of various sizes to be ranked against each other. These indexes are the 'Cost Performance Index' (CPI), 'Schedule Performance Index' (SPI) and the 'Schedule Performance Index with respect to Time' (SPI(t)). These Indices are derived as follows:

- **Cost Performance Index** – is found using the equation CPI = EV / AC

- **Schedule Performance Index** – is derived using the formula SPI = EV / PV

- **Schedule Performance Index Time** – is found from the formula SPI(t) = ES / AT

In all of these indexes a value less than one indicates that the corresponding variance is below zero. This signifies that the project is either behind schedule or over budget depending on the metric that is being evaluated at that time. Whereas, values equal to one or larger show that the project is ahead of schedule or under budget, once again when compared to the metric, as shown in figure 2.15. (Acebes et al 2014).

Using indexes allows projects of differing sizes to be compared to assess how effectively they are being delivered. This further allows for the ranking of projects so that the overall effectiveness of the entire project programme can be assessed. However, there is one limitation to this methodology, as it does not account for the fact that tasks off the critical path may not affect the schedule of the project, though may have a considerable effect on the budget of the project (Acebes et al 2014).

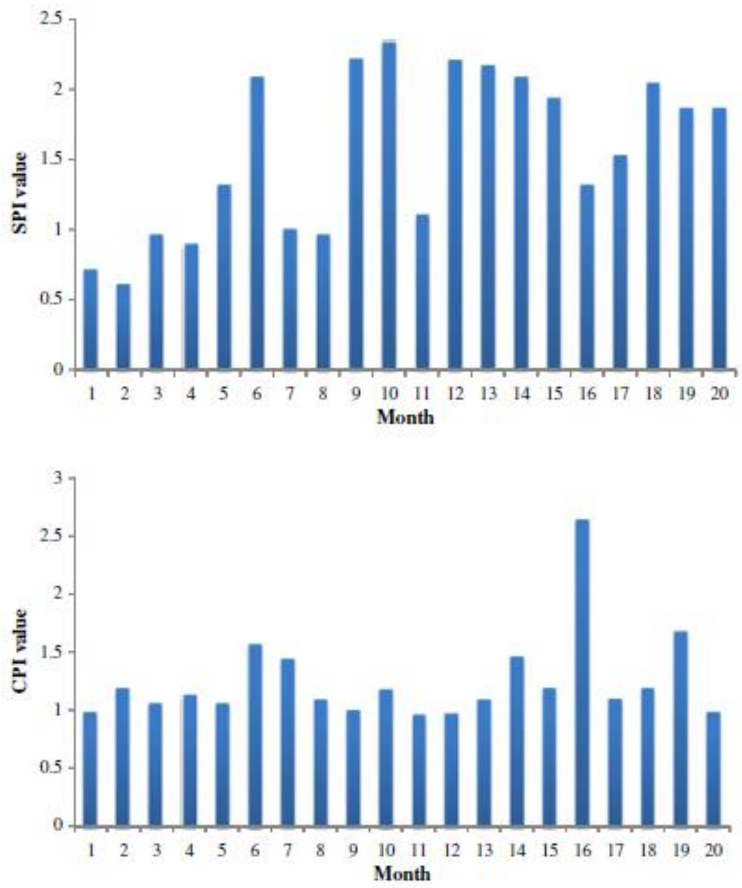


Figure 2.15– Example of SPI and CPI vs Month Graphs (Aliverdi et al 2013)

2.4 Why Projects Fail

Within the literature it is identified that Australia has a very high failure rate on completed project work. Infrastructure Australia, in 2013 presented findings that on average 48% of projects fail in Australia. The Auditor General of New South Wales suggests that a project has failed if does not meet one of the three controlling constraints of time, cost or performance. Therefore, project failure can be described as either a time failure, late project delivery, a cost failure, project cost overrun, or performance failure, where the expected outcomes are not met by the project (Achterstraat 2013).

The NSW Auditor General has found in his experience that the reasons that are generally given for a project failing are:

- **Poor Business Case -** Opportunities can be missed as all relevant options have not been explored.

- **Uncertain Statements of Expected Outcomes –** Poor communication of the project goals to all parties can lead to unrealistic expectations of the benefit of the project.

- **Insufficient Gate Way Reviews –** This indicates that the project is not being managed appropriately. Gate way reviews are import to assess how a project is progressing and if changes are required.

- **Poor Communication –** Communication channels should be free flowing from the project manager up to the executive, and from the project manager to the project team. Doing so will ensure that concerns and issues are addressed as they occur.

- **Insufficient Stake Holder Engagement –** Poor or uninspiring leadership will mean that the team will not be committed to the project fully.

- **Scope Creep –** Changing the scope of the project to get more out of a project will lead to either a delayed project or an over budget project.

- **Conflicts of Interest –** leads to the selection of uncompetitive tenders or overpriced materials

- **Unrealistic Bias when Assessing Prospective Benefits** – The project never meets the expectations of the stakeholders

- **Group Think** – Will often mean that right decision is not made, team members will try and reach consensus rather than offering an opinion that might be correct.

- **Lack of Big Picture Appreciation** – The true benefit of the project is never realized and opportunities are missed to capitalize on a dynamic market.

- **Decision Makers Too Involved in the Project** – decisions will get bogged down by the small details of the day to day running of the project, rather than of the big picture of what the project is aiming to achieve.

In a report presented by Achterstraat in 2013, it is suggested that the commonly given reasons for project failure can be grouped into the three overarching themes, which are 'Poor Governance', 'Poor Project Management' and 'Lack of Effective Leadership'. Infrastructure Australia (IA), also support this finding and further suggest that poor governance of projects leads to the most failures (Infrastructure Australia 2013). In a 2013 report, Infrastructure Australia found that project governance in Australia can be generally classified as 'Highly Dysfunctional'. Figure 2.16, shows that on average project governance is rated at only 24% effective by industry experts.

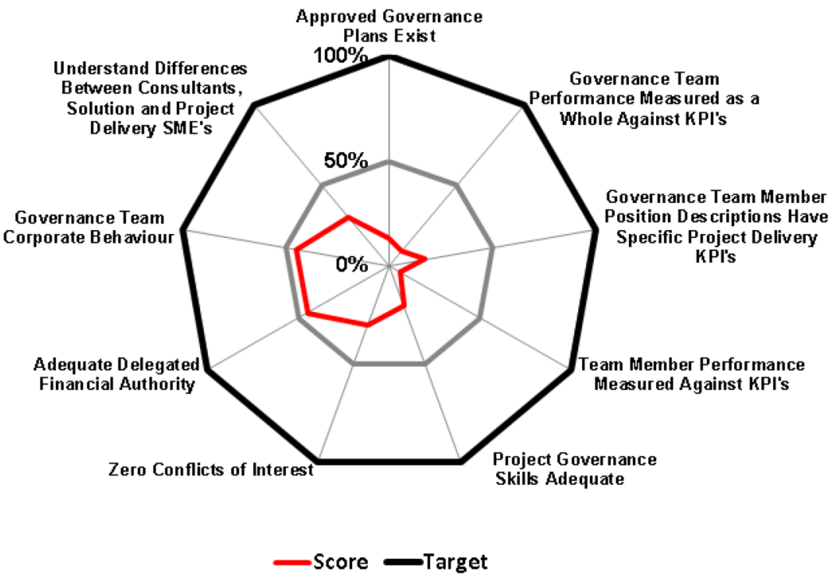


Figure 2.16 – Overall Governance Performance Score Card (IA 2013)

2.5 Conclusion

Water authorities in Australia have traditionally under spent on asset renewals when compared to other service providers. This means that much of the water infrastructure is nearing the end of its ‘Asset Life’ and in need of replacement. Recent drought events have seen increases in expenditure, however these projects are generally concerned with securing supply in short time frames. Increases in labour and energy costs have seen comparable rises in ‘Operational Expenditure’.

The combination of all these factors will mean, water authorities are coming under increased scrutiny from stakeholders to increase efficiency to produce a cheaper product. To achieve this, the water industry will need to employ ‘Best Practice’ in asset and project management strategies to maximize asset life while minimizing capital expenditure costs. Furthermore, the industry will also need to be able to demonstrate to its stakeholders that a robust and transparent decision making process has been applied to the delivery of its Capital Expenditure projects.

The traditionally used project management tools that have been investigated as part of this literature review have been proven as reliable methods for project delivery. Incorporating one or more of these techniques will provide the robustness required in delivering an effective project management programme.

3 Methodology

3.1 Introduction

The core function of the project is to develop a suite of project management tools and a procedure to describe the use of the tool in delivering AUS Water FW's Capital Expenditure projects. The project management tools are to be developed using quantitative and qualitative sources. As the water authority is subject to both governmental and public scrutiny on project delivery, AUS Water FW's processes must be transparent and repeatable. The project will produce these expected outcomes:

- Identification of quantitative sources of data available to AWFW
- A formal process of documenting the qualitative information sources.
- Selection of a set of criteria to judge a projects effectiveness that are aligned with AWFW's business philosophies
- Management reached consensus on information that needs to be conveyed by the PM suite.
- Formal policy on using the project management suite to show transparency in AWFW's project delivery.

Furthermore, the above process once documented in a dissertation, will serve as a blueprint for other regional water authorities seeking increased control over delivery of their capital projects. More broadly, increased use of project management tools in the water industry will ensure that less wastage of capital funds occurs.

3.2 Project Feasibility Analysis

Developing a suite of Project Management tools and procedures for their use, will ensure that AUS Water FW's capital projects are justifiable and withstands public scrutiny. Using a program such as Matlab or Excel as a platform for the suite would be considered a feasible solution. As Matlab is within the skill set of a student at the University of Southern Queensland and Excel is a standard program used in most offices. Both of these programs offer the necessary development tools to produce a user friendly graphical interface needed to convey information on project health to the user.

As this project has been suggested by a Manager at AUS Water FW, there will be sufficient access to the resources required to successfully develop a usable Project Management Suite and procedure, hence the project is feasible. The subsequent phase will be to further develop the concept to a completely scoped project as is outlined in Section 3. This project development phase was completed in conjunction with the advice of the following individuals:

- **Mr. Stephen Bastian** (Manager of P&D)
- **Mr John Coffey** (Manager of Water Quality and Supply)

3.3 Literature Review

The first step in the process was to conduct a detailed literature review. The literature review was undertaken to increase the theoretical knowledge of the chosen topic area. Firstly, in this review, research was conducted into the current factors that are affecting the water industry within Australia. Secondly, research was undertaken on into project management and fundamental project management tools that are considered industry standard. Finally, the factors that affect timely project delivery were researched to understand how and why projects fail.

A brief summary of the research undertaken as part of this literature review found that water authorities have traditionally underspent on their capital works programs when compared to other service providers. Capital works programmes are important as they are used as the authority's justification for their pricing structure. However, drought, climate change, population growth and a need for efficiency gains are placing the sector under increased scrutiny. Hence there is a need for robust and transparent methods of managing their CAPEX programmes. Traditional project management tools have be proven to be effective methods to deliver projects and should be the basis of a comprehensive and project management programme.

3.4 Project Initiation Meeting

The next step was to have a project initiation meeting with the management group of AUSWater FW. The purpose of this meeting was to, formally introduce the aims of the project to the group and to identify the quantitative (measurable data) and qualitative (informal data) resources. As both of these resource types are likely to yield information required to complete the project. Furthermore, the meeting was held to decide the best way to document the information obtained from this research.

3.5 Policy Review

In line with the company wishes policy and procedures are available for review and can be identified by the policy number in the report. However, the policy and procedures are not to be reproduced as they are classified as ‘Commercial in Confidence’ and are not for public dissemination. Therefore, to conform to the organisations wishes only a brief review of the policies will be undertaken as it may prove hard to discuss policies without providing examples for consideration.

3.6 Quality Assurance Plan

The following procedures will be used in the development of the suite of project management tools to ensure that it is made to best practice and limit errors.

- ‘Criteria Matrix’ will be developed to AS/NZS ISO 31000:2009 / Risk management - Principles and guidelines.
- ‘Condition Monitoring’ tools used to collect data will be calibrated to the manufactures specifications.
- The Project Management Suite and Procedures l will be developed using the standards from AS/NZ ISO 9001:2008 – Quality Management Guidelines.

Furthermore, if issues arise in the project which are beyond the competencies of an undergraduate student, assistance will be sort from USQ Supervisor and Essential Water management when needed.

3.7 Project Plan

The project is planned to be completed in 6 distinct stages, which are as follows:

- **Further Research -** To fully explore the project management procedures and project management tools in similar industries, such as the energy and transport industries.

- **Project Initiation** – At this point it will be necessary to conduct an inception meeting with the Essential Water management team to ensure that the resource required to completed the project are available as needed.

- **Data Collection** – this stage requires AUS Water FW computerised maintenance management system and Financial Business Systems to be assessed and quantitative information retrieved. This will need to be supplemented with staff interviews to get qualitative information. Finally information from formally completed 'Project Reviews' from the 2015/2016 CAPEX programme to be collated.

- **Project Management Suite Authoring –** This will require development of the suite in Excel using the VBA programming language. Also meetings will be held with the management team to gain consensus on the functionality of the suite and what information is require to be displayed on the project dashboard.

