A TIMELY EXPANSION – WAIKATO WTP

Chris Aspinall, David Ward
Major Projects, Watercare Services LTD, Auckland, New Zealand

ABSTRACT

Continued regional growth and the need to secure the Auckland region's water supply against drought prompted a fast-tracked project to expand the capacity of one of Watercare's most strategic assets, the Waikato Water Treatment Plant (WTP), from 75 Megalitres per day (MLD) to 125 MLD. The expansion project planning/design phase commenced in November 2010 with the upgraded 125 MLD treatment capacity being fully realised, on time and budget, in March 2013. An interim stage was included to remove plant bottlenecks and increase the interim plant capacity to 100 MLD, this was achieved, on target, in December 2011 enhancing drought risk mitigation for the 2011/2012 summer and beyond.

A brief discussion of the key project challenges and the strategies successfully employed to mitigate the associated risks are presented. Lessons learned and critical success factors are also described.

The key project challenges can essentially be traced to either the nature of the site or the timeframe within which the project was required to be completed.

Site based challenges:

- Brownfield, constrained site
- High degree of expansion integration with the existing plant coupled with the requirement to keep the existing plant fully operational without compromising drinking water standards.

Accelerated project delivery time frame:

- Compressed project timeframe
- Interim capacity milestone requirements

The most important tool that was used to overcome these challenges was the tailoring and control of the project delivery. All aspects of the project delivery including planning, design, construction, commissioning and handover were customised to meet the specific project challenges.

KEYWORDS

Water Treatment, Project Delivery, Brownfield Expansion, Construction.

1 INTRODUCTION

1.1 REGIONAL CONTEXT

Watercare Services Limited (Watercare) is New Zealand's largest company in the water and wastewater industry. Each day, Watercare supplies around 370 Megalitres per day (MLD) of drinking water to approximately 1.3 million customers across the Auckland region. Historically, Watercare has relied upon protected catchments in the Hunua and Waitakere Ranges to provide the majority of Auckland's water supply. Whilst this still remains the case in 2013, whereby 80% of the water supplied to the Auckland region is supplied from these two catchments, a number of key drivers led Watercare to make the decision in late 2010 to expand the treatment and supply capacity from the Waikato River Source from 75 MLD to 125 MLD. An aerial photograph of the Waikato Water Treatment Plant (WTP), pre-expansion, is shown in Photograph 1.

Photograph 1: Waikato Water Treatment Plant – Pre Expansion (75 MLD capacity)

1.2 PROJECT DRIVERS

Watercare had three clear drivers for the expansion project, including:

- Ongoing source diversification to mitigate against the effect of drought or raw water quality risks associated with other catchments
- Increase water supply system capacity to cater for continued region wide expansion
- Increase the Southern Auckland region treatment and supply capacity to facilitate supply direct to some of the regions that had recently been integrated to Auckland council.

Given the Waitakare and Hunua catchments both require regular local rainfall to maintain storage levels within the impounded sources; the Waikato River offers an excellent source to improve the drought resilience of the Auckland water supply. Given the Waikato River extends some 450 kilometers the catchment is significantly less dependent on local rainfall in the Auckland region. Increasing the treatment capacity of the Waikato WTP to 125 MLD allows the Waikato source to make a greater contribution to the region's water supply during drought or normal rainfall conditions and increases the flexibility to manage adverse raw water quality events in any of the major sources, further improving the security of supply to the Auckland region.

Following integration of the Auckland Council in 2010, Watercare became responsible for supplying water services to additional Auckland regions. Significant water quality and treatment challenges were present in some of these regions and the selected approach to resolve these issues included the construction of infrastructure to supply some of these Southern regions directly with water from the Waikato WTP. To support this ongoing initiative the increase of the WTP capacity was well-timed.

1.3 PROJECT CONSTRAINTS

The total project budget for the Waikato WTP expansion project was $NZ48M. The project completion dates were broken into interim and ultimate capacity milestones. The interim milestone represented an increase in treatment capacity to 100 MLD, which was required to be achieved by December 2011. The Ultimate capacity increase to 125 MLD was required to be available by March 2013. The timeframe available for project completion will be discussed in greater detail as it represented one of the key project challenges. Another key constraint was the plant needed to be available for continuous uncompromised operation throughout the entire project; short shutdowns were available provided they were well planned, requested weeks in advance and aligned with other work taking place at other major water treatment plants or in the distribution network.

1.4 PLANT PROCESS OVERVIEW

The Waikato WTP is located in Tuakau (approximately 60 kilometers South-East of the Auckland CBD); abstracting water from the Waikato River approximately 35 kilometers before the river empties into the Tasman Sea. A simplified overview of the water treatment process is provided in Figure 1 below.

