Deloitte.

Major water capital projects
Critical factors for improving outcomes

March 2010
Deloitte Energy & Resources

Michael Rath, Robert Spittle, Paul Osman and Nicholas Tawa

Content

Introduction

The large-scale projects required in the water services sector over the next five to ten years will cost billions

They will involve complex technical, environmental and financial issues, complex decision-making and approval processes, large numbers of vendors, and have high stakes in terms of performance, liability and safety.

Due to their widespread impacts, these projects will come under intense scrutiny from community, regional and industry stakeholders, and the reputations and careers of the leaders and decision-makers involved will be at risk.

These projects, like major capital infrastructure projects in other sectors of the economy, will involve risk and challenges at every stage in the project lifecycle: from strategy and planning to conceptual design, approval, contract award, detailed design, financing, construction and operation.

Broad historical data puts the average cost overrun of original budget in projects in excess of $1 billion at 34%. With substantial investment in water projects already underway across the nation, early indications are that considerable cost overruns are already being experienced – even though many projects are not yet at construction phase.

This paper examines the key factors underlying cost overruns in major capital projects. It draws upon the experience of Deloitte's global as well as Australian practices to highlight some of the lessons learned in previous cases of capital projects and focuses on three key areas where best practice methodology has been shown to improve project outcomes.

It will also identify where opportunities exist to implement best practice project management, and governance and delivery methodologies in order to realise potential – and not insignificant – project savings.

Two case studies will provide some specific learning in the context of the Australian water services sector.

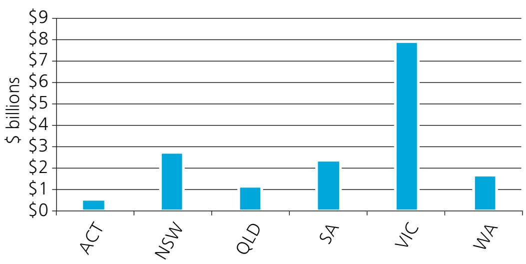
Current status of water infrastructure projects across Australia

The scale of the investment project

State governments and water authorities will invest approximately $30 billion between 2006 and 2013 to complete a portfolio of major water infrastructure projects driven by the urgent need to secure the water supplies of the nation. These projects are outside of the ongoing normal capital works for these water authorities.

Sixteen billion dollars worth of projects are currently in the design through to commissioning phase[2]. The largest of these projects are the $3.5 billion Wonthaggi desalination plant and $2 billion Foodbowl modernisation projects in Victoria, and the $1.8 billion desalination plant in South Australia[3].

Figure 1: Investment value by state
Source: WSAA Report Card 2009, Various, 2009

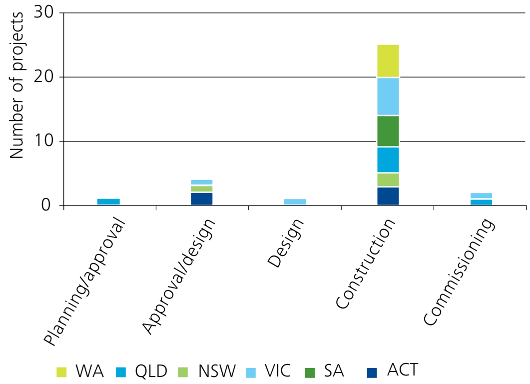


The huge level of investment and social importance of these developments means that effective project management and governance are critical.

Stage of project phase

As of November 2009, the majority of water projects under way are still in the construction phase with few in the final stages of being commissioned. This has resulted in on-going competition for skilled resources between projects.

Figure 2: Point in project lifecycle by state
Source: Various, 2009



The construction phase is where the great majority of cost in water infrastructure projects is incurred. Indeed a 2008 Melbourne Water study of a number of water infrastructure projects suggests that the construction phase represents approximately 85% of the total project cost[4].

Given that construction is the point of greatest expenditure and risk, if this phase is started poorly, there is a high likelihood of ongoing project overruns.