- **Testing** – Once the PM Suite is completed it will be presented to the EW management team and a series of acceptance tests completed to ensure that it functioning as designed.

- **Reporting -** Proposed that the process will then be written up to form the basis of the dissertation to be presented in 2016.

The Table 3 as shown below has been developed using the example presented in the 'Research Proposal' that formed part of the study guide for ENG 4110. This table shows individual tasks that will be required to complete this project.

Table 3 – Project Task Descriptions

Stage 1	Further Research
1A	An expanded literature review to be completed to ensure that the authors' knowledge base is consummate to the task ahead.

1B	AUS Water FW 'Project Management' philosophy to be researched as well as it policies and procedures around project justification and capital expenditure.
Stage 2	**Project Initiation**
2A	Meeting to be held with AUS Water FW management group to lock in access to resources that are needed, for example, out of hours access to prevent disruption to daily work activities, or access to key staff when needed
Stage 3	**Data Collection**
3A	Interviews to be held with key staff members so that qualitative data can be collected on AWFW's project management and project delivery. Interviews will be document and minutes taken.
3B	Quantitative research to be undertaken with information to be collected from EW's CMMS and business systems on the current effectiveness of its project management.
3C	Information about AWFW's current standard of project delivery to be collated.
Stage 4	**Project Management Suite Development**
4A	Consensus meeting to be held with AUS Water FW management group to confirm expected outcomes of the Project Management Suite
4B	Concept PM Suite to be developed and presented to AWFW management group for comment
4C	Working PM Suite to be developed
Stage 5	**Testing**
5A	Final / Working PM Suite to be presented to the AWFW management
5B	PM Suite to be evaluated through implementation on a CAPEX project.
Stage 6	**Reporting**
6A	Procedure to be written on using the PM Suite and Project management processes.
6B	Report to be written on process and conclusions drawn on the effectiveness of the implementation of the PM Suite and PM Procedure.

3.8 Resource Requirements

Before undertaking the project a proposed list of resources is presented in Table 4. This has also been developed through using the example research proposal as an informed guide. As the outcome of the project will be a computer based tool, there will be minimal expenditure required to complete this project. The main resources required will be access to key staff critical times in the project development. AS this tool is being proposed as a project to benefit AUS Water FW, access to staff should be granted as required.

Table 4 – Project Resource Analysis

Task	Item	Amount	Source	Cost
1A	Ream A4 Paper	1 Packet	Office Works	$5.00
1A, 2A,3A,3B, 4A & 6B	Printing Cost	As required	AWFW Printer	Up to $50.00

3.9 Risk Assessment

A critical part of developing a project plan in is completing a risk assessment to identify hazards that will affect the safe and timely completion of the project. In this section two risk assessments were completed, the first, Table 6, is concerned with the personal safety of those contributing to the project. The second, Table 7, was completed to identify hazards which could prevent the project from being completed on time. Both of these tables were adapted from the example research proposal supplied in the course notes.

The risk matrix, Table 5, used to assess the hazards, was adapted from one found on the University of Southern Queensland website. The matrix is a standard ‘Likelihood versus Consequence’ matrix where the higher the tabulated score the more profound the risk. Although, the matrix used was taken from the ‘Procurement Risk Assessment’ sheet, the concept of the sheet is still standard, if a hazard is assessed to higher then 5, Green, then the risk should be mitigated by the introduction of a control.

Fortunately, due to the nature of this proposal the only real risk in this project is to it being delivered on time. The level of proficiency in programming in Excel VBA will be the biggest hazard to delivery of this project, and the second, AUS Water FW’s commitment to this project.

Table 5 – Risk Matrix (University of Southern Queensland 2015)

			Consequence				
			Insignificant	Minor	Moderate	Major	Catastrophic
			1	2	3	4	5
Likelihood of Occurrence	Almost Certain	5	5	10	15	20	25
	Likely	4	4	8	12	16	20
	Possible	3	3	6	9	12	15
	Unlikely	2	2	4	6	8	10
	Rare	1	1	2	3	4	5

Table 6 – Personal Risk Assessment (University Of Southern Queensland 2015)

Task	Hazard	Risk	Control
All Tasks	General slips, trips or falls associated with office work	Rare/ Minor =2	PPE - Safety boots, long sleeve shirt and trousers

Table 7 – Project Risk Assessment (University of Southern Queensland 2015)

Task	Hazard	Risk	Control
1B	Unable to access policy via intranet	Rare/ Minor =2	Reference printed copy, note which version of policy is referenced
2A	Limited access to site	Rare/ Minor =2	Only completed work between 4pm and 6pm – these hours are available as cleaning staff are on site
3A,3B,3C	Limited access to staff	Rare / Major = 4	Ensure that all meetings are planned 1month in advance
4A	Management cannot reach consensus	Unlikely / Moderate =6	Criteria will be chosen to be in line with AWFW Strategic Plan – work will procced
4B, 4C	Programming skills inadequate	Possible / Major = 12	Develop an idea of features needed, slider bars etc., and Complete online tutorials in these features before development begins
5A, 5B	PM Suite does not meet expectations	Possible / Minor = 6	Involve management from the start of the process so there will be no surprises
6B	Project not delivered on time	Rare / Catastrophic = 5	Set deadline for draft dissertation to be complete by mid-September 2016. This will allow a month for editing

3.10 Communication Plan

The 'Communication Plan' (COM's Plan) for this project proposal is shown in Figure 4.1, and explained in detail, in Table 8. The COM's Plan was developed with the understanding that the proposer, Aron Molloy, is a full time employee of AUS Water FW in the Planning and Design Department, and has a good working relationship with EW management. Furthermore, USQ academic staff member, Mr Bob Fulcher, is included as he has been formally allocated as Project Supervisor for this development of this dissertation.

Table 8 – Communication Links

Link	Description
1	Mr Bob Fulcher to Aron Molloy free to communicate as needed
2	Progress and Mentoring meeting with Mr Bob Fulcher, 15mins every 3 weeks. Minutes from meeting to be distributed to for comment by email.
3	Resolution of any issues that may arise between project and work commitments
4	Daily communication, AWFW mentor, diary to be kept of communication all meetings to aid in final delivery of dissertation
5	Formal communication between AWFW management team on issues relating to the project. Minutes to be kept and distributed by email for comment

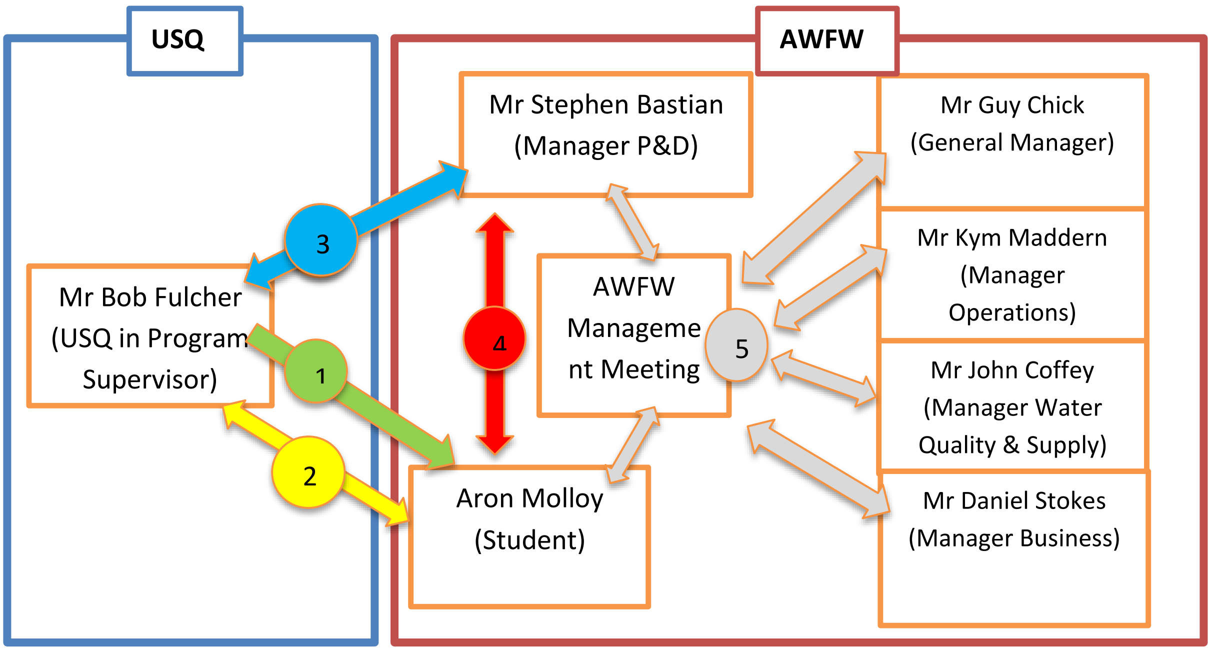


Figure 3.1 – Communication Plan Schematic

3.11 Special Requirements

At the time of writing this research proposal there are no special requirements regarding intellectual property or confidentiality relating to this project. However, if concerns are raised by management during completion of the project, it will be suggested that creating a fictitious organisation would be sufficient in protecting the organisations reputation.

3.12 Project Schedule

The project schedule is presented on the following page in Figure 3.2, the schedule has been developed to ensure that the project will achieve its objectives, by utilising as much of the remaining time until the project is due as possible. Features of the project schedule are as follows.

- The project is to run over a 31 week period and has 3 distinct phases. These being, Research, Development and Testing. It is proposed that documentation will occur during all phases of the project.
- Periods when it will be impractical to work on the project have been highlighted. These periods include holidays, exams and ENG4903 presentation.
- The schedule has four milestones indicated. These were chosen as they represent key points in the project.
- The final section of the schedule is a one week period where final changes are made before final submission.

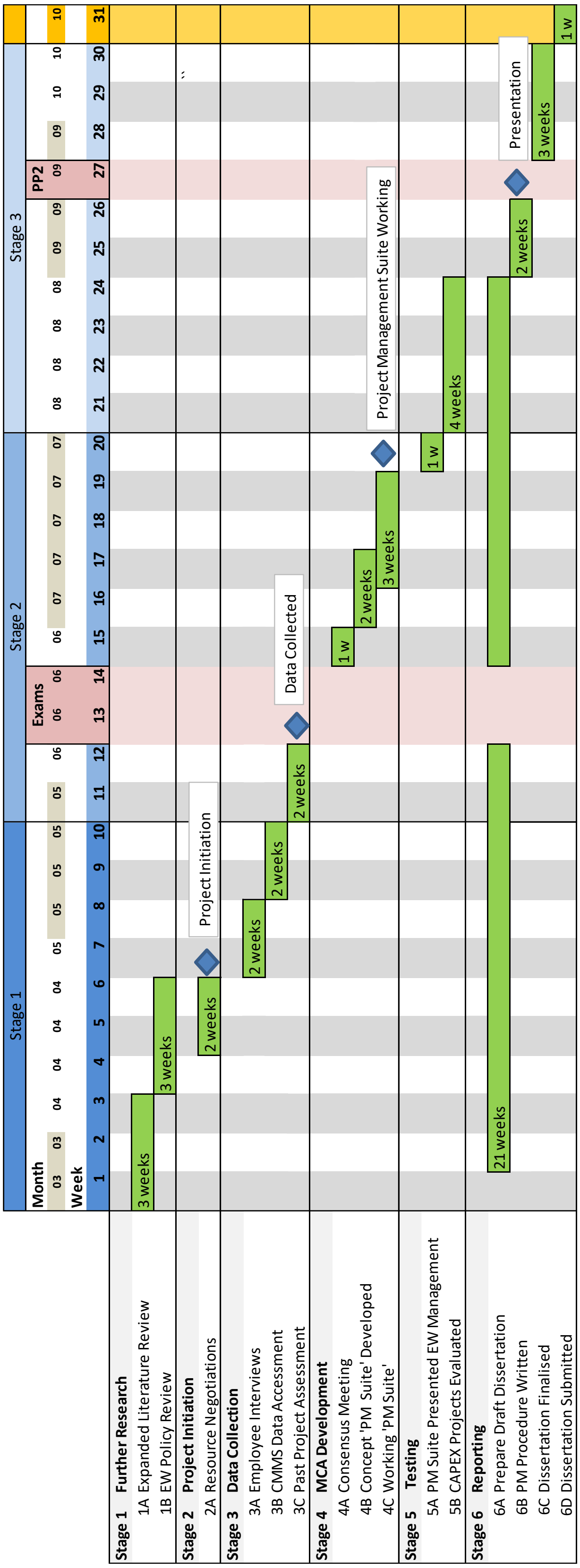


Figure 3.2 – Project Schedule

4 Analysis

The following Chapter has been written using the information gathered from sources of information internal to AUS Water FW. These sources are interviews with employees, financial business systems and the organisations asset management system.

4.1 Introduction AUS Water FW

As discussed in the introduction to this report AUS Water FW is a water authority that's area of operation is in the Far West of NSW. AWFW supplies water and sewer services to ten thousand customers throughout the towns of Broken Hill, Menindee, Silverton and Sunset Strip, as shown in Figure 4.1. This area is one of the most arid zones in the State of NSW, with an average rain fall of only 250mm, which means that for 8 out of every 10 years AWFW relies on its pipeline from the Darling River to Supply its customers. To supply its services, AUS Water FW has an extensive and aging infrastructure network which AWFW is required to maintain and replace as needed to continue servicing its customers. All of which is achieved with only 80 employees which are spread over work groups and a large geographical location (Essential Water 2016).

