THE MAROOCHYDORE STP UPGRADE – CAN INNOVATIVE PROJECT DELIVERY METHODS CONTRIBUTE TO SUSTAINABILITY

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Abstract

In late 2000, Maroochy Water Services entered into a Project Alliance with ExcelWater, a joint venture between JWP, consulting engineers, Aquatec Maxcon, equipment contractor and P Ward Civil Engineering, civil contractor, for the upgrade of the 21 ML/d BNR Maroochydore STP.

The project objective was to upgrade part of the existing plant to a total plant capacity of approximately 25 ML/d, with equal or better nutrient reduction in a cost-effective manner until a long term plant strategy is finalised.

The unique feature of the Maroochydore STP Project Alliance was its small size. This imposed a number of limitations on how the Alliance was managed to minimise costs whilst still maintaining an effective Alliance 'culture' and the contact between team members that is critical to innovative solutions and successful outcomes.

The project also had a very tight timeframe with the commissioning of the upgrade to be completed by 30 June 2001. As the plant was loaded at or near capacity and had to continue to treat wastewater, risk management practices were implemented in conjunction with operators at the plant to ensure that licence breaches did not occur.

The paper reports on the degree of success of the strategies employed for this Project Alliance and how they might be applied to other water and wastewater infrastructure to achieve better sustainability outcomes, and whether Project Alliances are really viable for small projects, and if so what variations on the Alliance model might evolve in the future.

Key Words: Project Alliance, Wastewater Treatment, Brownfield Upgrade, Nutrient Reduction, Innovation, De-bottlenecking

Introduction

In late 2000, Maroochy Water Services entered into a Project Alliance with ExcelWater, a joint venture between JWP, consulting engineers, Aquatec Maxcon, equipment contractor and P Ward Civil Engineering, civil contractor, for the upgrade of the 21 ML/d BNR Maroochydore STP.

The project objective was to upgrade two of the three modules of the existing plant to a total plant capacity of approximately 25 ML/d, with equal or better nutrient reduction in a

cost-effective manner thereby minimising capital expenditure until a long term plant strategy is finalised.

The target and bonus nutrient levels are shown in the table:

Nutrient	Nitrogen	Phosphorus
Target	7 mg/L	4 mg/L
Very good Level 1	6 mg/L	3 mg/L
Outstanding Level 2	5 mg/L	2 mg/L

The project had a very tight timeframe with the commissioning of the upgrade to be completed by 30 June 2001.

Alliance Structure

The alliance consists of 4 parties, Aquatec Maxcon, JWP, Maroochy Water Services and P Ward Civil Engineering. The work split was done on a "best-for-project" basis, with nominal areas being:

- Aquatec Maxcon – Mechanical equipment design, procurement, installation and commissioning,
- JWP – Project management, process, civil, hydraulic, and electrical design, process control, and plant optimisation
- Maroochy Water Services – operations and maintenance
- P Ward Civil Engineering – Civil construction, and construction site management

The non-owner participants were subject to a risk:reward model consisting of a cost KPI and three non-cost KPI's relating to plant performance during and after implementation:

- 50%ile total nitrogen
- 50%ile total phosphorous
- Licence breaches during construction

The risk:reward payments for non-cost KPI's associated with effluent quality were slanted heavily in favour of the total nitrogen parameter as this is a more critical nutrient.

Ken Hartley Pty Ltd is also a sub-alliance member under JWP but subject to a lesser risk-reward exposure. It was considered important for all key participants to have a financial incentive to strive for outstanding outcomes.

Cost to Set-up Alliance

The decision to proceed for an alliance design and construct (DC) contract for this project was the outcome of a number of workshop sessions facilitated by project management consultant, IDSM to evaluate various project delivery methods.

These workshops involved input from senior management of Maroochy Shire Council and Maroochy Water Services, a commercialised business unit of Council, as well as design and operational staff.

The second phase of the process involved preparation of Expression of Interest (EoI) documentation, followed by evaluation of the EoI's received. A workshop format, again facilitated by IDSM, was adopted for evaluation the EoI's.

The third phase consisted of inviting tenders from short-listed consortia, workshops with each consortium and a final evaluation workshop for Maroochy Water Services key staff members. This phase was also coordinated and facilitated by IDSM.