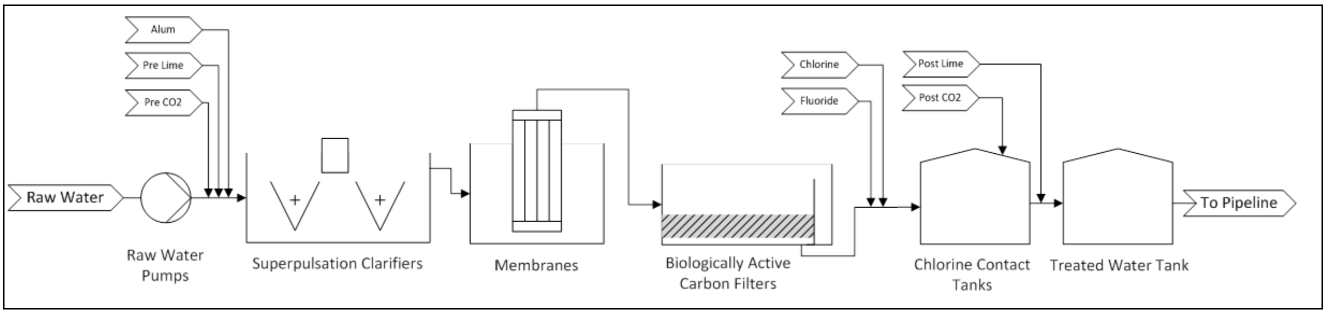

Figure 1: Process Schematic – Waikato WTP

The river intake comprises of four cylindrical wedgewire screens that feed a flooded wetwell. Submersible raw water pumps lift the water from the wetwell and deliver the flow to the coagulant dosing point immediately upstream of the hydraulic flocculation zone; pre lime is also added periodically for pH correction on an as needed basis. Each pair of clarifiers has a hydraulic flocculation zone which is provided with weirs to split the flow equally between the clarifier pair. The Clarifiers are the Degremont Superpulsator design which utilizes lamella plates and tubes plus a centralized vacuum chamber which creates a pulsating effect upon the sludge blanket. Clarified water is fed to the GE (Zenon ZW500D) submerged membrane trains and finally to Biological Activated Carbon (BAC) contactors. The filtered water is then dosed with chlorine and fluoride before finally being dosed with lime and carbon dioxide to achieve water stability targets. The treated water is then pumped from site approximately 38 kilometers where it connects to the Auckland distribution network. The plant includes a wastewater handling circuit (thickener and centrifuges) to treat clarifier sludge and a recycle option for the membrane and BAC contactor backwash water.

1.5 EXPANSION SCOPE

The primary objective of the expansion was to increase the plant output capacity from 75 MLD to a reliable 125 MLD. A secondary objective was to construct all civil structures such that the final planned site expansion to 150 MLD could be achieved without requiring any significant civil works and completed within a 12 month timeframe. A brief outline of the scope includes:

- 2 new raw water pumps, transformers and Variable Speed Drives (VSD)
- 2 additional clarifiers, platform access and lighting
- 4 new submerged membrane tank structures, including fitout of 3 tanks with membranes
- 4 new BAC contactor structures, associated pipework and valves and BAC media in 3 contactors
- 1 additional 2260 m^3 baffled chlorine contact tank
- 1 additional treated water pump and associated VSD transformer and pipework
- 1 additional centrifuge and feed pump
- 1 additional plant air compressor system
- Chemical system upgrades (Alum, Polymer, Chlorine, Lime, Carbon dioxide and Hydrofluosilicic acid
- Electrical and control system hardware upgrades

The scope and scale of the expansion is shown in Photograph 2 which was taken during the construction phase.

Photograph 2: The site during the construction phase

2 KEY PROJECT CHALLENGES

The majority of the challenges that were faced during the project can be traced back to either the nature of the expansion project, i.e. that it is a brownfield site and/or the challenging timeframe that was applied for project completion. These challenges are broken down and discussed in greater detail below.

2.1 BROWNFIELD EXPANSION

2.1.1 KEEPING THE EXISTING PLANT OPERATIONAL

The Waikato WTP is one of the three major water treatment plants that, on average, supply a combined total of greater than 95% of the Auckland region's water. Shutting down one of these major WTPs for an extended period, although it would have greatly simplified the project, to allow construction to proceed without restriction was not considered feasible or practicable i.e. removing 75 MLD of treatment capacity from the network for a twelve month period would significantly reduce the security of supply and unreasonably limit raw water source options.

Furthermore, any shutdowns of the Waikato WTP in excess of 48 hours were severely restricted. Shutting down the WTP for an extended period of greater than 48 hours would create significant operational challenges to restart the plant. These challenges included:

- Managing the chlorine residual in the Waikato treated water main. In the current configuration the Waikato treated watermain is connected to the Auckland distribution network via the 38 kilometre 1.2 meter diameter Waikato treated watermain. During the project period there were no bulk supply points along the watermain and as a result the water would be static for the period of the shutdown. Following a > 48 hour shutdown, the WTP would be restarted at minimum flow (30 MLD) and as a result it would take a minimum 3 – 4 days before the water reaches the distribution network. As a result the chlorine residual may be less than desireable. Consideration to increasing the chlorine residual prior to a shutdown was given but coupled with other operational startup restrictions, 48 hours was considered the limit for reasonably managing the chlorine residual.