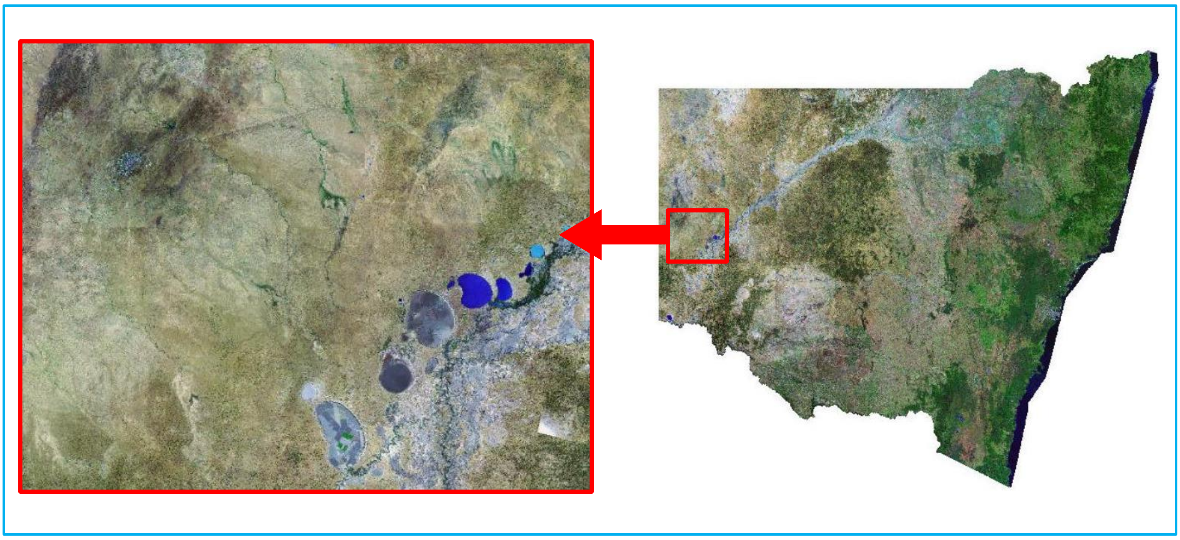


Figure 4.1 –AUS Water FW Area of Operation in NSW (Molloy 2016)

The isolation of the region in which AWFW operates means that the organization has a monopoly on supply of water in this area. Therefore as a monopoly, the prices of AWFW's services are set by IPART, thus ensures transparency in AWFW's pricing practices. This means that proposed Capital and Operational budgets are scrutinized to ensure that works are required and offer a benefit to the customer.

4.2 AUS Water FW Assets

AUS Water FW have an extensive network of assets to deliver services to its customers, as shown in Figure 4.2. The organisation provides the following:

- Harvesting and delivery of raw water
- Water Treatment Plants to produce potable water,
- Water reticulation to deliver the potable water to customers,
- Sewer reticulation for collection of waste water,
- Waste Water Treatment Plants and
- Effluent water delivery mains for industry, sporting grounds and wetlands.

The assets are briefly described in the following section of this report, which highlights the diverse nature of the assets that are owned by the organisation. The information forming this broad overview of these assets has been taken from AWFW'S asset management system.

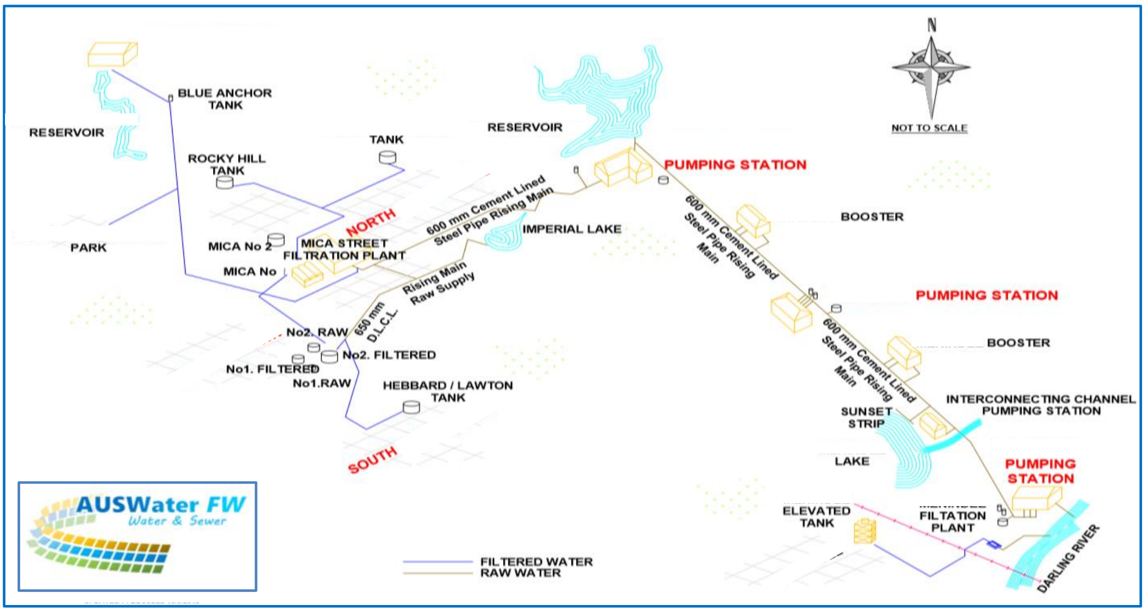


Figure 4.2 – AUS Water FW Water Assets Schematic (AUS Water FW 2016)

4.2.1 AUS Water FW Raw Water Assets

Table 9 – AWFW Raw Water Assets

Asset Type	Area	Number / Length	Description
Reservoirs / Catchments	Broken Hill, Stephens Creek & Umberumberka	3	Located within 30 km in Broken Hill, filled by surface water run-off in rain events
Rising Mains	Broken Hill, Stephens Creek, Umberumberka & Menindee	150 km	DN600 Mild Steel Cement Lined main, used to transfer water from reservoirs to water treatment plant in Broken Hill
Pump Stations	Broken Hill, Stephens Creek, Umberumberka & Menindee	5	There are a total of 12 High-Lift pumps and 5 Low-lift pumps as well as associated electrical equipment spread over the 5 pump stations. All of these pump units are used to supply water to the water treatment plant in Broken Hill.
Booster Pump Stations	Between Stephens Creek and Menindee	2	4 booster pumps to aid in transferring water when high volumes required

4.2.2 AUS Water FW Water Treatment and Reticulation

Table 10 – AWFW Water Treatment Assets

Asset Type	Area	Number / Length	Description
Water Treatment Plant	Broken Hill	1	30 Mega litre Conventional Water Treatment Plant • Flocculation • Sedimentation • Chlorination and Fluoridation • UV Treatment
Reverse Osmosis Plant	Broken Hill	1	13 Mega litre Reverse Osmosis Plant (Drought Contingency) • 5 Brackish Water Trains • 2 Sea Water Trains
Water Treatment Plant	Menindee	1	1.5 Mega litre Conventional Water Filtration Plant • Flocculation • Sedimentation • Chlorination and Fluoridation
Ultrafiltration Plant	Sunset Strip	1	8 l/s Ultra Filtration
Water Reticulation	Broken Hill	220km	Used to deliver water from service reservoirs to the Broken Hill customers. Ranges from DN200 to DN 80, typically DN 150 or DN 100
Service Reservoirs	Broken Hill	7	Used to store potable water and also to provided pressure and flow through the use of gravity / height differential.
Water Reticulation	Menindee	30km	Used to deliver water from elevated tank to the Menindee, typically DN 150
Elevated Tank	Menindee	1	Used to store potable water and also to provided pressure and flow through the use of gravity / height differential.

4.2.3 AUS Water FW Waste Water Reticulation and Treatment

Table 11 – AWFW Waste Water Reticulation and Treatment Assets

Asset Type	Area	Number / Length	Description
Waste Water Reticulation	Broken Hill	226km	DN 150 Vitrified Clay Pipe, in 10 catchment areas
Waste Water Pump Stations	Broken Hill	10	Pump Stations of various sizes to deliver water via rising mains and gravitation to the Waste Water Treatment Plant
Waste Water Rising Main	Broken Hill	10km	Principle Rising Main DN 400 Ductile Iron approximately 4 km's long
Water Treatment Plant	Broken Hill	2	3 Mega litre plant built in the 1940's 1 Mega litre plant built in the 1960's
Effluent Water Delivery Mains	Broken Hill	20km	Delivering effluent to customers for use in industrial applications, sporting fields and wetlands

4.3 AUS Water FW Project Stakeholders

As discussed in the literature review presented in Chapter Two, project stakeholders are individuals or organisations that exert a level of influence over the delivery of the project. AUS Water FW have external and internal stakeholders. The following section is an explanation of the project stake holders that affect the project delivery at AWFW.

4.3.1 Project Governance

The role of Project Sponsor is taken up by the Managers at AUS Water FW. They are the individuals who hold the ultimate responsibility of delivering the CAPEX Program. To ensure that the CAPEX program is progressing these managers develop project plans for their departments in Microsoft Project. At the management meeting that is held fortnightly updates on major projects are discussed. Further to this the managers regularly meet with the manager of planning and design to discuss how all minor projects are progressing in each department.

4.3.2 Project Managers

The project management positions at AWFW can be filled by any employee. Usually it is filled by the middle level managers and supervisors, however, for reporting purposes it is the individual how has completed the project justification form for the project. This situation confuses project delivery as sometimes justifications are completed by employees who are relieving in a higher grade position while an individual is on leave. Then when they return to their normal roles, the individual is still responsible for the project on the financial reporting for the project.

4.3.3 Other Stakeholders

The other stake holders as they are termed are considered to be extremely important to the business. The business has regulatory bodies that influence projects as well as customers and employees. The following is a following is a description of these stakeholders can influence project delivery:

4.3.3.1 Employees

AUS Water FW has 80 employees spread over a different business units and a large geographical area. Employee engagement in the process has been identified by the management group as major factor that can influence the delivery of projects. In 2015 a long running industrial dispute over the award / agreement that dictates the employee's conditions and wages ended in protected action being taken by a number of the workers unions. During this time of protected action morale in the work force has been described as low, and employee engagement has suffered as a consequence.

4.3.3.2 Customers

The customers of AWFW can influence the CAPEX program. As previously stated the organization is required to present its capital program to IPART for scrutiny every 4 years. As part of this process IPART chair a public meeting to gauge the community's opinion on the proposed projects and the ability of the customers to pay for any increases in the price of water. At the last determination, IPART ruled that the Tiered system of water pricing be replaced by flat rate for water regardless of use, as a direct result of the lobbying from the public.

4.3.3.3 Regulators

As the services that AWFW provide to their customers relate to different areas of water delivery, each area has its own regulation. The regulator can enforce through fines that a project be completed, for example the Dam Safety Committee may require upgrades be completed to a Dam to ensure that it will meet current safety standards. Table 4.12 briefly outlines what aspect of the business that each regulator controls.

Table 12 – AWFW Regulating Bodies

Area	Regulator	Description
Raw Water	Dam Safety Committee	Instruct work that is required to ensure dams meet safety standards
Raw Water	NSW Office of Water	Raw water access ensuring that all water is metered as it leaves raw water source
Filtered Water	NSW Department of Health	Monitor factor effecting acute health, Fluoride levels and presences of E Coli
Filtered Water	DPI Water	Monitor water treatment process for factors that affect long term health (heavy metals) and aesthetics of water (taste, salt levels)
Waste Water and Effluent	Environmental Protection Agency	Regulates the contact of waste water and effluent with the environment to prevent pollution
Waste Water and Effluent	NSW Department of Health	Regulates the contact that people have with waste water and effluent to prevent illness and disease.
Waste Water and Effluent	DPI Water	Monitors the treatment process to ensure that it meets the required standards
Employee Health & Safety	OH&S Legislation	To ensure that a safe work place is provided for employees
Pricing	IPART	Regulates what AWFW can charge for the water they sell

4.4 AUS Water FW Project Identification

An important part of the project program and its delivery is to quantify how an organisation identifies what projects are needed. There are 3 main ways that a project is identified for consideration for inclusion into AUS Water FW's project program these are outlined as follows:

4.4.1 Breakdowns

If an asset breaks down and requires replacement the work is completed as a project as the asset is being renewed. Breakdowns are problematic as they will drain resources and money that may be required in the completion of another project.

4.4.2 Regulator Instructed

There are times when the regulator will instruct the business to complete a project. For example the EPA closely monitor the businesses waste water treatment plants. Previously the EPA have instructed AWFW to line dams to prevent effluent from contaminating the water table. The EPA in this case are instructed on the progress of the project at all stages to ensure that it is meeting their deadlines.

4.4.3 Top-Down Identification

AUS Water FW have very comprehensive process that is used to identify assets that will need to be replaced in future CAPEX programs. This process is best described as a 'Top-Down' approach to project identification and is shown in figure 4.3. The following section outlines the process:

4.4.3.1 Integrated Water Cycle Management Plan

This plan is a very high level document that outlines the future direction of the business. It has been described as the 'Shape' that the business will take into the future. The plan identifies how the company will supply water into the future.