The final phase involved preparation of the actual contract and agreement on the Target Cost estimate (TCe) and performance targets. This required input from IDSM and lawyers in drafting the contract document.

This whole process commenced in October 1999 and was completed by the end of 2000 and obviously required significant input from Maroochy Water Services staff as well as the management and facilitation role provided by

IDSM and associates. Towards the end of the process, a full time project officer was employed by Maroochy Water Services to manage the project.

The costs incurred by Council in setting-up the alliance therefore consisted of:

- Maroochy Shire Council and Maroochy Water Services staff costs;
- The Management consultants' fees;
- Legal costs; and
- The Maroochy Water Services project officer's costs.

Staff costs were not separated out and specifically allocated to the project, and are therefore difficult to determine. The other costs listed above totalled approximately $100,000.

Bidding Costs

As the project outcome was largely driven by process design solutions, the bidding phase focussed on technical solutions and marginal cost implications. This led to a large amount of work being required during the bid on the "solution".

The result was that the bid costs were very high for an alliance, especially given the project size. The bid costs for all non-owner participants were in excess of $100,000 or around 10% of the project value.

If one assumes the three short-listed consortia all expended similar amounts, the cost to the industry as a whole was excessive and clearly not sustainable. Alternative bidding models to reduce these costs on future projects should be encouraged.

Target Cost Process

Following negotiations between alliance participants at the start of the project, it was agreed that alliance cost risk:reward outcomes on the project would be based on the capital cost (CAPEX) of the upgrade works. For this purpose, direct project costs only were considered. Corporate overheads and profit were dealt with separately as a lump sum Fee calculated as a percentage of estimated direct costs at the time of agreeing to the TCe.

Consideration was given to using Net Present Value (NPV) of CAPEX and an estimate of future operating costs (OPEX), however this approach was abandoned due to difficulties in reliably and accurately measuring and/or predicting future OPEX relating specifically to the alliance works. Instead, a measure of future OPEX (electricity consumption) was included as a non-cost KPI.

The alliance team developed a detailed work breakdown structure (WBS) for the project as the design progressed for the purpose of developing the TCe and for use in routine cost control and reporting.

The scope of work was agreed following a detailed assessment of options and a series of value/risk management and option evaluation workshops conducted in-house by the alliance team.

Each participant then developed components of the first draft TCe for the scope of work it was principally responsible for (eg. project management, alliance management, design, civil construction, mechanical & electrical supply and installation, etc). These estimates were based on direct project costs only (ie. no corporate overheads or profit components).

Where possible, firm quotes were obtained for major procurement items (eg. pumps, sub-contracts, etc). However, much of the TCe was based on estimates of cost due to the lack of detailed information available at the time.

Contingencies ranging from 0% to 15% were applied to base estimates of direct cost to reflect the risk profile of each major activity and the level of certainty surrounding the definition of the scope at the time the TCe was developed.

MWS's Project Officer represented their interests on the project then undertook a

detailed review of each component of the TCe. In general, the outcome of this process was reasonably close alignment on the estimated cost of the physical works (and the contingency percentages that had been adopted); however the estimated project and alliance management costs were disputed as being too high.

The more typical alliance approach of forming a dedicated estimating team and using an independent "industry expert" to validate the TCe was not justifiable on a project of this size.

At this time, it became apparent that the TCe for the agreed scope of work (as established through earlier value management and option evaluation workshops) was around 25% higher than the MWS budget. It was obvious that not even reducing all contingency percentages to zero would enable the work to be completed for the available budget.

The Alliance Project Control Group (APCG) was advised of this and requested the team to review the scope of work and TCe to bring it TCe within the available budget.

Over a period of approximately 2-3 weeks, a number of actions were taken by the alliance team to reduce the TCe. These included:

- Significantly reducing original estimates of project and alliance management costs (offered by the non-MWS participants in the interests of the project proceeding)

- Closely re-examining the scope of work that was essential to the proposed upgrade. A key constraint on this exercise was to avoid compromising the future ability to easily upgrade the plant to the next step in the identified upgrade path. The result of this exercise was deletion of a blower and a small reduction in the quantity of diffusers to be installed. A number of other smaller savings were also identified.