- Managing the BAC contactors. Since the plant commenced operation in 2002, it had never been shutdown for longer than 48 hours. This was in part due to the uncertainty of how the biology would respond to an extended offline period without a constant supply of Dissolved Oxygen (DO) and Assimilable Organic Carbon (AOC). Concerns were held that an extended ripening period post plant restart would be required to recover turbidity and AOC removal capabilities and given the filter to waste restrictions (only one contactor can filter to waste at any given time), 48 hours was considered the upper limit for a BAC contactor to be offline.

Given that the plant operation needed to be essentially business as usual. This ensured that the significant number of connections and connections (> 100) to the operational plant, commissioning new infrastructure and at times undertaking heavy civil construction meters away from operational plant were challenging.

2.1.2 MEMBRANE SENSITIVITY & WATER QUALITY

The ultrafiltration membranes are housed in open top (grated) concrete tanks, and are susceptible to construction debris being introduced via the open tank or through the membrane tank inlet with the clarified water. The introduction of debris into a membrane tank is a significant risk given that a handful of plastic swarf and debris may be capable of causing hundreds of thousands of dollars' worth of damage to the sensitive membrane fibers.

On a similar note given the plant remained in operation, risks associated with compromised treated water quality were significantly increased during the construction period. At the peak of construction it was estimated that more than 50 contractors were working on site associated with different work faces, often in very close proximity to operating equipment, this introduced many new contaminant paths and potential for damage to existing infrastructure or monitoring equipment.

On this basis site management, cleanliness and water quality risk management were significant challenges during the construction period.

2.1.3 PHYSICALLY CONSTRAINED SITE

Upon viewing photograph 2 it is clear that the site is very constrained. The footprint for the new infrastructure was essentially adjacent to the existing infrastructure; this is shown schematically in Figure 2. Given the proximity, the site definition and management during construction was challenging as the construction zone was between existing infrastructure. The Watercare operations group also required access to the construction zones to operate and maintain monitoring equipment and instrumentation and/or undertake normal operational activities. These challenges were compounded given that the Watercare access requirements were required 24 hours a day 7 days a week.