4.4.3.2 Strategic Business Plan

This plan works at a strategic business level and outlines the direction that the business must take if it is to meet the goals defined in the IWCMP. The plan will identify the infrastructure that is needed into the future.

4.4.3.3 Water Asset Management Plan

This plan is also at the strategic level and outlines asset management philosophies of the business. The plan will identify which assets are critical and thus require preventative maintenance or assets which are replace on breakdown.

4.4.3.4 30 Year Capital Plan

This plan is used to identify assets that are critical and have a long term needed to be replaced. The plan will identify assets such as 'Electrical Start Panels' that will require replacement after 25 years of service.

4.4.3.5 10 Year Capital Plan

This plan starts to identify the 'Options' for asset renewal and is the beginning of the project planning at AWFW. This plan might identify that a high-lift pump requires replacement in 8 years and suggest various configurations.

4.4.3.6 IPART Determination

This is completed every 4 years with projects being presented to IPART at a concept level. The business knows that a project needs to be completed and presents the best option for consideration for funding from IPART. At this stage IPART can decide that a project is not warranted and remove it from the approved list.

4.4.3.7 Yearly Capital Plan

IPART approved projects are ranked using a Multi Criteria Analysis and placed on a CAPEX Phasing chart to determine when it should be completed. The project is then planned and scheduled using a Gantt chart. This is at the project delivery level and as such the plans will need to be at a detailed design level.

Figure 4.3 – AUS Water FW Top-Down Project identification (Molloy 2016)

4.5 AUS Water FW Project Delivery Review

To assess the overall project delivery of AUS Water FW a selection of the projects were taken from the monthly CAPEX financial report for June 2016, a copy of which is presented in Appendix F. This is the same report that the project managers at AWFW receive on a monthly basis and besides project meetings this is the only feedback that is received as to how well the project is being delivered. In the monthly report Projects are listed according to project number and comments are recorded on the budget spent of the project so far. If the project has not been active that month the project manager is asked if the project has been completed.

4.5.1 Method

The method used was to assess one CAPEX financial report as to the overall success of the delivery of the Capital Program. This method was used for as a business this is how project managers are currently kept updated on their performance. Only projects with comments or a budget note were taken as the sample as no comments would mean that the project is not currently active. This method left a sample of 51 projects to be assessed on the comments for that project. Furthermore a month was considered to be a reasonable sample to use as the list of projects is dynamic.

4.5.2 Analysis

From the 51 projects taken as the sample of representative projects 12 had projects were indicated as over spent and 14 had questions regarding if project was complete. These projects were regarded for the analysis as a project that in trouble / failed. The 12 over spent projects had failed on cost, whereas the 14 questioned on time were considered failed as they had either stalled, not started or finished in the suggested timeframe. Using this method it was found that approximately 50% of the projects are considered failed

4.5.3 Discussion

While the methodology of project assessment was basic it was considered to be acceptable as this is the currently how projects are monitored at AWFW. The failure rate of 50% is considered to be in line with the accepted failure rate of projects in Australia as discussed in the literature review.

4.6 AUS Water FW Case Studies

The following two case studies were developed using information obtained from the AUS Water FW financial systems, Computerised Maintenance Management Software and interviews with the staff members involved with the delivery of the projects.

4.6.1 Case Study One - Grit Collector Overhaul

4.6.1.2 Background

A grit collector is a fundamental component of the wastewater pre-treatment process. The grit collector consists of a long narrow channel that regulates the velocity of the water as it enters the plant, which causes the sediment in the influent to fall to the bottom of a collection chamber (Renner 2000). The grit is then removed from the collection chamber using scrapper buckets that are chain driven using a mechanical drive, then collected in a hopper and transferred to a collection bin for removal (Liptak & Liu 1997).

Figure 4.4 – Grit Collector (Molloy FW 2016)

4.6.1.2 Project Justification

The influent in the channel and the git that is collected is very abrasive to both the chains and the scrapper buckets. As part of preventative maintenance schedule the chains and buckets are inspected and adjusted regularly. Once the chains are found to be nearing the end of their usable life a refurbishment of the grit collector is scheduled. Refurbishments are regularly schedule approximately every two years.

4.6.1.3 Project Planning

The project was considered to be a 'routine project', as it is a preventative maintenance task which is completed approximately every 2 years. As such estimates were derived using past projects as a guide for time that the project would take to complete. Following the AWFW procedure three quotes were obtained for the chains as these items are specially cast and cost over thirty thousand dollars supplied. Once the project was approved the 'Mechanical Trades Group' were allocated the task of delivering the project.

4.6.1.4 Project Estimated Vs Actual

The table compares the estimated and actual hours and budget of the grit collector overhaul. An expanded version of the table is supplied in Appendix C.

Table 14 – AWFW Estimated Vs Actual Grit Collector Overhaul

Item	Actual	Budget	Variation
Materials/Stores	44,995.20	44,426.77	568.43
Fleet	11,991.05	5,426.40	6,564.65
Labour Costs (inc. Oncosts)	52,343.33	21,076.56	31,266.77
Contract	-	-	
Contingency	-	7,092.97	
Total	**109,329.58**	**78,022.70**	**31,306.88**
Labour Hours	700.40	266.00	434.40

4.6.1.5 Discussion

As the project progressed a number of factors caused this project to go over the estimated time, which in turn caused the project to go over budget. Firstly, the Mechanical Supervisor left for an extended holiday, believing that the project was routine, no other project manager was assigned, and the tradesmen were left to their own devices. Secondly, a number of issues arose that that were missed in the initial inspection and scope, the tradesman fixed the issues as a matter of course. However, as the issues were out of the original scope variations should have been submitted which would have given more time to complete the project. These factors caused an additional 434 hours of labour and fleet attributed to the project. The additional hours caused the project to exceed the original budget by approximately $31,000

4.6.1.6 Conclusion

The poor supervision of this project allowed for the tradesman to lose focus. Then in turn excess hours were booked to project which caused the project to exceed the allocated budget. In short the project failed on time and cost, two of the three constraints, due to no project manager being assigned to drive the project in the supervisor's absence.

4.6.2 Case Study Two – Polyaluminium Chloride Tank Installation

4.6.2.1 Background

Due to severe drought conditions the water quality in one of the town's water supplies was reaching a level too saline for human consumption. The solution was to switch to another source, however this source was full of suspended solids. To reduce the sediment an emergency installation of a 'Poly Aluminium Chloride' dosing system was installed.

Poly aluminium chloride is a very high molecular weight inorganic polymer that is used as flocculating agent in the water treatment process (Binnie et al 2002). Flocculating agents are used in water treatment to form a 'Precipitate', a grouping of suspended sediments. This precipitate will continue to group until it becomes too heavy to float in the water, it then falls to the bottom of the containment area for removal (Benjamin & Lawler 2013).

Figure 4.5 – Polyaluminium Chloride Installation Work in Progress (Molloy 2016)

4.6.2.2 Project Justification

This was an emergency project that was required to be completed in a short time frame. The need for this was so that AUS Water FW could continue to supply a quality of water that would meet the Australian Drinking Water Guidelines to its customers.

4.6.2.3 Project Planning

As this was an emergency project it was considered to be out of the ordinary operation of the organisation. As such it was decided to use a contractors to complete the installation of the tanks and dosing pump skid. Completing the project in this way required a detailed scope of works to be completed, so that the contractors approached by AWFW to tender would all have the same information on which to quote. Furthermore, using outside labour required the use of an experienced 'Project Co-ordinator' to ensure that the project would be delivered without variation and in a timely manner.

4.6.2.4 Project Estimated Vs Actual

The table compares the estimated and actual hours and budget of the PACl tanks installation. An expanded version of the table is supplied in Appendix D.

Table 15 – AWFW Estimated Vs Actual Grit Collector Overhaul

Item	Actual	Budget	Variation
Materials/Stores	4,764.23	1,200.00	3,564.23
Fleet	4,281.97	2,676.91	1,605.06
Labour Costs (inc. Oncosts)	22,334.16	15,155.90	7,178.26
Contract	62,863.00	66,263.00	
Contingency	-	8,529.58	
Total	**94,243.36**	**93,825.39**	**417.97**
Labour Hours	334.47	217.90	116.57

4.6.2.5 Discussion

The project required addition work from AUS Water FW staff to secure the fill pipes, set the correct dosing rate and install an eye-wash station. The eye-wash was required by the chemical delivery company before a shipment of PACl could be received. The additional work by AWFW staff meant that extra hours were booked to the project, which in turn increased fleet charges and wages. However, these extra costs were mostly covered by the 10% contingency and the project only exceeded the estimated budget by $418.

4.6.2.5 Conclusion

The scope of the project had not taken into account the needs of the delivery company as a stakeholder in the project. This in turn added additional cost to the project through the additional work required. However, the project was delivered on time which meant that AWFW could continue to provide potable during the drought crisis.

4.7 Discussion

AUS Water Far west has an extensive network of assets that it needs to maintain to provide the services that it offers to its customers. The methods used to identify projects are robust and are in line with what is required by the IPART determination conducted every 4 years. The age of AWFW's asset's mean that breakdowns are likely to occur which can be problematic for the timely delivery of other projects.

Overall the project delivery of AUS Water FW has been shown to be consistent with the level of dysfunction that is common in Australia. Which would suggest that the issues causing the failure rate are the same as suggested in the research. However, the case studies also show that projects are more likely to succeed when the delivery is managed.

4.8 Conclusion

There is considerable room for improvement in project delivery at AWFW. The issues of lack of employee engagement in the process and continually managing the project delivery are areas for improvement. The case studies in this section highlighted these two themes. The PACl tank installation was required at short notice and as such was closely monitored, which meant that variations were handled in a timely manner. In contrast the grit collector overhaul was considered as business as usual and as such the process was not managed, workers lost focus and the project was considerably over time and over budget. In conclusion this shows that AWFW does have the expertise to deliver its projects in a timely manner, the challenge is to extend this expertise to all of its Capital Projects.

5 Development

5.1 Introduction

The initial plan for this research project was to develop a suite of in-house project management tools using VBA in excel to address the needs of AUS Water FW to aid in project delivery. On completing the research in the form of the 'Literature Review' and the 'Detailed Analysis' of the business a time of reflection on the issues that AWFW faced highlighted a number of key points. These key points were:

- Low employee engagement in the process,
- Reporting on project status that is only financially focused, and
- Up to a month out of date when received
- Overall poor documentation, project folder not being updated regularly.
- Project Managers who are trying to fill multiple roles in the organisation

To address these issues a brainstorming session was held and the following brief description of what was required from the tool was developed. The tool should incorporate these following principles:

- Tool should be novel and enjoyable to use to build employee engagement.
- The Status of the project should be judged on more than just a balance sheet.
- Feedback should be immediate so that if asked the project manager can give a status update.
- Encourage the habit of documenting each step in a project folder.
- Keep the project managers organised as changing between roles can mean steps are missed or information is lost.

The parameters of the tool had been set, the challenge was now to develop a tool that met the brief as outlined above.

5.2 What Should the Tool Include?

The next step in the process was to take the brief and develop concepts that would address the issues. Ideas were shared with the management team as to what they felt the tool should incorporate. It was suggested by management, that the suite should incorporate the tools that were investigated in the literature review, a Gantt chart, Earned Value Analysis and a PERT Analysis to help in estimating task durations. Furthermore, the Multi Criteria Analysis that is completed to assess the need of the project should be included so that the purpose of the project is clear in the mind of the project manager.

The ambiguity that often surrounds the roles that employees play in delivering the project also needed to be addressed. To achieve this it was decided that the tool should clearly the names and role of the individual clearly on the dashboard. To address the issue of projects currently only being judge on financial grounds it was determined that the tool should include a means of changing the driving constraint as required, and this also should be displayed on the dashboard.

To keep the project manager up to date and keeping a project folder the idea of scoring these actions was considered. The idea of a performance mark for the manager was not overall desirable, however, this led to the idea of a 'Project Health Score'. This score would then give the Project Manager a metric that could be used to update senior management on the projects performance. Finally the elements that were needed on the dashboard were taking shape the next step in the process was to developing the tools using VBA in Excel.

5.3 Visual Basic for Applications in Excel

Visual Basic for Applications (VBA) is a standard feature in Microsoft Excel and it is generally hidden on start-up. To access VBA the developer tool bar must be activated which can be done through the options / tool bars pathway. The developer tab allows buttons and sliders to be added to the spread sheet, with macros for functions added using VBA.

After a period of two weeks it was decided that the skills needed to develop the tool using VBA were beyond the current skill set of the author. In these two weeks the skill set had developed to the point where a button could make a tone when pressed or a cell change colour. It was decided that to save time on learning a new program that the tool would developed exclusively in Excel.

5.4 Further Research into Dashboard Design

At this point it was then necessary to complete further research into the elements that contribute to a user-friendly/ergonomic dashboard design. The majority of this research was completed using ‘Google Images’ and taking notes on the elements that worked and didn’t work on other dashboards. Textbooks on visual communication of information were also accessed as a resource at this stage. One notable resource was Steven Few’s 2006 text ‘Information Dashboard Design: The Effective Communication of Visual Data. In this text Few advocates a less cluttered visual style and appropriate chart choice for displaying information.