Recent cost evaluations of water infrastructure projects in Australia suggest that they are already experiencing considerable cost overruns.

The following sections describe the current level of cost overruns in infrastructure projects, their current progress and the expected end state that will be achieved without intervention.

1 WSAA Report Card, 2008 – 09: Performance of the Australian Water Industry Progress for the xxxx

2 Ibid

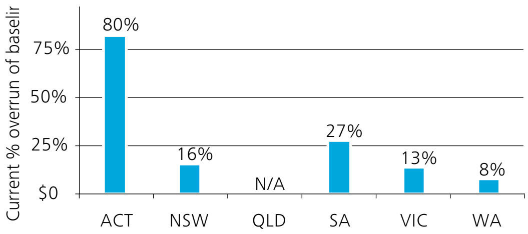
3 Ibid

4 Melbourne Water Capital Expenditure: 2008 Waterways Water Plan

Current and projected cost overruns

The current water project cost overruns, as a percentage of the original project budget, are displayed in Figure 3[5]. They vary across jurisdictions from a high of 80% to a low of 8% but, even at the lower end, given the value of the projects involved, this represents many hundreds of millions of dollars.

Figure 3: Total current cost overrun by state
Source: WSAA Report Card 2004, Various, 2009



Given the majority of water infrastructure projects in Australia are still under construction with the commissioning phase yet to be initiated (Figure 2), it is reasonable to expect further cost overruns. Similarly, cost overruns could also be expected for the projects in the $30 billion portfolio that are not yet under construction.

A more accurate estimate of the likely total overruns on all current projects, and the implications for the total value of investment in securing Australia's water security, can be obtained using a combination of global data.

Empirical evidence from a sample of 258 infrastructure projects (across different project types, geographical regions and historical periods) suggests an average cost overrun of 28% across the typical project lifecycle[6]. This equates to an average cost overrun of approximately 23.8% attributable to the construction phase.

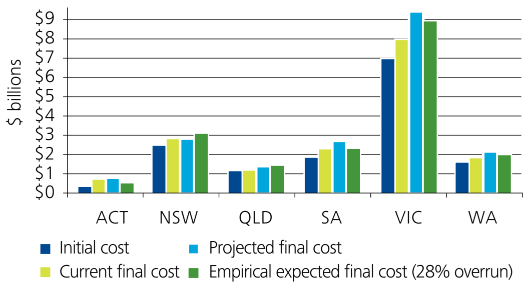
Based on this average cost overrun of 28%, the expected final cost of the water projects within each state was calculated. It is concerning to note that the current final cost estimations for each of the projects are already close to, and in some cases exceeding, the expected final cost.

A linear projected final cost of the water projects underway was also calculated using a cost overrun formula, based on:

- the nominal overrun factor
- the duration remaining in each of the 35 projects currently underway in Australia
- the current forecast final cost[7].

When calculated for all 35 projects and compared to the original cost for each of these projects, this calculation results in an overall projected cost overrun of 37.4% from the original project budgets (total of $14.1 billion) or an additional $5 billion across the nation. This data is displayed by state in Figure 4.

Figure 4: Projected final cost overruns
Source: Various 2009



The projected overspend estimate of $5 billion can be influenced if appropriate measures are taken. The measures that have the greatest potential to influence this overspend are discussed in the remainder of this paper.

[5] Detailed cost overrun data was not available for infrastructure projects in QLD. Cost overruns for all other states were calculated based on publicly available original project costs and current forecast total costs, as of November 2009. See Appendix 1

[6] Bent Flyvbjerg, Holm, Buhl, Understanding costs in public works projects xxx xxx

[7] See Appendix 2

Factors influencing cost overruns

Based on our experience in the Australian water industry, the current cost overruns are the result of several key factors

Fluctuating market pressures:

- significant increases in metals and other raw material costs
- escalation in plant and equipment costs due to the buoyant Australian construction market
- labour shortages and supply cost increase.