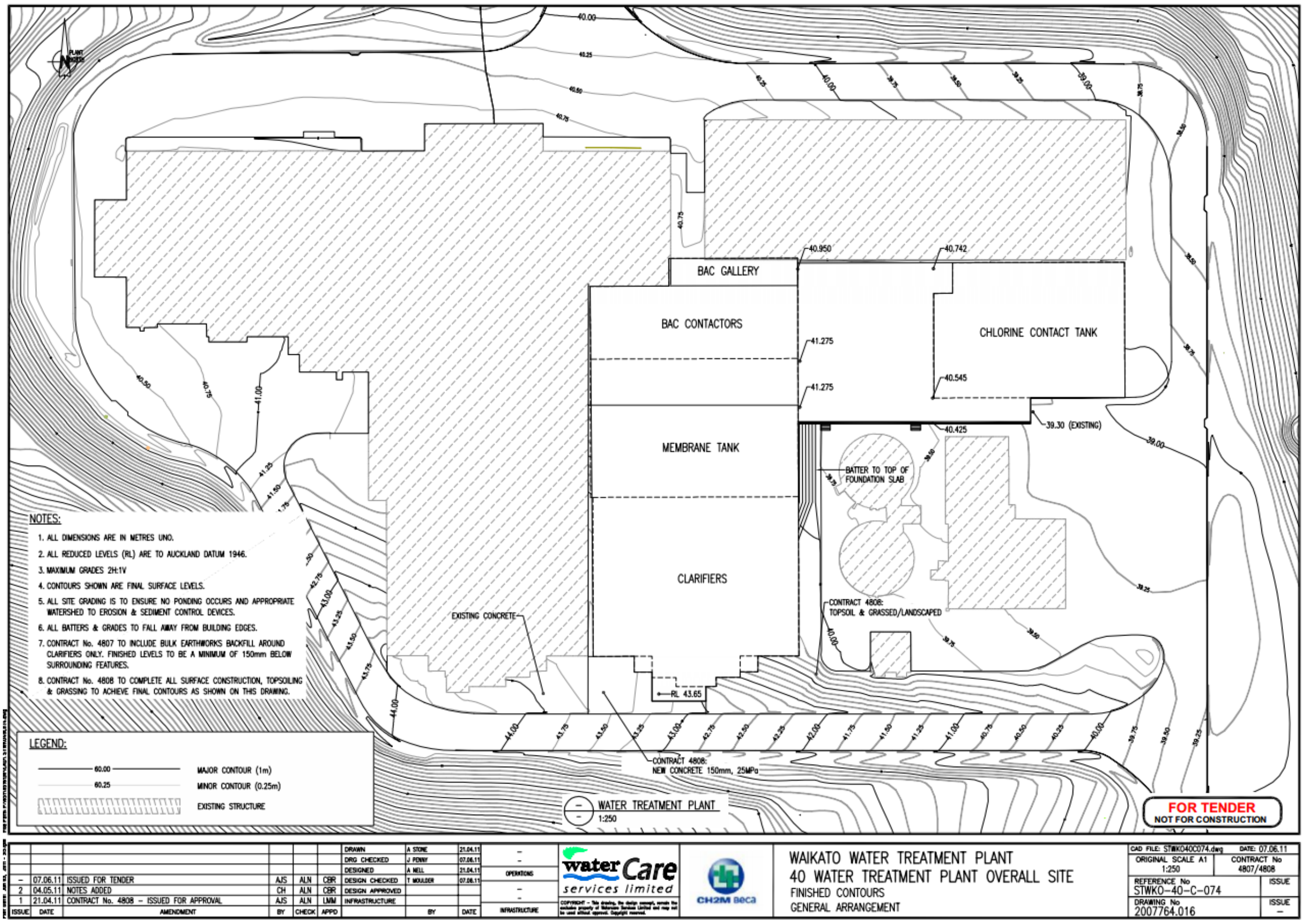

Figure 2: Expansion Project General Arrangement (Diagonal lines represent existing infrastructure that needed to remain operational, solid white blocks represent new infrastructure)

2.1.4 MAINTAINING SITE CONSISTENCY

A primary mandate of the expansion project was to maintain site consistency, as far as possible, especially with regards to the way equipment is operated via the control system. This was challenging for a number of reasons including:

- Ensuring competitive pricing is provided by vendors when considering sole sourcing equipment options to match existing equipment.
- Attempting to match control functionality for equipment that has developed in the past 12 years since the original equipment was purchased and installed.
- Trying to overcome shortcomings of the existing infrastructure, yet being constrained by operational consistency.

2.2 ACCELERATED TIME FRAME

The time frame applied to the project was certainly challenging. In total 27 months were available from formation of the project until final delivery was required. As an example of the challenges that were faced some equipment had lead times close to 12 months, so that did not leave a lot of time to decide which types of equipment may have long lead times, what the equipment should be, create a specification, request quotations, run a tender period, evaluate the tenders, award the contract, install the equipment, test the equipment and finally commission and prove performance.

2.2.1 INTERIM MILESTONE – 100 MLD

The interim milestone was due for completion approximately 15 months after project initiation. In general this incorporated the design, construction and commissioning of the two new clarifiers, an extension of the membrane inlet channel and connection to the existing membrane process. Major software modifications were also required to enable equipment such as raw water pumps to run as duty/duty/duty rather than the duty/duty/standby mode that they had historically been configured. Chemical dosing systems also required re-ranging for the increased plant flow.

2.2.2 ULTIMATE MILESTONE – 125 MLD

Project completion required the balance of scope outlined in section 1.5 to be fully tested and operational. It is noted that this also required an extended steady flow ramp up period within the treated water main to prevent scouring of lime and other sediments owing to the increasing velocities associated with expanded treatment plant capacity.

3 TAILORED PROJECT DELIVERY MODEL

During the initial project planning stages it was clear that the project delivery model that was selected would need to be capable of meeting the challenging time frames that had been applied. This drove a number of decisions that are outlined in more detail below. Aspects of the project delivery were either setup in advance or modified to adapt to key site specific challenges.

3.1 PROCUREMENT

3.1.1 OVERALL CONTRACT STRUCTURE

Two basic contract structures were considered, design and build or detailed design/bid/build. The option of detailed design/bid/build was selected as it allowed the programme to be decoupled and controlled more readily and more importantly allowed Watercare greater control to manage and be involved in the design. Watercare being actively involved with the design was important given the large impact the construction project would have on the operation of the plant during the construction and commissioning phase. Significant experience associated with ten years operation of the plant also allowed Watercare to make a good contribution either in avoiding design decisions that did not work the first time around and building in extra features to allow the plant to be constructed and commissioned in the brownfield environment.

The decision was also made to engage the membrane supplier directly via a FIDIC yellow book contract. This allowed Watercare freedom to liaise directly with the membrane supplier and took advantage of the good relationship that has been fostered since the original plant was constructed.

CH2M Beca was chosen as the plant designer on the basis that they were the designers of the original plant (the original project was delivered through a design and build contract) and following determination that a competitive pricing structure could be ensured. Having the experienced original designers on board removed any time lag associated with a new design party coming up to speed with the plant and reduced the risks of design issues arising during construction. A number of members of the original CH2M Beca design team were made available for the expansion project.

3.1.2 CONSTRUCTION CONTRACT STRUCTURE

The construction works was split into two separate tendered NZ3910 contracts. The first construction contract was referred to as the Enabling & Piling Works contract which essentially included the earthworks, piling, construction of the clarifier concrete shells, services relocation and construction of the overflow and off spec network to service the new infrastructure. The second construction contract, the main works contract, was the balance of the works and included mechanical fit-out of the clarifier, construction of the membrane and BAC contactor tanks and construction of the new chlorine contact tank.