- Reducing some of the contingency percentages (also offered by the non-MWS participants in the interests of the project proceeding)

Following this process, a new TCe was produced that was within 5% of the MWS budget. The revised scope of work and TCe were submitted to the APCG and approved.

At this time, the Fee percentages for each non-MWS participant were converted to lump sum Fee amounts based on the agreed TCe values.

The original TCe remained unchanged for the majority of the project and virtually all project risks were captured within the quantum of the agreed TCe.

Towards the end of the project, MWS directed three scope changes that resulted in additional work unrelated to the original scope. Also, the non-MWS participants agreed to delete the value of one PLC from the TCe that proved to be unnecessary.

Results of Project - Non-cost Performance Outcomes and Cost

Performance of the alliance against the four KPI's is shown below:

- Project cost approximately $140,000 or 11.7% below TC. Savings are shared equally between MWS and non-owner participants. Following difficulties in developing a risk:reward model based on NPV, it was agreed to base cost performance on capital cost alone.

- 50%ile total nitrogen concentration of 4.6 mg/L achieved exceeding 7 mg/L base target and Level 1 and 2 targets of 6 and 5 mg/L respectively

- 50%ile total phosphorus concentration of 3.3 mg/L achieved exceeding 4 mg/L base target but not Level 1 and 2 targets of 3 and 2 mg/L respectively

- No environmental breaches during project implementation

The timing of risk:reward payments followed achievement of performance proving and a high degree of certainty of capital cost outcomes. This led to a sliding scale starting at 75% of payments following practical completion, increasing to 100% at the end of the two (2) year defects period.

Dealing with Difficult Issues

A number of significant challenges were addressed over the life of the project. These included:

1. Finalising the Project Agreement

   The commercial basis and risk profile of the draft Project Agreement published with the request for tender document was based more on a traditional design and construct contract with partnering than on a "pure" form alliance. In its tender, ExcelWater expressed numerous concerns regarding the draft agreement and these needed to be addressed prior to execution of the contract. Through a number of meetings between ExcelWater representatives, MWS legal advisers and the consultant engaged to establish the alliance, a compromise position was reached. The final agreement was still far from a "pure" form alliance, but largely through the good faith of the parties to the contract, this did not significantly limit outcomes and behaviours that would be expected from a "pure" alliance.

   Negotiation of the contract took several weeks, due mostly to difficulties in getting agreement on insurance related issues. In addition, a separate agreement had to be prepared and executed between the member companies of ExcelWater to enable apportionment of risk and responsibility for project deliverables to the satisfaction of insurance companies and MWS.

   The problem of insurance cover for project alliances has worsened significantly since this project and it is now very difficult to obtain Professional Indemnity (PI) insurance for project alliances. This has forced owners embarking on project alliances to consider alternative PI insurance arrangements such as self-insurance or including the PI risk as part of the overall risk:reward profile of the alliance.

   This whole issue of insurance needs to be carefully thought out and dealt with early in the life of a project alliance. It is unrealistic to expect an alliance contract to be executed immediately after selection of an alliance partner. Arrangements for commencing early works under an alliance (such as an interim alliance agreement) need to be put in place prior to resolving the full alliance contract.

2. Target Cost estimate (TCe) reconciliation

   This issue is discussed above. It is clear that agreement on the TCe is one of the biggest challenges for alliances and is a potential source of breakdown of relationships. The interests of the owner and the non-owner alliance participants are not aligned prior to agreement on the TCe and this issue needs to be carefully managed. All parties must clearly understand the different risk profile of an alliance contract compared to more conventional contracts.

   The TCe cannot be compared to a tender price under a conventional contract. This is because the TCe has to cover virtually all normal project risks. In contrast, conventional contracts include a range of measures (eg. variations, latent conditions, extensions of time, delay and disruption provisions, liquidated damages, etc) that do not apply in alliances. Unless these differences are understood, the TCe negotiation process can be extremely difficult.

   In the case of the Maroochydore STP upgrade alliance, agreement on the TCe was relatively painless due to goodwill and a mature approach adopted by all parties. This was aided by an interest in developing and maintaining long-term relationships between the parties and

preparedness to trade off short and long term benefits.