Inadequate ongoing governance and risk management:

- a lack of appropriate governance and decision making
- inadequate risk management, including poor transparency of information and remediation activities.

The following section will deal with each of these three key factors in more detail.

Cost estimations

The original project budget is a critical reference point to objectively assess the performance of a project. Original project budgets are inherently associated with uncertainty, as they represent an estimate of what the realised future will be. They are affected by the level of detail in the design, risks foreseen in the project, processes and controls, contracting strategies and the constraints placed on the project sponsor to gain approval for the project through regulatory bodies.

Of the projects currently over budget, a primary factor in the cost overrun is that at the point of initial costing, the design was incomplete. This was sometimes attributed to the conceptual design being costed and then being publicised as the original cost. In these cases the design was further developed and additional costs were added to accommodate the conceptual design that was not appropriately covered in the initial budget.

Inadequate contingency within cost estimates is a consistent cause of cost overruns in the water industry. Inadequate contingency is directly linked to inadequate assessment of project risk. This can be attributed to the impact and probability of risk occurring being underestimated, or risks eventuating during the project that had not been identified at the point of the design cost forecast.

Failing to carry out a proper risk identification process early in the conceptual design stage jeopardises project success in a number of ways, including budget, timelines and functionality.

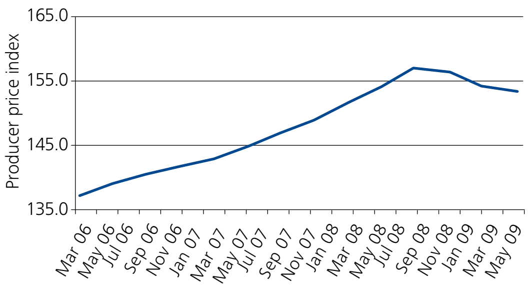
Failing to ask the right questions during the design phase may result in a flawed initial design, often leading to significant changes to be made at a higher cost than initially planned. Assumptions made in the initial design create additional risk, which needs to be adequately costed into contingency values.

Fluctuating market pressures

Infrastructure projects are highly dependent on the cost of labour, raw materials and equipment. Increases in the price of these key inputs is another primary reason for cost overruns in water infrastructure projects in Australia. Upward pressure on prices comes when supply shortages occur for these inputs in Australian and overseas construction markets. For example, in the past three years there have been significant increases in metals markets impacting raw material costs as highlighted in Figure 5.

Figure 5: Price of Australian construction materials (RBA, 2009)

Price of Australian construction materials
Source: Reserve Bank of Australia, 2009

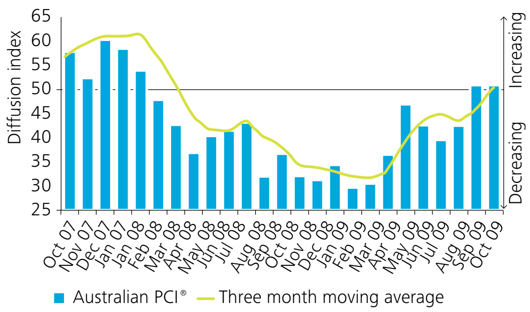


The impact of rising construction costs can lead to errors in the forecasts created by project finance teams. Effective modelling or forecasting is required to cater for the effect of movements in commodity prices.

With the high level of infrastructure projects currently under construction across the nation, water authorities and project sponsors have also been competing for a finite pool of specialist resources.

Figure 6 shows a steady rise in Australian construction market activity from January 2009.

Figure 6: Performance of Construction Index (PCI)
Source: Australian Industry Group, 2009



The increased demand for skilled talent has increased wage costs for construction personnel, and many projects have been forced to operate without the specialist construction resources required to complete key project processes such as design, cost forecasting and construction management.

An additional impact of the high level of activity in the construction market is an escalation in plant and equipment costs.