The choice to structure these contracts this way was well considered, whilst it introduced additional complexity the decision was made on the basis that a single contract would require the full plant design to be complete before it could be tendered. The programme did not support this option. As a result the detail design for the balance of the plant was undertaken during the enabling works contract. This overlap was a critical success factor in achieving the delivery with the required time frame.

3.1.3 WATERCARE FREE ISSUE LONG LEAD ITEMS

Watercare and the designer identified key long lead items and orders were placed by Watercare. Free issuing long lead items to the contractor allowed these items to be decoupled from the main construction programme; the more traditional procurement model for items such as major pumps, centrifuges and clarifier internals would have the supply of these items embedded in the construction contract. As another example of strategic procurement Watercare purchased the piles directly from the supplier so that they could be delivered during the tendering of the enabling works construction contract. As a result, once the enabling works contractor was selected they could proceed directly with the piling and earthworks, effectively cutting 12 weeks out of the overall programme.

It is noted that the approach to free issue major items required additional Watercare resourcing to manage these procurement activities, generally the cost of doing so was offset by not incurring the contractor’s margin on such large items.

3.1.4 WATERCARE PROJECT TEAM

Watercare created an efficient project team to provide essential project management services, however to support the aforementioned procurement and project delivery method additional Watercare resources were recruited into the project team. This included an operations team member dedicated (100% work load) to the project who had an intimate working knowledge of the site; having an operations team member focused on delivering good outcomes for their team as part of the project group is highly recommended, but it is understood that this is often a very difficult position to resource. The larger project team allowed much more control of design, construction and commissioning activities. This will be discussed in greater detail in forthcoming sections.

3.2 DESIGN

Watercare project team members worked closely with the design team, in so far as even attending internal consultant design sessions to ensure that the Watercare contribution was maximized. Working that closely had the key advantage of keeping the design focused; where Watercare had strong opinions on how dosing pipework should be laid out or where the tank access points should be, for example, this was communicated directly to the designer before any drawings had been completed and acted to minimize design rework that would usually only become apparent during formal design review milestones in a more traditional design contract. Keeping the design focused and answering questions promptly allowed the design to meet the tight schedule and achieve good outcomes.

The identification of the requirements to achieve the interim milestone target of 100 MLD allowed those design elements to be prioritized and eventually led to the inclusion of the clarifier shells in the enabling works contract. The staging of the design to allow the enabling works contract to proceed on site whilst the detailed design was completed for the main works elements essentially removed the design from the critical path. The extra time was used to conduct a thorough review of the design in order to minimize design related delays that may become apparent during the construction phase and threaten the overall programme.

Given the site challenges and the large number of connections that the contractor would face, special focus was given to marking all connections and expansion infrastructure clearly on the drawings; a register that referenced all of the drawing connection annotations was developed. A draft construction methodology that addressed some of the more challenging connections was also provided to the contractor. The connection register was used to track and monitor connections and gave the contractor a platform from which to determine constructability knowing that they would need to work closely with Watercare to complete any and all connections to the operating system. An example of how the connections and new infrastructure were highlighted on the drawings is shown in Figure 3, whereby new infrasturcture with is shown with the use of clouding and connections are referenced by hexagonal boxes containing the connection number (

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Knowing that connections during construction would be difficult and contain risk to the WTP operation, extra infrastructure was included, where required, to enable these connections and/or commissioning to be completed more efficiently or to reduce the risk to the operating plant. A good example of this was the inclusion of engineered stop log rails within the membrane inlet channel that allowed isolation of the operational plant and the membrane inlet channel that needed to be constructed. Incorporating extra design features allowed this to be done during the design phase by the plant designers rather than contractor temporary works designers who might not have a good appreciation of the requirements in a water treatment plant framework.