One aspect of this alliance that was very confusing to the non-owner participants was the requirement to submit a price for the works as part of the tender. It was unclear how the price would be used (eg. Was it to be used for price based selection? Was there an expectation that it would become the TCe or a benchmark for the TCe? How would any changes in pre and post tender scope be recognised in comparing the tendered price to the TCe?).

At the end of the day, the tendered price was not used during the TCe process, and although considered during the selection process was not a major factor. The need to bid a price at time of tender significantly added to bid costs (discussed elsewhere in this paper) and added little value to the project. It is considered that using price as a selection criteria for an alliance is extremely problematic and could increase the risk of "choosing the best liar" as your alliance partner!

3. Establishing Non-Cost KPI's

Focus on achievement of non-cost KPI's is an important element of project alliances.

In this case, a set of very simple non-cost KPI's in relation to effluent standard and environmental breaches was agreed at the foundation workshop. The targets and associated **risk:reward** payments were agreed in the following Table.

During the alliance, further work was done to develop and agree a simple measurement and testing regime and timing of assessment of these variables for payment of risk:reward. This very simple approach proved to be very successful in terms of focussing effort on achieving desired outcomes without adding significant cost to the project. More sophisticated risk:reward arrangements used on larger alliances could not be justified on this project.

KPI	Risk:reward
TN 7 mg/L TN < 6 mg/L TN < 5 mg/L	Nil $15,000 $40,000 total
TP 4 mg/L TN < 3 mg/L TN < 2 mg/L	Nil $7,500 $10,000 total
Environmental breaches	- $2,000 per notifiable event

In addition to the KPI's outlined above, it was also agreed at the foundation workshop that a non-cost KPI would be developed relating to future operational cost. This was driven primarily by the potential power cost savings offered by the Aquatec Maxcon AquaBlade aeration diffusers.

This proved to be somewhat difficult to achieve in practice and resulted in lengthy debate between the parties over what and how to measure this KPI. Following consideration of numerous options, power usage (before and after the upgrade) was agreed as the KPI to be measured.

The agreed risk:reward arrangement was all saving in power costs over the two year Defects Liability period following Performance Proving be passed onto ExcelWater. Following the Defects Liability Period, Maroochy Water would benefit from all the future savings in power costs.

Savings would be calculated at the end of each twelve-month period and the savings distributed at that time. In this way, the savings have already been made to MWS and no further funding would be required.

Any additional costs would be funded 100% by ExcelWater, with the total limit of

ExcelWater's liability (including that related to all other KPI's) equal to the Project Fee.

In practice implementing this KPI model became impractical as the alliance's activities only affected less than half the original plant. This meant that any operational changes to other parts of the plant had to be quarantined or calculated and the overall calculation modified according to the net effect of the change.

Given these difficulties and the strict two year performance criteria placed on the aeration diffusers to ensure their guarantees, it was decided to abandon the NPV cost KPI in favour of a simple capital cost KPI

4. Performance Proving

Following initial mechanical and hydraulic commissioning of the plant, several performance problems were discovered and target effluent standards were not consistently achieved for about four months. The following initial problems were encountered:

- Poor aeration control with upgraded reactors running in parallel with unmodified reactors.
- Poor sludge age control due to a severe foaming event.
- Poor nitrogen removal due to unexpectedly adverse sewage quality.
- Normal plant optimisation issues

Resolution of all of these problems was a testament to the success of the alliance approach on this project. The parties were all very conscious of the shared risk:reward profile and worked together collaboratively to resolve each issue.

For example, it was shown that the influent characteristics had changed significantly between the time of project commencement and the performance proving stage. This problem was embraced by the parties who all worked together to find a solution. Resolution of this issue would have been far more difficult under a conventional contract and could have left MWS significantly more exposed as a result of contractual claims and/or the need to resolve the problem on its own.

5. Maintaining the alliance momentum after construction completion

There was little difficulty in maintaining the alliance momentum during the design and construction phases of the alliance. However, it was more difficult to sustain the alliance culture after completion of construction. This is an area where the alliance could have worked better and the post construction issues could have been given more attention. Loss of a couple of key people from the alliance soon after construction completion also impacted on this problem.