Inadequate ongoing governance and risk management

Capital projects require effective governance to provide the necessary level of supervision, guidance and monitoring of project costs, activities and progress. Effective project governance provides the structure for decision making, establishing control and managing the overall delivery of the project. Poor project governance and risk management is another major factor influencing cost overruns in Australian water projects.

Examples of poor governance include:

- a lack of accountability for project outcomes
- decision making at inappropriate levels or with inappropriate knowledge
- a poor link between program and business objectives
- poor stakeholder management
- poor management of project budgets across time.

Proactively identifying and assessing areas of risk to project performance is also a key to effective capital project delivery. Inadequate risk management leads to poor transparency of information and limited ability to remediate cost overruns.

Examples of poor risk management and information availability include:

- overly detailed project reports and losing sight of key messages
- failure to identify key performance indicators of project status
- failure to disclose downside risk leading to under-forecasting of potential cost exposures
- failure to monitor use of contingency budget
- failure to update the initial risk register.

In summary these revolve around three areas:

Cost estimations:

- an incomplete initial design or further development of the design prior to secondary costing
- inadequate contingencies to accommodate the level of project design maturity at tender.

Effectively driving better project outcomes

Each of the three key factors identified raise challenges for the project sponsors, water authorities, construction organisations and State governments

The remainder of this paper is focussed on addressing the challenges of cost estimations, fluctuating market pressures and inadequate governance and risk management to help drive better project outcomes.

Capital project design risk assessment

The first question required to be addressed is, how should the project sponsor eliminate uncertainty around incomplete initial design cost estimates?

All project designs have an assigned level of risk which is realised during the lifecycle of the project. The key to eliminating uncertainty in design cost estimates is to understand these risks.

The risks embedded in the design need to be assessed and appropriate contingencies put in place to cover them.

The objectives of project design-risk cost estimations then are twofold:

- to identify the underlying sources of uncertainty in the project's design that may contribute to budget overspend
- to quantify the impact of these on the budget.

Understanding the maturity of the design at the point of costing is critical. This provides the project sponsor with a greater ability to answer the following questions confidently:

- how likely is it that the current budget will be met?
- which of the budget items/groupings has the greatest ability to impact the overall budget in terms of savings and additional costs?

Introducing an effective design risk assessment and quantification stage into the project design review and budget preparation allows for a focussed and prioritised effort to manage ongoing costs. This can be targeted at the sources that are likely to have the greatest budget impact, either in terms of providing the greatest opportunity for savings or for avoiding budget overspend.

Typical influences on design risk include:

- the level of assumptions – how aggressive are the settings for costs of labour, currency etc?
- the time of assessment of the project and the design/construct approach being used – is the design being run in parallel with construction?
- the time available to document the design – has the project design been fast tracked?
- the estimating method used – how is the design costed? i.e. is it based on empirical estimations (eg. cost/m^2) or actual unit costs (eg. bill of materials)
- the level of detail required to gain sign-off of the current phase – how much detail is required in approval documents to meet regulatory, contractual and engineering standards?

A case study

Design risk assessment

Deloitte performed an independent design risk assessment for a capital project within the water industry in Australia.

The project had undergone an extensive design and estimation phase with cost estimations increasing as the design matured.

The assessment reviewed the estimation techniques, the items estimated and the project's risk contingency.

The review found that the increases to project design cost estimations were a result of:

- escalation and changes to scope – increases in the rates and quantities used, as well as changes to scope
- items not estimated – missing direct cost items as well as indirect costs and margins.

Whilst some degree of scope growth would be expected, insufficient contingency existed within early estimates to absorb this.

The review also documented risks that could potentially lead to future cost estimation increases, including details of changes in scope or requirements, escalation of project cost elements, and changes in the design and construction methods.

The following recommendations were documented in relation to cost management in the remaining phases of the project:

- introduction of clear agreement on the basis of cost estimations, and consistency in all future communications
- establishment of the correct incentives and metrics to be monitored during the construction phase
- close monitoring to ensure actual costs are tracked against expected cost, in order to help achieve the final project cost and limit any potential variances.