5.5 Project Management Tool Dashboard

The following figure 5.1 shows the final makeup of the dashboard, the development of which will be further outlined in the subsequent sections.

Figure 5.1 – Project Management Tool Dashboard (Molloy 2016)

5.6 How the tool works

The following is a brief and general description of how the tools works, more detailed descriptions on individual components are contained in the reference material on the development of that tool.

The main goal of the sheet is to keep the project on track by keeping the project manager organised. This is achieved through a data entry sheet, where questions on the status of the project are answered, in regards to six key areas of project delivery. Each question answered in the affirmative (yes) will attract points and if the stage is documented, points are also given.

The points are derived using weighted averages that update depending on the driving constraint of the project and stage that the project is in. The points are added and a Project Health Score ranging between 0 and 10 is returned to give immediate feedback as to how the project is progressing.

5.7 Dashboard Elements

The following section is a listing of each element of the dashboard and how it works. All the elements were developed using the Microsoft Excel, basic shapes have been used to form the dashboard elements and shading applied to give depth. All the charts are standard to excel with formatting applied aesthetic purposes. Conditional Formatting has been added to cells so that they change colour where needed. Selected tables driving the chart are shown in Appendix I to K of this report.

5.7.1 Information Bar

Information regarding the project is added to the cells where required, the aim of which is to display who is filling which role on the project.

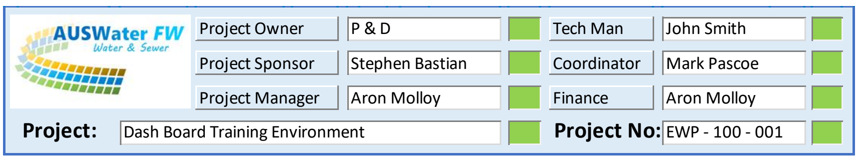


Figure 5.2 – Information Bar (Molloy 2016)

5.7.2 KPI's and Project Phase

The 'Phase' of the project is selected using an up or down button. Once the phase has been selected it works in conjunction with the 'Driving Constraint' to allow the sheet to access the weighted score for this phase of the project, which is then displayed as the 'Project Health Score'.

The KPI section of the display allows the user to add what is being termed as a 'Correction Factor' to the Project Health Score. The idea of the correction factor is that for every incidence or variation points are deducted from the health score, hence it is being corrected.

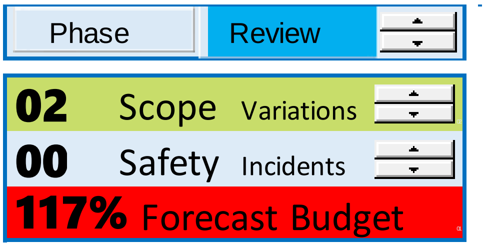


Figure 5.3 – KPI's and Project Phase (Molloy 2016)

5.7.3 Driving Constraint

The 'Driving Constraint' is chosen depending on the need of the project using an up or down button. The selected constraint will work in conjunction with the 'Phase' to select the weighted score for the 'Project Health Score'. The chart is a standard radar chart, the values are updated via the use of the buttons allowing the chart to update dynamically. Titles update through the use of an =IF() statement.

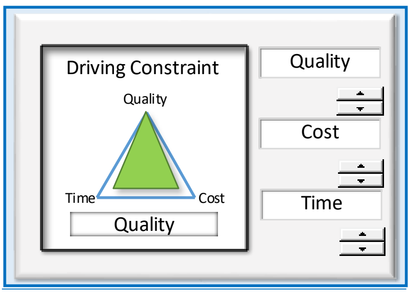


Figure 5.4 – Driving Constraint Chart (Molloy 2016)

5.7.4 Project Health Speedometer

The 'Project Health Speedometer' is the main focus of the dashboard, and is used for displaying the overall health of the project. As the project Check List is updated the health of the project will change depending on how the project is currently progressing. The addition of the colored cells below highlight project areas that need work for the overall score to improve

The chart is the combination of a doughnut and a pie chart, with all but one of the pie chart segments hidden, creating the effect of a needle. The version shown in the figure below has the needle moving on a slider bar, which also updates the health score.

The original concept for the design came from a YouTube posting by 'My E Lesson' (https://www.youtube.com/watch?v=f6c93-fQlCs). In this video however, there is a flaw in the speedometer design as it only uses 3 segments on the pie chart, which causes the chart not give a true approximation of distance when set up in this fashion. This problem has been fixed through the addition of a fourth segment and a formula that drives this additional segment.

Figure 5.5 – Speedometer Project Health Chart (Molloy 2016)

5.7.5 Simple PERT Chart

Developed using the formula's in the literature review. The chart is termed simple as it can only derive approximate time expected and 90% on a single task. The curve is created using a normal distribution. Buttons control the data entered into the chart, which updated the chart dynamically.

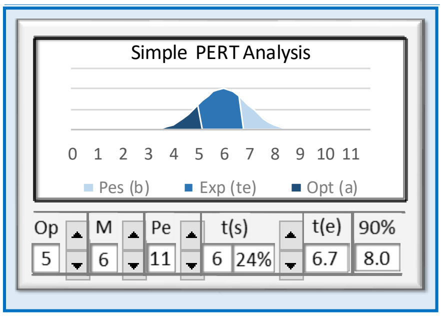


Figure 5.6 – Simple PERT Chart (Molloy 2016)

5.7.6 Simple S-Curve

Developed using the formula's in the literature review. The chart is termed simple as it only displays the expected over or underspend, however, SPI and CPI is shown a driving sheet. The chart type is a combination of a line and scatter chart. Buttons are used to change the high and low limits of the chart.

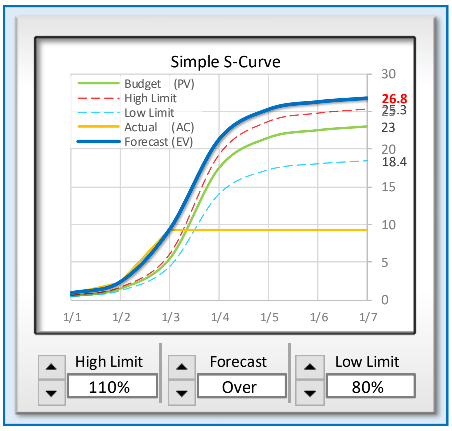


Figure 5.7 – Simple S-Curve (Molloy 2016)

5.7.7 Simple Gantt Chart

The Gantt is developed from a simple Stacked Bar chart with formatting applied. The buttons and sliders control the data entered into the chart area and position the tasks where required. Overdue task will turn read until completed. Task Durations will adjust automatically for the weekend by the addition of a formula.

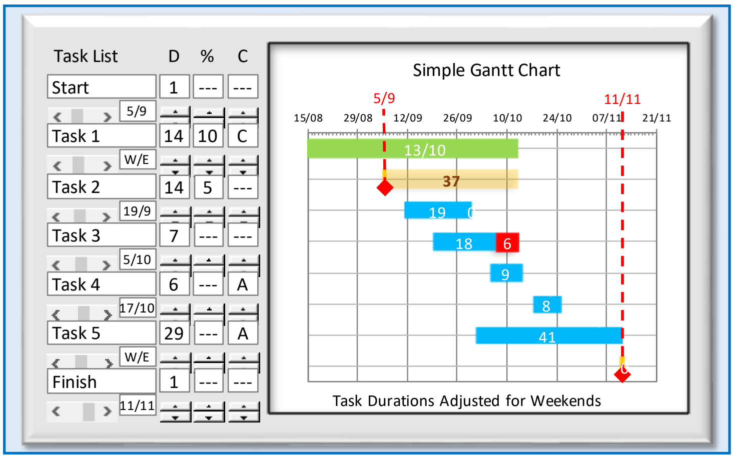


Figure 5.8 – Simple Gantt Chart (Molloy 2016)

5.7.8 Multi Criteria Analysis

The multi criteria analysis uses weighted averages to give the project a score out of ten. Criteria are assessed using the matrix in Appendix E of this report. The matrix was developed with AWFW management. The chart type is a radar chart sliders are used to enter data

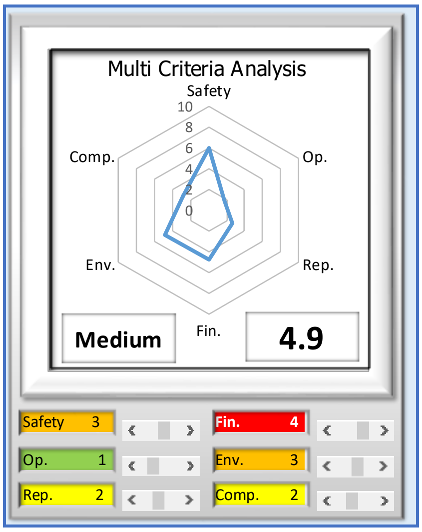


Figure 5.9 – Multi Criteria Analysis (Molloy 2016)

6 Testing, Discussion and Recommendations

6.1 Introduction

Once the tool had been fully developed it was decided that acceptance testing would be required to ensure that the tool was working as required. To test the tool it was decided to complete ‘Desktop Audits’ on the cases studies previously presented in Chapter 4 of this report. The results of these audits are presented and discussed in the following sections of this report.

6.2 Desktop Audits

To test the veracity of the tool it was decided that a series of desktop audits were to be completed. The ideal subjects for the audit were considered to be the projects that formed the case studies previously presented in this report. It was expected that the ‘Project Health Scores’ returned by the tool would mirror the real world experience of these two projects.

To complete the audits the project managers on each project were interview and project folders were assessed. This information was then entered retrospectively into the tool to receive an overall Project Health Score for the completed project.

For a complete overview of the data that was entered into the project tool, checklists for the grit collector overhaul and the PACl tank installation are shown in Appendix G and Appendix H of this report respectively. Each project was also assessed with time as the driving constraint so as to create a like for like comparison

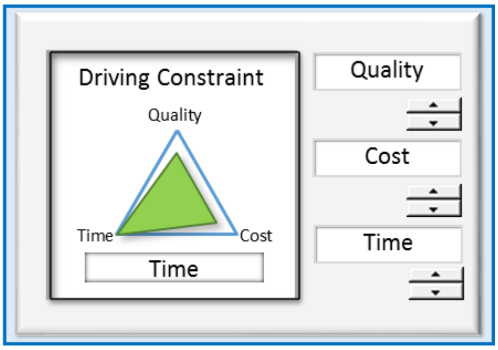


Figure 6.1 – Time as Driving Constraint (Molloy 2016)

6.2.1 Desktop Audit – Grit Collector Overhaul

The Project Health Score returned from this exercise was 2.9 and the project was given a ranking of 'Medium Health'.

Figure 6.2 – Project Health Score for the Grit Collector Overhaul (Molloy 2016)

6.2.2 Desktop Audit – PACl Tanks Installation

The Project Health Score returned from this Audit was 8.0 and the project was given a ranking of 'High Health'.

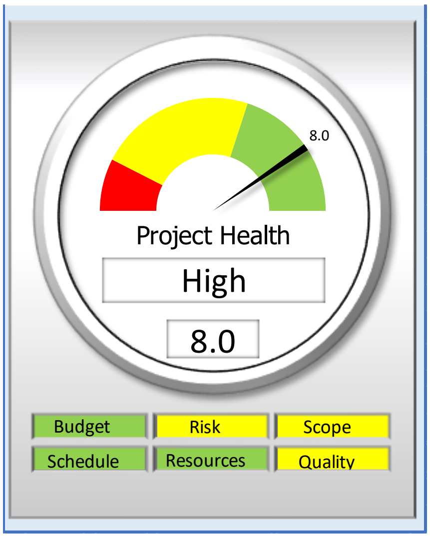


Figure 6.3 – Project Health Score for the PACl Tank Installation (Molloy 2016)

6.3 Discussion and Recommendations

The Audit was successfully completed and the results were returned as what was expected before undertaking the analysis. The PACl tanks Instillation was considered a success on completion of the project, as water quality remained high during the drought, and the result of 8.0 reflected this. Whereas the Grit Collector overhaul is unanimously considered a failure and the tool highlights this situation as well.

Even though the tool performed well in this test there is improvements that need to be made if the tool is to be deployed for use at the company. These are:

- **Check List Questions** - need to be reviewed as some were written so as to return an opposite result from the desired result, eg, were scope variations required? A yes answer would add health points.

- **Correction Factor Weightings** – even though the PACl tank installation had a variation for the addition of the eyewash station the resulting mark was still high. These weightings need to better reflect the impact that the variation has on the project

As discussed the desktop audit was successfully completed returning believable project health scores for each project. Also while filling in the checklist an appreciation for how the tool will be useful over the entire project was gained. Project scores changed as different stages of the project were entered. Confirming that if the form was used regularly during a project deficiencies in the delivery would be spotted immediately.

7 Conclusion and Further Work

7.1 Conclusion

The infrastructure owned by AUS Water FW is diverse in nature. Like other water authorities, the infrastructure spans Civil, Mechanical, Electrical, Chemical and Environmental Engineering disciplines (Rokstad, M, Ugarelli, R 2015). Furthermore, in the current business environment of falling revenue and changing population bases, diverse and aging infrastructure profiles (Hicks & Woods 2010) it is necessary that Capital Expenditure (CAPEX) projects are delivered on time and on budget. Managing projects over a diverse range of fields can be a complex proposition which can lead to failed project delivery and increased project costs.