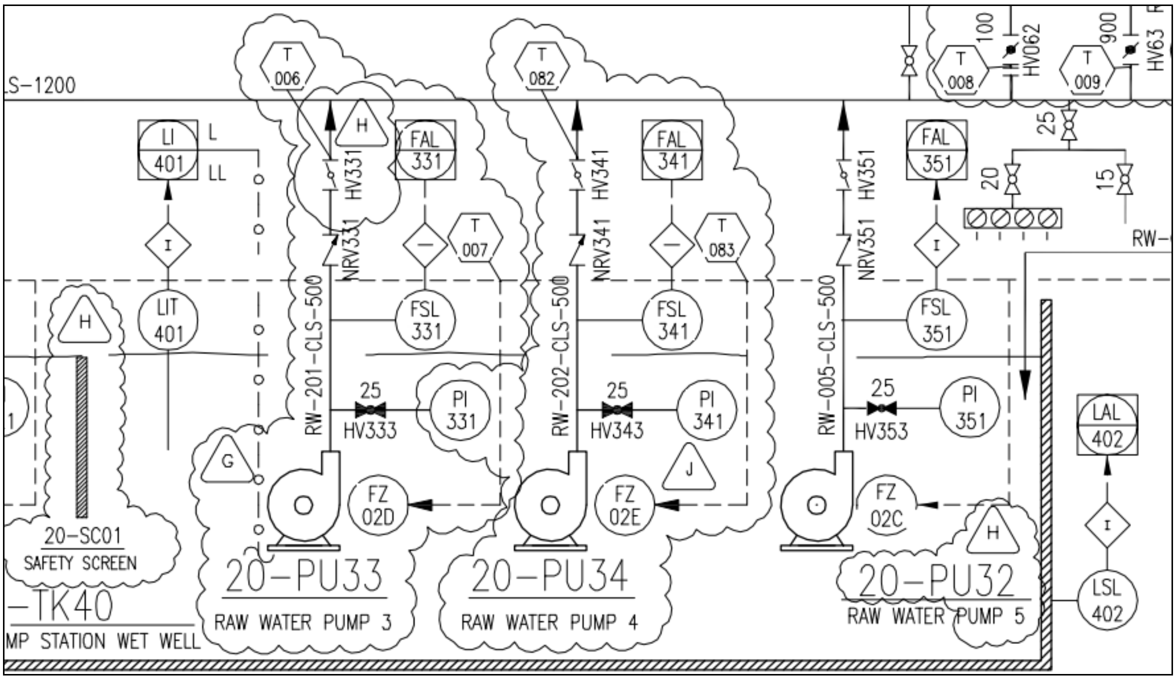


Figure 3: Selected Element of a Raw Water P&ID showing Connections and New Infrastructure

3.3 CONSTRUCTION

3.3.1 CONTRACTOR EDUCATION

Following contract award but before any soil was turned on site, Watercare invested time and energy in educating the Contractor's leadership team on the unique requirements for working in and around an operational water treatment plant. This was seen as an important step to managing the relationship between the parties and developing an awareness and responsibility in the contractor of the risks that Watercare faced during their time on site. Key messages included:

- The criticality of the water treatment plant operation to Auckland's water supply
- How the water treatment process works and at what stages additional hygiene measures were required
- The sensitivity of the membranes was explained and samples of the membrane fibres were provided
- The criticality of shared services such as compressed air and site water to the plant operation were outlined
- The criticality and sensitivity of monitoring instrumentation
- If something goes wrong come and tell us!

This education process continued throughout the whole job, not just with the leadership team but the entire contracting crew. An open relationship was developed whereby if things did go wrong the operations group would not have to spend critical time searching for the cause of the incident but could respond in resolving the issue directly. An example of where this approach paid dividends was during piling when a hydraulic hose broke on the piling rig. Despite the clarifier being covered, the proximity of the rig when the hose failed saw a small amount of hydraulic oil land in the clarifier. The contractor made Watercare aware of the issue promptly which allowed the immediate isolation of the clarifier to be undertaken before the oil could have a chance to spread through the downstream processes.

3.3.2 ASSET PROTECTION

Given the proximity of construction, which was often as close as 1 meter from the operating plant, protective measures such as covering the clarifiers were employed during construction to lower the risk to operating equipment; although it reduced operational flexibility it was agreed with the operations group that the entire membrane trains would be covered and sealed to prevent the ingress of construction debris. Whilst other measures were also employed covering the membrane trains provided a final robust barrier. A photograph of the membrane train covering is shown in Photograph 3. It is noted that these membrane covers remained in place until construction was complete.

Photograph 3: Membrane Coverings

3.3.3 REFINING THE CONSTRUCTION METHODOLOGY

The construction methodology was also developed in order to minimise risk to plant operation as far as practicable. For example, the membrane trains and BAC contactors are housed in a large weather proof building. The expansion project required that the building be extended to accommodate the new membrane and BAC contactors. A construction methodology was developed such that the wall could remain in place to the last possible moment. Retaining the wall as long as possible, made some construction activities more complex but provided an effective barrier between the construction zone and the operational plant.

The contractors were supportive of such initiatives and regularly identified creative ways to complete the job whilst lowering the potential impact on the plant. Another example was using a customized ejector skid to load GAC to the BAC contactors. Although pre washed GAC was specified there was still a residual risk of GAC dust that Watercare wished to avoid as it could settle in the membrane trains and/or in the operating BAC contactors where it could pass through and cause turbidity noncompliance. To ensure the GAC dust potential was minimized for the 400 $m^3$of GAC that needed to be transferred to the new BAC contactors, a contained hopper and ejector skid was setup outside, in a non-critical area and the GAC was pumped as a slurry to the tanks.