Capital project investment optimisation

The second question requiring consideration in order to drive better project outcomes is, what is the best way to manage the cost of these projects whilst containing fluctuating market pressures?

Capital project investment optimisation is an effective method by which to manage the cost of capital infrastructure projects whilst reacting to, and containing, fluctuating market pressures. This methodology is based on understanding the effect of market fluctuations on the project's business case, and applying the effect of these to project value drivers (eg. the cost of construction labour).

Building a capital investment optimisation model begins with answering the following key questions:

- is this a stand alone initiative or part of a larger portfolio?
- how much benefit will the initiative deliver and how important is it compared with others in the portfolio?
- what are the project cost drivers and value drivers?
- what are the critical resource requirements for the project and where are potential demand conflicts with other projects?
- in the context of all other capital projects, when is the best time to deliver this project?

This model should be maintained and updated over the course of the project to ensure that project cost forecasts remain accurate.

A capital project investment optimisation model is that it enables the project sponsors to manage the project more effectively through:

- measuring project interdependencies across a portfolio of projects
- forecasting project costs and schedules in a risky world
- quantifying the impact of risks at project and portfolio level
- providing a consistent evaluation across project types and sizes (e.g. revenue vs. cost-cutting; large vs. small)
- accounting for multi-year funding constraints
- projecting the impact of schedule delays on project cost forecasts.

A capital project investment optimisation model is a key plank supporting project governance structures.

Capital project assessments

The final key question to be considered in seeking to drive better project outcomes is, how should the project sponsor ensure that its governance and risk management processes are adequate?

In any organisation senior management needs the confidence of key stakeholders. It can go a long way to attaining this by meeting agreed objectives and benefits whilst delivering to time, cost and quality.

To achieve this, management requires sufficient oversight, understanding and visibility over the projects to enable them to make critical decisions based on accurate information and status.

Capital project assessments evaluate the 'health' of a project by undertaking independent assessments. They are focussed on identifying the major risks to project delivery. Improved visibility and understanding achieved from project assessments reduces risk of failure and increases likelihood of success.Six key components within the governance, stakeholder and management framework pose the greatest risk to capital project success.

Each of these components needs to be established, activated and maintained effectively through the project lifecycle in order to deliver positive project outcomes. They should be subject to project assessments to protect the stakeholder community.

The six componants are:

- achieving optimisation of the capital investment portfolio
- developing a robust and realistic business case
- establishing the right governance, structure and delivery models
- ensuring effective and reliable information management
- embedding effective supply chain operations
- managing the transition from construction and commissioning to operations.

A case study

Capital project assessments

Deloitte was engaged to undertake an assessment of the health of a multi million dollar capital project within the water industry in Australia. The assessment was undertaken during the project's construction phase. Cost overruns had been experienced continuously from the project's outset.

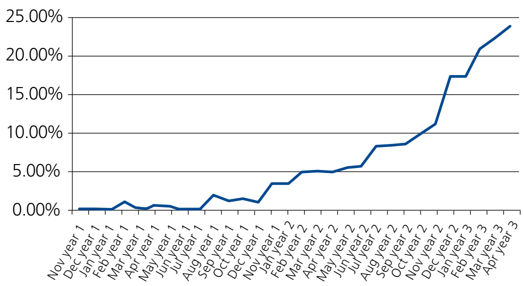
A multi-faceted hypothesis-based approach was undertaken in the review, covering components of the project's establishment, governance and delivery. The review found that:

- more effective governance was required for a project of this complexity, including more timely decision making and improved reporting
- more effective project planning and project management processes were required: including more effective cost forecasting, recruitment of key personnel, and project phase integration. There were also examples of non-essential project scope being added during the project's construction phase.

As a result of the assessment, Deloitte introduced an improved risk reporting and management process to the project sponsor's organisation. This framework defined the structures, roles, decision-making triggers and controls related to the project's risks.