To deliver projects in a timely manner it is important that organisation's undertake their project work using proven project management techniques. Tracking the progress of the project through the use of 'Key Performance Indicators' (KPI's) and 'Project Dashboards' will ensure that the project is delivered on time, on budget and meet the expectations of the organization. One way that smaller organisation's can monitor their project delivery and build employee engagement in the process, is to develop in-house project management tools. It is important that the tools are based on fundamental project management principles and be user friendly.

In conclusion, the project management suite that was developed and documented in this report does meet the brief of being a novel and an engaging tool. Feedback from users at AUS Water FW when trialing the tool has been favorable. More development is required to make the tool robust enough for full deployment to the staff of AWFW. However, the enduring success of the tool will depend on the acceptance of the work force in the long-term, it is hoped that it will not be viewed as yet more paper work to be completed.

7.1 Further Work

On completing this report there is still further work to be undertaken to make the implementation of the in-house project management tool a success. The further work that needs to be completed is as follows:

- **Investigation in to using Microsoft Access** – Microsoft Access has been recommended as a more robust delivery method for the tool. A major concern with the design as outlined in this report is the need to access tables that are off of the main dash board page of the tool. This increases the chance of users accidently deleting or writing over important information. Microsoft Access has been suggested as tables are hidden in the and only required information is displayed.

- **Improving Check List Questions** – It is suggested that this will be an iterative process. As the tool evolves with use and as the organisation changes over time, the required questions should also change.

- **Improving the Applied Weightings –** This will also be an iterative process to develop a robust set of weightings. Currently the weightings differentiated by the driving constraints are only slightly different, these should be more diverse to make give the questions relating to the constraint further gravitas. Furthermore the driving constraint should also affect the weightings applied through the correction factors, as a time variation should be more critical on a time sensitive project then other variations.

- **Writing a Formal Procedure** – To ensure that users are fully aware of how to use the tool a procedure needs to be written. A detailed procedure will also contribute to the transparency that is required of the CAPEX program when scrutinised by IPART and other corporate auditors.

- **Implementation and Training –** The final step is to implement the tool in the work environment. To achieve this a training package will also need to be developed to ensure that the staff are fully engaged in the use of the tool. The training should not only build a working appreciation of the tool, though should also highlight the possibility for improvement that its application could bring if used throughout the project.

8 References

Acebes, F, Pajares, J, Galan J. M. & Lopez-Paredes, A, 2014, *'A new approach for project control under uncertainty. Going back to the basics'* International Journal of Project Management, vol 32, p. 423–434, viewed 15 April 2016, <http://www.sciencedirect.com/science/article/pii>

Achterstraat, P 2013,*'Why Large Public Sector Projects Sometimes Fail*' Audit Office of New South Wales, Sydney

Aliverdi, R., Naeni, L.M. & Salehipour, A. 2013,*'Monitoring Project Duration and Cost in a Construction Project by Applying Statistical Quality Control Charts'*, International Journal of Project Management, vol. 31, p. 411–423

Australian Beura of Statistics 2013, '*3222.0 - Population Projections, Australia, 2012 (base) to 2101'*, ABS, Canberra, viewed 23 May 2016, < http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/3222.0Main%20Features22012%20(base)%20to%202101?opendocument>

Australian Standard 2016, '*AS ISO 21500:2016 – Guidance on Project Management'*, SAI Global Ltd, Sydney

Benjamin, M & Lawler, D 2013,*'Water Quality Engineering: Physical/Chemical Treatment Processes*' John Wiley & Sons, New Jersey, USA

Binnie, C, Kimber, M & Smethurst, G, 2002,*'Basic Water Treatment*' 3rd ed, Thomas Telford Publishing, London

Briggs, J, Joubert , F & Loke, J 2014, '*Water Infrastructure Asset Management – Addressing The Challenges That Lie Ahead'* , Australian Water Association, Australia, viewed 19 October 2015 <http://www.awa.asn.au/htmlemails/Ozwater14/pdf/natozw14Final00413.pdf>

Brunner, M 2009,'*What Is Asset Management and What Are the Most Critical Elements'*, The Asset Reliability Road Map, Melbourne, viewed 15 October 2015 < http://thereliabilityroadmap.com/html/article_pg_7.html>

Coombs, G & Roberts, C 2007, '*Economic Roundup Summer 2007: Trends in Infrastructure*', Australian Government the Treasury, viewed 27 September 2015, < http://archive.treasury.gov.au/documents/1221/HTML/docshell.asp?URL=01_public_infra.asp>

Deckro, J & Hebert, E 2011 '*Combining contemporary and traditional project management tools to resolve a project scheduling problem'*, Computers & Operations Research, vol. 38, p. 21–32, viewed 20 March 2016, <http://www.sciencedirect.com/science/article/pii/ S0305054809003293>

Dobson, M & Leeman, T 2010,*'Creative Project Management: Innovative Project Options to Solve Problems on Time and on Budget*', McGraw Hill, New York

Essential Water 2016, '*About Us'*, EW, Port Macquarie, viewed 15 October 2015 <http://www.essentialwater.com.au/>

Few, S 2006, '*Information Dashboard Design: Effective Visual Communication of Data*', 1st ed, O'Reilly Media, California, USA

Flank, M 2015,*'The Project Managers Guide'* Lulu Publishing, New York, viewed 23 June 2016 <https://play.google.com/books/reader?id=OSw7CgAAQBAJ&printsec=frontcover&output=reader&hl=en&pg=GBS.PT2

Gray, C.F. & Larson, E.W. 2011,'Project Management: The Managerial Process' 5th ed, McGraw-Hill/Irwin, New York, USA

Hicks, P & Woods, G 2010, '*Regional Population Trends in Australia*', Parliament of Australia, viewed 27 September 2015, < http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/BriefingBook43p/regionalpopulation>

Infrastructure Australia 2015, '*Australian Infrastructure Audit: Our Infrastructure Challenges*', IA, Canberra

Infrastructure Australia 2013, '*A Review of Project Governance in Australia*', IA, Canberra

Jordan, J 2010, '*Maintenance Management for Water Utilities'*, American Water Works Association, Denver Colorado, 3 ed

Kaspura, A 2013,*'Analysing Australia's Infrastructure Trends 2012: What Has Happened Since The 2010 Infrastructure Report Card?*', Institute of Engineers Australia, viewed 15 May 2016, <https://www.engineersaustralia.org.au/about-us/research-and-reports>

Lester, A 2013, '*Project Management, Planning and Control, Sixth Edition: Managing Engineering, Construction and Manufacturing Projects to PMI, APM and BSI Standards'* Elsevier Science Technology, United Kingdom

Lienert, J, Mauer, M, Reichert, P, Scheidegger, A & Scholten, L 2014,'*Strategic Rehabilitation Planning Of Piped Water Networks Using Multi-Criteria Decision Analysis'*, Water Research, vol. 49, p. 124-143, viewed 27 September 2015, <http://www.sciencedirect.com/science/article/pii/S0043135413009287>

Lipke, W 2004. '*Connecting Earned Value to the Schedule*', Measurement News, vol 1, p. 6–16. viewed 24 March 2016, <http://www.sciencedirect.com/science/article/pii>

Liptak, J & Liu, D 1997,*'Environmental Engineers' Handbook'*,2nd ed, CRC Press, Kentucky, USA

Lock, D (2007),*'Project Management'* 9th ed, Gower, Burlington USA

Mantel S.J., Meredith J.R., Shafer S.M.,& Sutton M.M. 2011 '*Project Management In Practice'*, 4th ed, John Wiely & Sons Inc, New Jersey, U.S.A.

Muller, R & Turner, R.J 2003, *'On The Nature Of The Project as a Temporary Organization'* International Journal of Project Management, vol 21, p. 1–8, viewed 24 March 2016, <http://www.sciencedirect.com/science/article/pii>

Nicholas, J & Steyn, H 2008, '*Project Management for Business, Engineering and Technology: Principals and Practice'*, 3 ed, Butterworth-Heinemann, Oxford

National Water Commission 2014, '*National Performance Report 2012–13: Urban Water Utilities'*, NWC, Canberra

Pries, K & Quigley, J 2011, '*Scrum Project Management'*, CRC Press, New York

Project Management Institute 2004, '*A Guide to the Project Management Body of Knowledge (PMBOK® Guide)–Third Edition'*, 3rd ed, Project Management Institute Ltd, Newton Square, USA

Renner, D 2000,*'Hands-on Water and Wastewater Equipment Maintenance: Volume 2'*, Technomic Publishing Co Inc., Pennsylvania, USA

Rokstad, M & Ugarelli, R 2015, '*Minimising the Total Cost of Renewal and Risk of Water Infrastructure Assets by Grouping Renewal Interventions'*, Reliability Engineering & System Safety, vol 142, p. 148-160, viewed 27 August 2015, <http://www.sciencedirect.com/science/article/pii/S0951832015001635>

Smith, N.J. 2002,*'Engineering Project Mangement*', 2nd ed, Blackwell Science, Oxford, UK

Stephens, M 2010,*'Productivity and Reliability-Based Maintenance Management'*, Prudue University Press, Indiana, USA

Westland, J 2006, '*The Project Management Life Cycle*' Kogan Page, London

Wysocki, R.K. 2009,*'Effective Project Management: Traditional, Agile, Extreme*' 5th ed., Wiley, Indianapolis

8 Appendices

Appendix A – Project Specification

For: Aron Molloy

Title: Improving Project Delivery in a Regional Water Authority

Major: Mechanical Engineering

Supervisors: Mr Bob Fulcher

Sponsorship: Essential Water

Enrolment: ENG4111 – EXT S1, 2016
ENG4112 – EXT S2, 2016

Project aim: To develop a suite of project management tools and procedures to improve the project management processes of a regional water authority

Programme: Issue A, 20th March 2016

1. Research current best practices in 'Project Management', research to be presented in the form of extended literature review.
2. Analyze the policies, procedures and culture that influence 'Project Management' practices at Essential Water.
3. Develop through consultation with Essential Water's management team a suite of in-house project management tools to aid in project delivery.
4. Develop a procedure for using the project management tools.
5. Develop a set criteria for how the effectiveness of the tool and procedure will be evaluated.
6. Implement a trial of the procedure and project management tools on a small sized project.
7. Evaluate the effectiveness of the trial, through collecting feedback from staff and data collected from Essential Water's business systems.

If time and resources permit:

8. Implement a trial of the procedure and project management tools on a medium sized project.
9. Evaluate the effectiveness of this trial, through collecting feedback from staff and data collected from Essential Water's business systems.

Appendix B – USQ Procurement Risk Assessment Matrix – Level of Risk

USQ
AUSTRALIA

USQ Procurement Risk Assessment Matrix – Level of Risk

Version 2.1
Mar 2012

Control Methods

Note: Highest score in any risk category takes precedence over lower scores in other categories for multiple risks

25: Extreme risk
Must refer to USQ Manager Audit & Risk for clearance to proceed.

15-20: High risk
Use appropriate procurement documentation, as a minimum Full Offer process. Possible refer to Audit and Risk

8-12: Moderate risk
Use appropriate procurement documentation, must use Special Conditions of Contract for acquisitions under $100k

1-6: Low risk
Manage by routine procedures/processes (dependent on value of procurement)

	Consequence →					Rating
People	First aid	Injury requiring medical attention	Single person injury requiring hospitalisation	Multiple person injuries requiring medical attention or hospitalisation	Death or multiple life threatening injuries.	
Infrastructure	Minor damage not requiring repair (superficial)	Minor damage requiring attention to reduce potential major damage (such as rust or rot)	Damage requiring major repair to make serviceable	Damage requiring major immediate repair so as to not prohibit continued operations	Damage requiring immediate repair so as to prevent potential life threatening hazards	
Operational	Minor disruption to operations lasting less than 3 hours	Disruption to operations lasting up to 6 hours	Disruption to operations lasting up to 24 hours	Disruption to operations lasting up to 3 days	Disruption to operations lasting up to 1 week	
Reputation	Minor unsubstantiated negative publicity or damage to reputation to an insignificant audience	Minor negative publicity or damage to reputation to an insignificant audience	Negative publicity or damage to reputation to a specific audience which may not have sufficient long-term or community effects	Negative publicity or damage to reputation from a national perspective, industry perspective or community welfare perspective	Sustained negative publicity or damage to reputation from a national perspective, industry perspective or from the community welfare perspective	
"Other" (See examples next page)						

Likelihood	Numerical:	Historical:				Insignificant	Minor	Moderate	Major	Catastrophic
						1	**2**	**3**	**4**	**5**
↑	>1 in 10	Is expected to occur in most circumstances	>	**Almost Certain**	**5**	**5**	**10**	**15**	**20**	**25**
	1 in 10 - 100	Will probably occur	>	**Likely**	**4**	**4**	**8**	**12**	**16**	**20**
	1 in 100 – 1,000	Might occur at some time in the future	>	**Possible**	**3**	**3**	**6**	**9**	**12**	**15**
	1 in 1,000 – 10,000	Could occur but doubtful	>	**Unlikely**	**2**	**2**	**4**	**6**	**8**	**10**
↑	1 in 10,000 – 100,000	May occur but only in exceptional circumstances	>	**Rare**	**1**	**1**	**2**	**3**	**4**	**5**

Green: Low Risk Yellow: Moderate Risk Red: High Risk

Page **1** of **1**

"Other" Risk Category in USQ Procurement Risk Assessment Matrix is open to users' specific requirements, for example;

- Financial (cost of litigation, fines, penalties, litigation settlements, supply failure)
- Legislation (Compliance)
- Environment
- Strategic

In these scenarios the consequence would need to be assessed on a case by case basis and inputted into the matrix prior to evaluation (one consequence for each from Insignificant to Catastrophic). Likelihood would remain as per the matrix. Alternatively consult USQ Planning & Quality Risk Management Framework.