3.3.4 CONNECTION RISK ASSESSMENT & SHUTDOWN PLANNING

For each connection or shutdown request a formal risk assessment was undertaken. The contractor would present the work method statement and then as a group the risk to the operational plant would be assessed. Mitigations would sometimes include rework of the work method statement if the risk presented was excessive. Representatives from all stakeholders would participate in the risk assessments including site supervision (designer and Watercare), Watercare (operations and project team) and the contractors (project management and work package leads). Although this was a slightly tedious process given the large number of connections, acceptance of the process was relatively rapid; once the complexity and potential for adverse flow on effects on plant operation became apparent it was generally acknowledged that all risks were not readily foreseeable by any singular stakeholder, it was only by coming together as a group that the impact of each individuals activities on others were fully understood.

3.4 COMMISSIONING

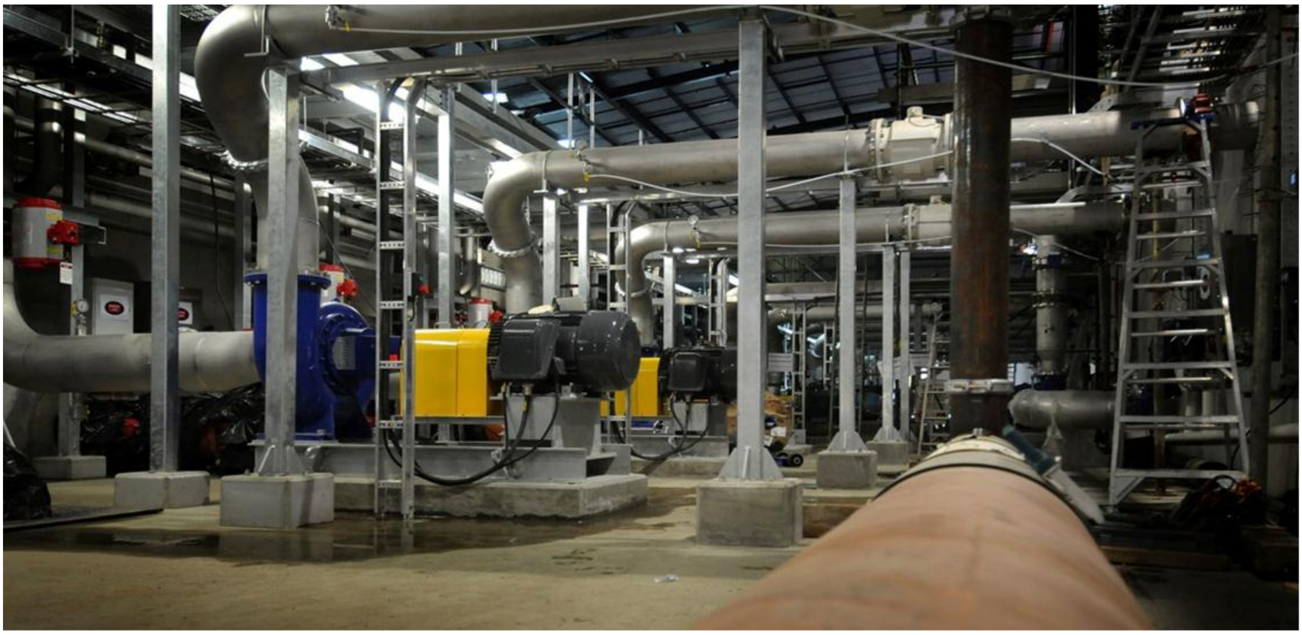
3.4.1 COMMISSIONING PLANNING

The detailed commissioning planning, including the preparation of the commissioning plan, was undertaken largely during the latter stages of the detailed design phase. The general approach during planning was to confirm how the new infrastructure could be commissioned in a manner whereby:

- The commissioning programme gave priority to production elements that would actively contribute to achieving the time driven milestones. A staged approach to the commissioning was refined during the construction programme in collaboration with the contractor to enable infrastructure to proceed to commissioning directly at the completion of Contractor testing. This allowed the commissioning team to work with the Contractor to shape and prioritize the programme to enable the final milestones to be achieved with the plant in service rather than solely focusing on the completion of construction.

- The plan allowed robust proof of performance before introduction to service. Whereby it was identified that a process, in its final configuration, was incapable of operating in a manner enabling confirmation that the process water quality was acceptable without remaining isolated from the main treatment process, additional infrastructure was incorporated into the design to enable this to be undertaken. For example, the three new membrane trains were operated in a ten day trial operation phase; a temporary permeate spool was installed that collected the membrane permeate from the three new membrane trains and directed it to waste. Decoupling the permeate from the main process stream allowed a robust evaluation of water quality and numerous days of membrane integrity testing before the final permeate spools were refitted and the membrane permeate was connected to supply. Gated checkpoints applied for the connection of major unit process operations to supply. A photo of the temporary permeate to waste spool is included below as Photograph 4.

- The commissioning of new infrastructure did not compromise the treated water quality or the operation of existing infrastructure. Similarly to the approach during construction, detailed risk assessments were held to establish the risks to the operational plant for each unit process during the commissioning phase. Numerous plant shutdowns were avoided using this approach; nuances of the complex control system known solely to experience operational meant the presented commissioning methodology would not work wholly as intended.