Lessons Learnt

The following is a summary of key lessons learnt from the alliance:

- It is clearly possible to extend the life and capacity of existing assets through a strategic approach to "de-bottlenecking". This can avoid or delay major capital expenditure thereby achieving more sustainable outcomes through lower consumption of resources.
- Overall, all parties considered the project alliance approach to this brownfield STP upgrade a success.
- Project alliances can be successfully applied to small projects using alternative communication and working arrangements
- Adoption of an open and honest collaborative approach to all issues resulted in an environment conducive

to achieving excellent project outcomes whilst minimising waste.

- Reducing the requirements of the tender process would have resulted in lower overall costs to industry and no significant reduction in benefits to the owner

- Price should not be used as part of the tender or selection process for an alliance

- Insurance is a significant issue for project alliances and needs careful consideration well in advance.

- Consideration needs to be given to implementing an interim alliance arrangement prior to finalisation of the main alliance contract.

- Special attention needs to be paid to the post-construction phase to ensure that the alliance momentum is maintained at an appropriate level.

- Successful project alliances can forge strong relationships between member companies and personnel that survive and strengthen in future years.

Internal Relationship Management

It is normal practice for project alliances to adopt some form of relationship management program to help encourage and support development of a high performance alliance team. In this case, the project was not large enough to justify creation or co-location of a dedicated project team or a large externally facilitated relationship management program.

Apart from an initial facilitated 1-day foundation workshop, an "in-house" approach was taken to developing and maintaining relationships within the alliance team. Some of the key processes used include:

- An informal "team of teams" approach including the APCG, the Alliance Project Management Team (APMT) and task teams (eg. process design team) established to undertake specific functions.

- Regular team meetings held in the offices of various members of the alliance

- Value management, risk management and option evaluation workshops integrated as part of scheduled APMT meetings

- Occasional joint APCG/APMT meetings

- Regular contact between team members on a face-to-face, telephone or e-mail basis

- Periodic "Health Check" process to test the health of relationships within the alliance

- Extensive use of e-mail for written communications and transfer of information relating to the project.

- A supportive approach from other team members to help overcome challenges as they arose.

Overall, relationships have been developed and enhanced as a result of this alliance, although this is an area where improvements could have been made had the project been large enough to support the additional effort.

Health Check Process

As previously stated, a project of this size clearly could not support a significant externally facilitated relationship management program of the type often undertaken on larger project alliances.

A very simple Health Check survey was developed by the alliance team to measure and monitor the "health" of the alliance in terms of achievement of objectives that it had set for itself at the foundation workshop.

This survey was distributed periodically via e-mail and responses were sought either

anonymously or with the respondent identified. It was interesting to note that in all cases, respondents were prepared to be identified (although responses were not identified to an individual as part of the health check reporting process). This is perhaps a measure of the open and honest environment that was achieved on this project.

Would Maroochy Water Services Do It Again?

From the owner's perspective, the project achieved the desired objectives, ie the project was completed on time and under budget and the target effluent quality was achieved or bettered, and the alliance was therefore deemed to be a success.

Probably the key factor in achieving this success was the high level of cooperation between all parties that was provided by the alliance. This was quite different to the sometimes adversarial environment that can exist for more conventional project delivery methods.

The inclusion of key Maroochy Water Services staff in all stages of the project was also critical to this success. In particular, Maroochy Water Services provided input in the development and refinement of the treatment process design, development of a risk management strategy for the project, implementation of a HAZOPS review and during construction and commissioning of the new works.

This project has demonstrated that an alliance can be successful for small projects. As a result, Maroochy Water Services will consider the alliance approach for appropriate projects ie where there is the potential to achieve cost savings and improvements in process and facility design through a co-operative environment offered by an alliance.

However, this will be assessed on a case by case basis as it is recognised that an alliance may not be appropriate for all projects.

Contribution to Sustainable Outcomes

The major objective of the project was to achieve a low cost upgrade of the plant, combining an increase in capacity with reductions in effluent Total N and Total P concentrations. This provided a more sustainable outcome in three ways:

- Higher effluent quality, minimising impacts on the Maroochy River and enhancing opportunities for effluent reuse.