QUALITY ASSURANCE SCHEDULE

Determining appropriate quality assurance requirements (Ref 5.3 Procurement Guidance Quality Assurance Manual)

USQ Determined Level of Risk	**Value of goods or service**	**QA Requirement**		**Proof**
	Below $10,000	No formalised QA required except by Chief Financial Officer direction		Not applicable
		Level of risk	**QA requirement**	
1-6	$10,000 & over	**Low**	No formalised QA required	Not applicable
8-12		**Moderate**	Selected elements from: • QA System Standard (e.g. AS/NZS ISO9001) or, • Industry association QA, or • Industry-specific QA, or • Professional accreditation	Evaluation by registered evaluators; or formal recognition by audit or industry accreditation
15-25		**High**	• QA System Standard (e.g. AS/NZS ISO9001) or, • Industry association QA, or • Industry-specific QA, or • Professional accreditation	Formal QA certification or industry accreditation.

Page **2** of **2**

Appendix C – Wills St Grit Collector Overhaul Financial Information

Project No: W101184
Project Name: Wills St WWTP Overhaul Grit Collector
Project Owner:

Period	Department	Account	Transaction Amt	Expenditure Breakdown	Hours	Cost	Comments
December	482	55000				-	
December	482	55000				-	
				Labour Costs			
				Labour On-Costs			
April	484	55000	38262.77			38,262.77	
				Accounts Payable		38,262.77	
				Fleet Charge			
				Labour Costs			
				Labour On-Costs			
May	484	55000	2,418.14			2,418.14	
				Accounts Payable		263.16	
				Labour Costs	22	1,026.24	
				Labour On-Costs		476.45	
				Fleet Charge		207.90	
				Stores		405.50	
				Stores Overheads		38.89	
June	484	55000	52,290.97			52,290.97	
				Fleet Charge		9,510.20	
				Accounts Payable		5,316.74	
				Stores		216.11	
				Stores Overheads		10.22	
				Labour Costs	478.14	20,403.36	
				Labour On-Costs		16,834.34	
July	484	55000	16,196.64			16,196.64	
				Accounts Payable		149.09	
				Fleet Charge		2,250.25	
				Stores		302.47	
				Stores Overheads		30.25	
				Labour Costs	198.26	9,074.07	
				Labour On-Costs		4,390.51	
August	482	55000	161.06			161.06	
				Fleet Charge		22.70	
				Labour Costs	2	88.74	
				Labour On-Costs		49.62	
August	489	55000				-	
				Accounts Payable			
				Fleet Charge			
				Labour Costs			
				Labour On-Costs			
August	490	55000				-	
				Accounts Payable			
September	493	55000				-	
				Accounts Payable			
				Fleet Charge			
				Labour Costs			
				Labour On-Costs			
				Stores			
				Stores Overheads			
		Total	**109,329.58**				
		Project Budget:	**78,022.70**				
		Overspend	**31,306.88**				

Summary Table

Item	Actual	Budget	Variation
Materials/Stores	44,995.20	44,426.77	568.43
Fleet	11,991.05	5,426.40	6,564.65
Labour Costs (inc. Oncosts)	52,343.33	21,076.56	31,266.77
Contract	-	-	
Contingency	-	7,092.97	
Total	**109,329.58**	**78,022.70**	**31,306.88**
Labour Hours	700.40	266.00	434.40

Appendix D – PACl Tank Installation Financial Information

Project No: W101160
Project Name: SC Pipeline - Installation of PACL Chemical Dosing Tanks
Project Owner: Aron Molloy

Period	Department	Account	Transaction Amt	Expenditure Breakdown	Hours	Cost	Comments
December	482	55000	28,840.62			28,840.62	
				Contractors		28,840.62	
December	482	55000	31,323.62			31,323.62	
				Contractors		6,692.00	
				Contractors		16,671.00	
				Labour Costs	120	5,131.24	
				Labour On-Costs		2,829.38	
Jjanuary	482,490	55000	23945.15			23,945.15	
				Contractors		10,659.38	
				Accounts Payable		2,387.43	
				Fleet Charge		1,916.55	
				Labour Costs	139	5,782.60	
				Labour On-Costs		3,199.19	
December	490	55000	2,114.35			2,114.35	
				Accounts Payable		42.25	
				Fleet Charge		1,652.23	
				Stores		379.91	
				Stores Overheads		39.96	
February	490	55000	7,021.62			7,021.62	
				Fleet Charge		713.19	
				Accounts Payable		916.68	
				Labour Costs	75.47	3,507.92	
				Labour On-Costs		1,883.83	
April	490	55000	998.00			998.00	
				Accounts Payable		998.00	
				Fleet Charge			
				Labour Costs			
				Labour On-Costs			
September	482	55000				-	
				Fleet Charge			
				Labour Costs			
				Labour On-Costs			
September	489	55000				-	
				Accounts Payable			
				Fleet Charge			
				Labour Costs			
				Labour On-Costs			
September	490	55000				-	
				Accounts Payable			
September	493	55000				-	
				Accounts Payable			
				Fleet Charge			
				Labour Costs			
				Labour On-Costs			
				Stores			
				Stores Overheads			
		Total	**94,243.36**				
		Project Budget:	**93,825.39**				
		Overspend	**417.97**				

Summary Table

Item	Actual	Budget	Variation
Materials/Stores	4,764.23	1,200.00	3,564.23
Fleet	4,281.97	2,676.91	1,605.06
Labour Costs (inc. Oncosts)	22,334.16	15,155.90	7,178.26
Contract	62,863.00	66,263.00	
Contingency	-	8,529.58	
Total	**94,243.36**	**93,825.39**	**417.97**
Labour Hours	334.47	217.90	116.57

Appendix E – AUS Water FW Risk Matrix

Matrix

Developed by

	Insignificant	Minor	Moderate	Major	Severe
Safety	Low level injury / symptoms requiring first aid only.	Non-permanent injuries / work related illness requiring medical treatment.	Significant non-permanent injuries / work related illnesses requiring emergency surgery or hospitalisation for more than 7 days	Permanent injuries / work related illnesses to one or more persons.	One or more fatalities. Significant permanent injuries / work related illnesses to one or more persons.
Environmental	Limited localised damage to minimal areas of low significance	Minor impact on biological or physical environment or heritage item over a limited area. Little or no need for remediation.	Moderate damage over a large area or affecting ecosystem, or heritage item. Moderate remediation is required.	Serious widespread, long term damage to ecosystem or heritage item. Significant rectification is required.	Very serious long term, widespread impairment of ecosystem or heritage item.
Compliance	Indication of interest from Regulator. No fines incurred but administration costs may be payable. No litigation.	Warning notifications from Regulator. Minor financial penalties. Short term duration litigation.	Medium financial penalties. Medium duration litigation.	High financial penalties. Lengthy litigation.	Significant financial penalties. Potential jail term for individuals. Extensive litigation. Loss of Operational licence.
Operational	Loss of water or sewer supply to a small group of customers (<10) for less than 4 hours. Loss of water or sewer supply has a insignificant impact to community / insignificant economic impact to commercial customers.	Loss of water or sewer supply to a small group of customers (<10) for between 4 and 12 hours. Loss of water or sewer supply has a minor impact to community / minor economic impact to commercial customers.	Loss of water or sewer supply to a small group of customers (<10) for between 12 and 36 hours. Imposition of water restrictions to a large group of customers between 12 to 36 hours due to water supply issues. Loss of water or sewer supply has a moderate impact to community / moderate economic impact to commercial customers.	Loss of water or sewer supply to a small group of customers (<10) for between 36 and 1 week. Imposition of water restrictions to a large group of customers between 36 hours and 1 week due to water supply issues. Loss of water or sewer supply has a major impact to community / major economic impact to commercial customers.	Loss of water or sewer supply to a small group of customers (<10) for >1 week. Imposition of water restrictions to a large group of customers >1 week due to water supply issues. Loss of water or sewer supply has a severe impact to community / severe economic impact to commercial customers.
Financial	<$3000	$3001–$30000	$30001–$100000	$100001–$1m	>$1m
Reputation	Public concern restricted to local complaints or intra-industry knowledge / awareness.	Attention from media and or heightened concern from local community / external stakeholders. Criticism from multiple sources for one or two days.	Adverse state media / public / stakeholder attention sustained over 1-2 weeks.	Significant adverse national media / public / stakeholders attention sustained over 1-2 weeks. Loss of confidence by State Government Minister. Directive to amend practice received from Regulators.	Significant adverse national media / public / stakeholders outcry. Sufficient outcry to cause irreparable damage to brand. Ministerial enquiry / Royal Commission.

Almost Certain	Occurring >5 times per year	Low	Medium	High	Extreme	Extreme
Likely	Occurring more than once a year but <5 times per year	Very Low	Low	Medium	High	Extreme
Possible	Occurring more than once in 10 years but no more than once a year	Very Low	Low	Medium	High	High
Unlikely	Occurring more than once in 25 years but no more than once in 10 years	Very Low	Very Low	Low	Medium	High
Rare	Occurring less than once in 25 years	Very Low	Very Low	Low	Medium	Medium