Photograph 4: Temporary Membrane Permeate to Waste Pipe Spool

3.4.2 TEAM STRUCTURE

Watercare elected to take direct responsibility for commissioning of the expansion project, whereby Watercare staff held all of the key commissioning roles. The decision to take this approach was largely attributable to the Watercare team knowing the plant extremely well. The team comprised members of the operations group, the project group and the software development group. Having members from each key stakeholder on the team provided balanced objectives. Having team members with a detailed knowledge of the plant in combination with a threshold of commissioning experience provided the following advantages:

- Minimized the risk to operational plant
- Increased organizational accountability
- By representing all key Watercare stakeholders the integrated team largely mitigated the risk of interdepartmental conflict.
- Provided good value for money
- Smoothed the transition between commissioning and operation acting to minimize the resistance or reluctance toward new infrastructure.
- Ongoing professional development of Watercare employees

Effective communication between team members and the broader operation and project group was critical to maintain the swift commissioning pace yet reassure operations and project management that the process was being well controlled and meeting objectives. Two key examples of communication tools that were used to achieve this functionality included the routine end of day email and the morning standup commissioning meeting.

Each afternoon the end of day email was sent to the operations group responsible for the operation of the Waikato WTP. The email summarized what had taken place that day and the state that new or existing infrastructure and/or the control system would remain overnight, the email also highlighted key contact details for on call commissioning staff. This email was critical to keep on call operational staff up to date with site progress and in the event of a call out or alarm on the plant they could clearly identify whether the issue was linked to the new infrastructure and seek commissioning team assistance as a result. The email also acted to develop operator buy in to the expanded process over an extended period, whereby the extended operations group felt engaged with the expansion project because they always knew what was going on.

The daily standup commissioning meeting was held each morning. This was a brief 5-10 minute meeting to describe the planned activities for the day. The outcome of the meeting was that the Contractor, the onsite operators and commissioning teams all knew what each other had planned for the day. Where necessary these key messages could be relayed at toolbox meetings to the broader contractor group for example. The daily standup meeting approach proved especially beneficial when undertaking interface commissioning activities, for example, control system loop testing, a conjoint contractor-commissioning team task. At the conclusion of the meeting the key commissioning tasks were marked up on the project whiteboard at the entrance to the plant buildings to serve as a reminder and so that these activities were communicated to others arriving onsite.

It is noted that having Watercare lead the commissioning team did place significant resource stress on the organization, particularly the operations team. However given the priority nature of the project this was deemed acceptable. In future if this was to become a preferred or standardized approach to commissioning major Watercare projects, forward resource planning (1-2 years) would be warranted to support this approach.

3.5 SOFTWARE

Generally either the contractor or the design consultant would be responsible for the Controls System (DCS) and SCADA programming; however on this project Watercare decided to manage this internally, this represents a deviation from Watercare's general approach to software on major projects. This approach was chosen for the following reasons:

- It provided Watercare an opportunity to control the software development and manage the programme. The project team was provided weekly updates and

- Given there were specific changes to the existing code to achieve the interim milestone, it was determined that those who knew the code and its challenges were best positioned to make those changes.

- Using internal resources ensured the integration of the code was managed by those who were both familiar with existing software and the new software. Those implementing the software were also familiar with Watercare's QA systems which have specific requirements for software code modification.

- Having Watercare manage the software development promoted operations acceptance of the code and fast tracked the commissioning and software testing process.

- It allowed Watercare project and process engineers to work directly with the programmers to realize the intended functionality at an operational level and resolve existing plant issues. Resolving existing issues and controlling scope would have been more complicated if an external supplier had been used.

This approach was not without risk, by taking responsibility for the programming, Watercare effectively took responsibility for realizing the whole plant functionality. The management of the timing and control of the software was also borne by Watercare as was the scope control.

4 CONCLUSIONS

Key challenges were overcome by tailoring the project delivery to meet project constraints. Although this involved a number of major departures from the traditional project delivery approach and acted to introduce some additional peripheral risk to the organization, maintaining a standard delivery approach and 'doing nothing' would have severely compromised the potential to achieve the major project objectives within the allocated time. The validation of this project delivery approach was that there were no significant interruptions to the Waikato WTP supply during the 2+ year project. Given the complexity and scope of the project, this was considered a major success and largely attributable to the way the project was set up and the performance of key staff.

The 2012-2013 drought, labeled by NIWA as the worst in 40 years for the Auckland region (MPI 2013) placed significant stress on the security of the Auckland regions water supply. The decision to fast track the Waikato WTP expansion project, bringing additional treatment capacity online was well considered and ensured that water restrictions were not required during the drought period. The dry conditions saw the Waikato plant ramp up to the full 125 MLD production during March 2013, at the scheduled project completion, to preserve the dam levels as far as possible and enhance the security of Auckland's water supply.

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