- Increased capacity of existing infrastructure through de-bottlenecking and process intensification, thereby deferring the need for additional capital investment on parallel facilities.

- Increased energy efficiency through the installation of the latest generation of (Australian) aeration diffusers.

The alliance provided incentives for ExcelWater to achieve better than the target values set in the contract for Total N and Total P. As a result, the design phase focussed on developing a treatment process that would achieve the best quality effluent for the allocated budget and this focus was then carried through to the commissioning and performance proving phases where significant effort was provided by all parties to achieve the best results.

Apart from the financial incentives, the main reason for the strong focus on effluent quality was a desire to minimise the impact of discharging effluent into the Maroochy River, which attracts a high level of recreational activities. Hence, the long term sustainability of discharge to the river will depend on Maroochy Water Services being able to continue to produce a high quality effluent.

To a lesser extent at the moment, effluent quality is an important factor in the reuse of effluent for various purposes but particularly for higher risk activities such as irrigation of golf courses, landscaping and sporting ovals. As more opportunities for effluent reuse are identified in the future, the quality of effluent

(or recycled water) will become critical to the sustainability of such practices.

Hence, the alliance has contributed in a positive way to the sustainable disposal of effluent and to the reuse of effluent through the improvement in effluent quality achieved.

Adoption of this innovative alliance approach to delivering this project has produced the following outcomes that contribute to sustainability compared to more traditional delivery methods:

- Cooperative approach to solving problems, sharing risks and opportunities and generating "best for project" outcomes rather than striving or "best for party" outcomes
- Focus on project outcomes rather than conformance to specifications and contractual conditions
- Minimise wastage for the benefit of all parties and the environment
- Focus and incentive on energy efficiency as a key project outcome
- More efficient use of existing infrastructure
- Smarter/more strategic approach to plant upgrade delaying major capital expenditure and reducing demand on new resources

Conclusions

Selection of an appropriate project delivery mechanism is a key driver of behaviours that can lead to particular outcomes including promotion of sustainability.

The Maroochydore STP Upgrade using a project alliance delivery method led to a successful outcome based on a strategic "de-bottlenecking" approach to plant capacity. In doing so maximum use was made of existing infrastructure so as to reduce cost and waste of resources.

The alliance model promoted innovation by establishing well defined KPI's that reflected the owners project goals – lower capital and operating costs and reduced nutrient discharges to the Maroochy River. The greater importance of nitrogen in this environment was reflected in higher bonus payment for lower levels than for phosphorus.

The alliance delivered sustainable outcomes by allowing both owner and non-owner personnel to work together in a cooperative "best-for-project" environment with a focus on project outcomes without rigid contractual restrictions.

Alliance set-up and bidding costs were high especially related to project size and key drivers. More cost-effective bidding models should be promoted for future alliance style projects.

Finalisation of the Project Agreement and the Target Cost estimate presented a number of challenges which tested the alliance at an early stage of the project. Their successful resolution provided a sound foundation for the project to progress.

The NPV cost KPI proved to be an impractical measure for a project involving only part of the existing plant, and was abandoned in favour of a simple capital cost KPI.

The project was successfully completed ahead of 30 June 2001 deadline, below target cost, and met or exceeded all non-cost performance targets. The project's success has led to strong corporate and personnel relationships for future opportunities.

Authors Biography

Selwyn McFaul is the Manager of the JWP's Water and Environment Division and Leader of the Process and Technology Group based in Brisbane. Selwyn specialises in the investigation and strategic and detailed planning and implementation of wastewater transport, treatment and reuse infrastructure. He has over 20 years experience in the water and wastewater industry. Selwyn has expertise in all aspects of wastewater treatment plant augmentation planning and design involving physical, chemical and biological processes for nutrient reduction.

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Ken Hartley is an independent consulting engineer with 35 years experience in water and wastewater treatment. He has worked for the South Australian Government, consulting engineers GHD and the Advanced Wastewater Management Centre at The University of Queensland. He has wide experience in nutrient removal and has authored fifty publications in the water and wastewater field including the well known book *Operating the Activated Sludge Process*. Ken has recently co-developed two on-line training courses on activated sludge and biological nutrient removal.

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