The benefits of this approach included a greater assurance of the robustness of the project's delivery and governance frameworks as well as improved information management.

Figure 7: Increase in cost from baseline
Source: Deloitte



Conclusion

There are a several critical large scale water infrastructure projects currently under construction across Australia. Without appropriate action, there is a high probability that cost overruns – in the order of hundreds of millions of dollars – will continue to be a headline factor in these projects

Attention must be focussed on three key areas identified as the predominant sources of cost overruns:

- cost estimations – which cater insufficiently for underlying uncertainty in initial designs
- fluctuating market pressures – which were not predicted and their effect not mitigated
- inadequate ongoing governance and risk management.

There is a significant opportunity to mitigate these risks and protect against budget overspend by applying best practice in the following key areas:

- design risk assessment
- investment optimisation
- project assessment.

Best practice in all three needs to be applied to projects currently under way, as well as being built into all future water capital projects.

There is potentially an even bigger opportunity to achieve savings, albeit dependent on government collaboration. With numerous projects across Australia requiring the same resources during similar periods across Australia, competition for resources and personnel is unnecessarily escalating the total portfolio cost of water and other infrastructure projects.

One way to address this and to prioritise the most vital projects irrespective of political pressures would be to develop a portfolio management model through the State governments of Australia.

A high level portfolio management approach to these projects could be scheduled taking into account interdependencies and conflicts. Project approvals and project start dates would then be altered to optimise the total portfolio cost for each government.

While this may be some way off, the principles of this approach could be applied to benefit all participants in the water industry and effectively minimise the impact of continued blow outs in the cost of major capital projects in the sector.

Appendix 1: Original project cost and current forecast total costs

The following references by state, publically available information from which original water project costs and current forecase costs has been sources:

www.melbournewater.com.au/content/current_projects/sewerage/eastern_treatment_plant_-_planned_upgrade/Eastern_Treatment_Plant_-_planned_upgrade.asp

www.legislation.vic.gov.au/domino/Web_Notes/newmedia.nsf/b0222c68d27626e2ca256c8c001a3d2d/3089578ca7cd3832ca2574240003dd40!OpenDocument

www.ourwater.com.au/__data/assets/pdf_file/0020/479/FoodBowlInfoPaperFINAL20070625.pdf

www.dtf.vic.gov.au/domino/Web_Notes/newmedia.nsf/955cbeae7df9460dca256c8c00152d2b/080d451efd751fa9ca25720f0081f6a8!OpenDocument

www.mailtimes.com.au/news/local/news/general/wimmeramallee-pipeline-work-to-resume/1639422.aspx

www.northsouthpipeline.com/content/news_and_information/media_releases.asp#0908

www.sugarloafpipeline.com.au/content/faqs/FAQs.asp?FAQTypeID=4

www.wannonwater.com.au/index.php?option=com_content&task=view&id=291&Itemid=319

www.dse.vic.gov.au/DSE/dsencor.nsf/LinkView/2C942C91BC4A090BCA25764E007EAAD89B8E64CAE7EA2CEACA256DAC002901AF

www.melbournewater.com.au/content/current_projects/sewerage/melbourne_main_sewer_replacement/melbourne_main_sewer_replacement.asp?bhcp=1

trenchless-australasia.com/news/lucy_loo_tunnels_under_melbourne/007855/

www.maritime.nsw.gov.au/marine_notices/kurnell.html

www.sydneywater.com.au/MajorProjects/WesternSydney/ReplacementFlowsProject/index.cfm

pipeliner.com.au/news/replacement_flows_project_to_help_secure_sydneys_water_future/001601/

www.toowoombapipeline.com.au/index.php?id=128

www.toowoombarc.qld.gov.au/index.php?option=com_content&view=article&id=1929&Itemid=21