Appendix F – AUS Water FW CAPEX Update June 2016

Proj No.	PC B-Unit	Proj Owner	Project Description	Initial Justification	NOTES
W100250	PC007	SB	**14]**	NIL	Email 14.7.16 Steve - Is this completed?
W101010	PC007	NO	**Mica St WTP Umberumberka Main Replacement**	DS	**Suspended until FY16. Now FY17 said NO'C 14.17.16. No Costs .**
W101030	PC007	NO	**Menindee Pipeline - Anchor Block Valve Replacement (3)**	20846 Bal	**leave open NO 14.7.16.**
W101057C&R	PC007	NO	**MPL-Main Manifold "Y" Piece Replacement [Govt?]**	-	**Well over budget, costs in 2014/15 also. Closed 9.6.16 NO.**
W101117	PC007	Randy	**BH short term water supply RO (Not to be used)**	-	**Email RP 13.7.16**
W101127	PC007	SB	**Menindee WTP Upgrade Investigations**	-	**Email SB 20.10.15 advised Leave Open. Overspent. Email SB**
W101131	PC007	GC/JC	BH S/Term WS-DPW Project Mgt / RO Plant [GOVT]	-	MP Finance using for Osmoflo payments , accruals etc
W101133	PC007	TM	**Kan Rd SPS-Upgrade Rising Main**	-	Overspent. 2015/16 $79,437.64. Toby - Is this complete ?
W101135	PC007	TM	**SR-SAC Convert D/Square to Rnd**	-	Overspent. 2015/16 $22,308.53. Toby - Is this complete ?
W101136	PC007	TM	**SR-Remove Swr VP 60 Wills St**	-	Overspent. 2015/16 $16,563.98. Toby - Is this complete ?
W101137	PC007	TM	**SR-Remove Swr VP 158 Wills St**	5139.78 Bal	Spent $18,597.33 2015/16.
W101139	PC007	TM	**Sewer Main Lining Program**	48872.61 Bal	Spent $131,127.39 2015/16.
W101141	PC007	TM	**SMR - Creedon St (between Ryan St & Gaffney lane)**	?	Spent $41,524.09 2015/16.
W101142	PC007	TM	**SMR-Slag SPS Rising Main Rep**	-	Overspent. 2015/16 $211,466.10 Toby - Is this complete ?
W101143	PC007	TM	**SMR-Rep 5 Crush Main/Bound Con**	7372.84 Bal	Spent $22,627.16 2015/16.
W101155	PC007	DS	**WS - Menindee Common Bore**	?	Spent $37,470.66 2015/16.
W101158	PC007	?	**BH Brine Ponds (Short Term Water Supply RO Plant) Govt**	?	Spent $5,052,680.41 in 2015/16 (Oct 15-Apr16). Govt funded.
W101159	PC007	?	**BH Brine Pipeline (Short Term Water Supply RO Plant) Govt**	?	Spent $1,168,728.15 in 2015/16 (Oct 15-Jun16). Govt funded.
W101161	PC007	?	**Menindee WTP Chemical Dosing**	?	Spent $746,930.32 in 2015/16. (Nov 15-Apr16)
W101164	PC007	MPriess	**Menindee PL-Replace Air Valves (8 - 5HP & 3LP) 2015-16**	3062.6 Bal	Spent $14,927 (MAT) 2015/16 (Dec 15). Email MP 13.7.16. 13/7
W101167	PC007	SB	**WR-Rep Sec IL Raw Wtr Fed Main**	Nil	Overspent. Spent $34,307.28 2015/16 (Oct 15-Mar 16 est $30k). SB
W101170	PC007	NO	**Wills St. Bar Screen Overhaul**	Nil	Overspent in 15/16 $39,720.18 (Mar-Jun 16). Nev NOT COMPLETE
W101174	PC007	SP	**South Rd SPS - Rep Control Panel**	Nil	Overspent. 2015/16 $13,366.39(Feb-Jun). Incomplete. SP to advise
W101175	PC007	SP	**Menindee Pipeline - Box Tank Anode Replacement**	3051.42 Bal	Spent $18,056.58 2015/16 (Apr&Jun16). Incomplete. SP to advise
W101177	PC007	NO	**Wills St WWTP - Humus Pump Overhaul & Spares**	15448.63 Bal	Spent $2,917.98 Dec 15(15/16). Parts missing prob on OPEX NO ?
W101181	PC007	SB	**Stephens Creek Reservoir - Pool Options Study**	12569.42Bal	Spent $15,330.58 2015/16 (May-Jun16). Emailed Steve 8.6.16
W101184	PC007	NO	**Wills St WWTP - Grit Collector Overhaul**	Nil	Overspent. Spent $92,971.88 (Apr-Jun 16) in 2015/16. Costs in July
W101185	PC007	AM	**Sunset Strip WTP-Tank Replacement**	10081 Bal	Spent $6,074.68 in 2015/16 (Feb 16) . AM not complete yet 10/6/16
W101189	PC007	NO	**ILPS - Bypass & Isolation Valves Emergency Spares**	Nil	Overspent. Spent 8768.50 in 2015/16 (May June16) Email 14.7.16 Nev
W101190	PC007	NO	**Mica St WTP - No. 3 Booster Pump Replacement**	51,909.00	No cost in 2015/16. Email 14.7.16 Nev - Is this going to be
W101191	PC007	AM	**Block 10 Service Reservoir No. 3 Design Hatch & Internal Ladder**	27,000.00	No cost in 2015/16. AM not complete yet 10/6/16
W101195	PC007	NO	**Menindee WTP - Install raw water non return valve**	2043.49 Bal	Spent $1,371 Material only in 2015/16 June 16. Est incl Lab fleet.
W101200	PC007	AM	**Umber Suction Main - Replacement Materials**	76694.47 Bal	Spent $11,305.53 2015/16 (Jun 16).AM not complete yet 10/6/16
W101201	PC007	NO	**Umber PS - No. 3 Cavpower Motor Replacement Parts**	1681.39 Bal	Spent $16,813.95 Jun 16 Material only (Est 18495.34). Email NO
W101203	PC007	NO	**Menindee Pipeline - Cut Ins (3)**	29,000.00	14.7.16 Nev - Is this going to be undertaken or not ?
W101204	PC007	SB	**Wills WWTP - Construction of Concrete Sludge Dams & Assoc**	822445.45 Bal	Spent $7,554.55 15/16 Est $830k.
W101205	PC007	NO	**Block 10 Service Reservoir No. 4 Walkway Improvements**	21522.62 Bal	Spent $8,262.23 in Jun 16 (Est $29784.85).
W101208	PC007	SB	**Mica WTP - Serv Res No. 3 Structural Detail Design**	29,900.00	
W101209	PC007	SB	**Mica WTP - Serv Res No. 3 Mech & Elect Detail Design**	29,420.00	
W101210	PC007	SB	**Warren St SPS - Stabilizing Old Sewer Containment Wells**	54255.91 Bal	Spent $139,744.09 2015/16 (May/Jun16) Est $194k
W101214	PC007	SP	**Menindee PS - HV Battery Charger Replacement**	3925 Bal	Spent $11,475 Jun 16 (15/16). ETA 28 June 2016 SP. Not complete,
W101215	PC007	SB	**SCR Dam Wall Assessment & Options Study**	187,000.00	
W101216	PC007	NO	**South WWTP- Safety Fences -Digester No. 1-2**	55,181.81	
W101219	PC007	SB	**Sunset Strip WTP - Upgrade Options Assessment**	29,870.00	Spent $28,376.50 15/16 (Jun 16) Steve B - Is this complete ? Email
W101220	PC007	TM	**Wills St WWTP - Pressure Cleaners Replacement**	11,426.15	
W101221	PC007	NO	**SCPS - Fabricate Duck Foot Beds Emergency Spares**	37,000.00	
W101222	PC007	BC	**Umberumberka Pipeline Replacement Rising Main (4 lgths)**	19117.43 Bal	Spent $20,082.57 15/16 (May/Jun16)
W101223	PC007	NO	**Mica WTP Clarifier Wear Plates Replacement**	85,724.80	
W101224	PC007	NO	**Wentworth Rd SPS Delivery Lines Replacement**	22908.99 Bal	Spent $1,538.49 Jun16 (est 24447.48)
W101226	PC007	SP	**Sunset Strip WTP - Chlorine Analyser Replacement**	1408 Bal	Spent $5,172 material only Jun 16. Email Frank/Jade 14.7.16
W101227	PC007	JP	**Water Reticulation - Unplanned Mains Replacement Proj 8**		
W101228	PC007	JP	**WR - Water Meter Replacement Program**		
W101229	PC007	JP	**WR - Isolation Valves & Hydrant Replacement Proj 8**		
W101230	PC007	JP	**SR - Replace Sewer Access Chamber Tops (Rings & Lids)**		
W101232	PC007	JP	**WR - Renew 100mm Filtered Water Service BHHS**		

Appendix G – Grit Collector Overhaul Project Check List

Project Health Score Sheet

		Y/N			Doc	W	F	Score
Scope	Question			Doucumentation				
Budget:	Question 1: Has budget estimate been complete +/- 10%?	Yes	**Budget:**	Estimate sheet	Yes	1.6	1.0	1.6
Schedule:	Question 2: Has Master Gantt chart been matched to the CAPEX phasing plan?	Yes	**Schedule:**	Gnatt Chart and Phasing Chart	Yes	2	1.0	2.0
Risk:	Question 3: Has project been ranked using 'Multi Criteria Analysis'?	Yes	**Risk:**	MCA completed at Start	No	1.3	0.7	0.9
Resources:	Question 4: Have 'Roles & Responsibilities" been allocated?	Yes	**Resources:**	only to work group level	No	1.8	0.7	1.3
Scope:	Question 5: Has 'Data Sheet' been reviewed by Technical Manager?	No	**Scope:**	New addition	No	2	0.0	0.0
Quality:	Question 6: Has 'Gateway Review' been completed for this phase?	No	**Quality:**		No	1.3	0.0	0.0
Total								**5.77**
Planning								
Budget:	Question 1: have 3 quotes / tenders been received	Yes	**Budget:**		Yes	1.6	1.0	1.6
Schedule:	Question 2: has aon and Gantt chart been completed for project	Yes	**Schedule:**		Yes	2	1.0	2.0
Risk:	Question 3: have WHSE plans been reviewed	No	**Risk:**		No	1.3	0.0	0.0
Resources:	Question 4: Have 'Project Team' undertaken project start-up meeting?	No	**Resources:**		No	1.8	0.0	0.0
Scope:	Question 5: Has full scope of works been written and reviewed?	No	**Scope:**		No	2	0.0	0.0
Quality:	Question 6: Has 'Gateway Review' been completed for this phase?	Yes	**Quality:**		Yes	1.3	1.0	1.3
Total			**Total**					**4.90**
Construction								
Budget:	Question 1: is project running estimated budget	No	**Budget:**	monthly reports on financials however out of date when got	No	1.6	0.0	0.0
Schedule:	Question 2: Is project running to time frames?	No	**Schedule:**	time sheets showed that project running over time	Yes	2	0.3	0.6
Risk:	Question 3: have onsite audits of WHSE documentation been completed	Yes	**Risk:**	site safety interactions completed	Yes	1.3	1.0	1.3
Resources:	Question 4: Were resources available to 80%	No	**Resources:**	Time Sheets and leave forms	Yes	1.8	0.3	0.5
Scope:	Question 5: did the prject proceed with out variations?	No	**Scope:**	No variation requests were added to the project file	No	2	0.0	0.0
Quality:	Question 6: Has 'Gateway Review' been completed for this phase?	Yes	**Quality:**	Report written investigating why project as so over budget	Yes	1.3	1.0	1.3
Total			**Total**					**3.74**
Review								
Budget:	Question 1: Did budget stay with in acceptable limits	No	**Budget:**		No	1.6	0.0	0.0
Schedule:	Question 2: was project delivered a minimum 2 weeks over schedule	No	**Schedule:**		Yes	2	0.3	0.6
Risk:	Question 3: did any unexpected events delay the project	Yes	**Risk:**		No	1.3	0.7	0.9
Resources:	Question 4: were all hours worked on project accounted for	Yes	**Resources:**		Yes	1.8	1.0	1.8
Scope:	Question 5: has the project met the scope as outline in the data sheet?	Yes	**Scope:**		Yes	2	1.0	2.0
Quality:	Question 6: Has project file been archived for future reference?	No	**Quality:**		No	1.3	0.0	0.0
Total			**Total**					**5.31**

Appendix H – PACl Tank Installation Project Check List

Project Health Score Sheet

		Y/N			Doc	W	F	Score
Scope	Question			Doucumentation				
Budget:	Question 1: Has budget estimate been complete +/- 10%?	Yes	**Budget:**	Estimate sheet	Yes	1.6	1.0	1.6
Schedule:	Question 2: Has Master Gantt chart been matched to the CAPEX phasing plan?	Yes	**Schedule:**	Gnatt Chart and Phasing Chart	Yes	2	1.0	2.0
Risk:	Question 3: Has project been ranked using 'Multi Criteria Analysis'?	No	**Risk:**	this was emergency work caused by drought	No	1.3	0.0	0.0
Resources:	Question 4: Have 'Roles & Responsibilities" been allocated?	Yes	**Resources:**	only to work group level	Yes	1.8	1.0	1.8
Scope:	Question 5: Has 'Data Sheet' been reviewed by Technical Manager?	Yes	**Scope:**	New addition after project complete	No	2	0.7	1.4
Quality:	Question 6: Has 'Gateway Review' been completed for this phase?	No	**Quality:**		No	1.3	0.0	0.0
Total								**6.80**
Planning								
Budget:	Question 1: have 3 quotes / tenders been received	Yes	**Budget:**	In Project Folder	Yes	1.6	1.0	1.6
Schedule:	Question 2: has aon and Gantt chart been completed for project	Yes	**Schedule:**	Yes	Yes	2	1.0	2.0
Risk:	Question 3: have WHSE plans been reviewed	Yes	**Risk:**	Yes - Part of Tender Documents	Yes	1.3	1.0	1.3
Resources:	Question 4: Have 'Project Team' undertaken project start-up meeting?	Yes	**Resources:**		Yes	1.8	1.0	1.8
Scope:	Question 5: Has full scope of works been written and reviewed?	Yes	**Scope:**	Yes - Part of Tender Documents	Yes	2	1.0	2.0
Quality:	Question 6: Has 'Gateway Review' been completed for this phase?	Yes	**Quality:**	Yes - Reviewed before Tender was sent out	Yes	1.3	1.0	1.3
Total			**Total**					**10.00**
Construction								
Budget:	Question 1: is project running to estimated budget	Yes	**Budget:**	monthly reports on financials however out of date when got	Yes	1.6	1.0	1.6
Schedule:	Question 2: Is project running to time frames?	Yes	**Schedule:**	time sheets showed that project running over time	Yes	2	1.0	2.0
Risk:	Question 3: have onsite audits of WHSE documentation been completed	Yes	**Risk:**	site safety interactions completed	Yes	1.3	1.0	1.3
Resources:	Question 4: Were resources available to 80%	Yes	**Resources:**	Time Sheets and leave forms	Yes	1.8	1.0	1.8
Scope:	Question 5: did the prject proceed with out variations?	No	**Scope:**	Eye Wash Shower - security fencing	No	2	0.0	0.0
Quality:	Question 6: Has 'Gateway Review' been completed for this phase?	Yes	**Quality:**	final inspection on contractor handover of site	Yes	1.3	1.0	1.3
Total			**Total**					**8.00**
Review								
Budget:	Question 1: Did budget stay with in acceptable limits	Yes	**Budget:**	yes over by 1%	Yes	1.6	1.0	1.6
Schedule:	Question 2: was project delivered a minimum 2 weeks over schedule	Yes	**Schedule:**	on time	Yes	2	1.0	2.0
Risk:	Question 3: did any unexpected events delay the project	No	**Risk:**	Yes - Needed eyewash station installed	No	1.3	0.0	0.0
Resources:	Question 4: were all hours worked on project accounted for	Yes	**Resources:**		No	1.8	0.7	1.3
Scope:	Question 5: has the project met the scope as outline in the data sheet?	Yes	**Scope:**		No	2	0.7	1.4
Quality:	Question 6: Has project file been archived for future reference?	Yes	**Quality:**		No	1.3	0.7	0.9
Total			**Total**					**7.17**

Appendix I – Speedometer Control Formulas

Project Health			
Speedometer		Pointer 2	=E30
Start	0	Start	0
initial	15	initial	=Weights!I35
middle	45	middle	2
end	40	end	=(100-E31-E30)
max	100	max	100
=D34	=IF(E34<9.8,E34,10)	=IF(E28=0,"---",IF(E28<=14,"Low",IF(E28<=60,"Medium","High")))	=E30/10