www.sawater.com.au/NR/rdonlyres/A5AFA0C1-5070-4140-9D6A-A0E6EA365E94/0/WorkBeginsPilotPlant.pdf

www.sawater.com.au/NR/rdonlyres/E47D55A8-91F9-4029-A9A6-79A3EC21BE62/0/MedRelDesalMay09.pdf

www.sawater.com.au/NR/rdonlyres/B107F2A0-F272-4D06-90DC-5A240A1B8E1A/0/ChristiesNewsletterNovember2008.pdf

www.gapreuse.com.au/

www.parliament.sa.gov.au/NR/rdonlyres/E0CB8578-5505-4473-A982-7C52EE0790ED/13488/AgencysubmissionSouthernUrbanReuseProject.pdf

www.waterworld.com/index/display/article-display/6003450323/articles/waterworld/world-regions/australia-oceania/2009/11/dow-water___process.html

www.news.com.au/perthnow/story/0,21598,25683843-5017962,00.html

www.w2wa.com.au/About+W2W/Beenyup/News2Date+Archive+-+Beenyup/Downloads_GetFile.aspx?id=572

www.w2wa.com.au/N2Date_Been_10.pdf

www.watercorporation.com.au/_files/Alkimos/Alkimos_WWTP.pdf

www.actew.com.au/WaterSecurity/MajorProjects/enlarging_cotter_dam.aspx

www.actew.com.au/WaterSecurity/MajorProjects/filling_the_cotter.aspx

www.actew.com.au/watersecurity/majorprojects/GoogongDamSpillwayUpgrade.aspx

www.actew.com.au/publications/newsletter/Current_Aug09_Issue_7.pdf

www.abergeldie.com/easyweb3/WEBID-171953-ep_code-prdMoreInfo-prd_id-202921

Cost references:

www.melbournewater.com.au/content/library/current_projects/water_supply/seawater_desalination_plant/desalination_plant_feasibility_study_executive_summary.pdf

www.cleanocean.org/fifthestate/archives/010/1/melb%20water%20etp%20WorksApproval%20summary.pdf

www.cleanocean.org/fifthestate/archives/010/1/melb%20water%20etp%20WorksApproval%20summary.pdf

www.ourwater.vic.gov.au/programs/irrigation-renewal/nvirp 5. www.heraldsun.com.au/news/victoria/pipe-cost-blow-out/story-e6frf7kx-1111116467248

news.smh.com.au/national/extra-money-for-victorian-pipeline-20071101-1797.html

www.sugarloafpipeline.com.au/

www.ourwater.vic.gov.au/__data/assets/pdf_file/0012/705/FinalFactSheetGeelongMelbournePipeline.pdf

www.geelongadvertiser.com.au/article/2009/02/06/49021_news.html

www.wannonwater.com.au/index.php?option=com_content&task=view&id=293&Itemid=321

http://www.wannonwater.com.au/index.php?option=com_content&task=view&id=293&Itemid=321

melbournemain.melbournewater.com.au/

www.smh.com.au/news/water/in-the-pipeline-a-2b-desalination-bill/2007/11/11/1194766506938.html

www.smh.com.au/news/national/pipeline-price-inflates-cost-of-kurnell-plant/2007/12/19/1197740380961.html

www.planning.nsw.gov.au/asp/pdf/06_0190_wsyd_recycledwater_dg_assreport.pdf

www.sydneywater.com.au/MajorProjects/pdf/ReplacementFlowsProjectOverview.pdf

www.abc.net.au/news/stories/2009/03/20/2521606.htm

more.nsw.gov.au/projects?tid%5B8%5D=8&op=Filter+Results

www.johnholland.com.au/Project.asp?Action=Project&PID=54

more.nsw.gov.au/projects/north-head-sewage-treatment-plant-performance-and

www.sawater.com.au/NR/rdonlyres/1F776A47-BB68-47F6-84AE-697639F3FC75/0/ADP_preferred_bidder.pdf

www.parliament.sa.gov.au/NR/rdonlyres/799BC5B1-2EC1-4A66-A872-8754087F0AA9/11826/ReportChristiesBeachWWTPupgrade.pdf

www.ministers.sa.gov.au/news.php?id=2042

www.parliament.sa.gov.au/NR/rdonlyres/953CF473-BA84-431D-B941-7916E8362CA9/11506/ReportGlenelgtoAdelaideRecycledWater.pdf

www.onkaparingacity.com/wps/index.htm

www.watercorporation.com.au/m/media_detail.cfm?id=3551

WSAA Report Card 08/09

www.mediastatements.wa.gov.au/ArchivedStatements/Pages/CarpenterLaborGovernmentSearch.aspx?ItemId=130136&minister=Ripper&admin=Carpenter

www.mediastatements.wa.gov.au/ArchivedStatements/Pages/CarpenterLaborGovernmentSearch.aspx?ItemId=128495&minister=Ripper&admin=Carpenter&page=

www.abc.net.au/news/stories/2009/10/28/2726176.htm

www.thinkwater.act.gov.au/more_information/documents/FactSheet6_Murrumbidgee-GoogongTransfer.pdf

www.padpartners.com.au/siteadmin/userfiles/file/BWA%20Water%20Security.pdf

www.chifleyrecruit.com.au/actewagl/projects.asp

Appendix 2: Cost overrun formula

The following formula was used to generate a linear projected cost overrun for each water infrastructure project across Australia based on empirical statistics regarding cost overruns:

$$pfc = cfc \times (1 + (1 - pc) * of)$$

Where:
pfc = projected final cost
cfc = current final cost, as of 9 November 2009
pc = percentage complete of the project, as of 9 November 2009
of = overrun factor, sourced from empirical evidence (0.28 * .85 = 0.238 or 23.8%)

References

Australian Industry Group, Performance of Construction Index Report, October 2009, Australia

Baccarini, D. Estimating Project Cost Contingency – A Review and Preliminary Analysis, 2007, Department of Construction Management, Curtin University of Technology, WA, Australia

Flyvbjerg, B. Holm, MS. Buhl, S. Underestimating Costs in Public Works Projects Error or Lie?, 2002, Journal of the American Planning Association, 68(3), USA

Melbourne Water, Capital Expenditure: 2008 Waterways Water Plan, 2008, VIC, Australia

Merrow E W and Schroeder, Understanding the cost and schedule of hydroelectric projects, 1991, AACE Transactions, I.3.1–7

Construction Materials – Price Indicators – Producer Price Indicators, 2009, Reserve Bank of Australia, Australia

WSAA, WSAA Report Card 2008–2009 – Performance of the Australian Urban Water Industry and projections for the future, 2009, Water Services Association of Australia, VIC, AustraliaSchedule references:

Please contact your local Deloitte water industry group representative to discuss your water needs.

Michael Rath
Lead Water Partner, Australia
Tel: +61 (0) 3 9671 6465
mrath@deloitte.com.au

Peter Ryan
Partner, New South Wales
Tel: +61 (0) 2 9322 5693
pryan@deloitte.com.au

Richard Thomas
Partner, Western Australia
Tel: +61 (0) 8 9365 7024
richathomas@deloitte.com.au

Simon Lester
Partner, Tasmania
Tel: +61 (0) 3 6237 7066
silester@deloitte.com.au

Matt Thomson
Partner, Queensland
Tel: +61 (0) 7 3308 7153
matthomson@deloitte.com.au

David Black
Partner, ACT
Tel: +61 (0) 2 6263 7035
dablack@deloitte.com.au

Adrian O'Dea
Partner, South Australia
Tel: +61 (0) 8 8407 7143
aodea@deloitte.com.au

Francis Thomas
Partner, Northern Territory
Tel: +61 (0) 8 8980 3040
fthomas@deloitte.com.au

www.deloitte.com.au

Designed and produced by Aqua Media, AM_Mel_03/10_040677