EARLY CONTRACTOR INVOLVEMENT UPGRADE OF FOUR WATER TREATMENT PLANTS IN SOUTHLAND

P. Garrity – Cardno BTO
S. Mason – Downer NZ Ltd
I. Evans and B. McKenzie – Southland District Council

ABSTRACT

The existing Water Treatment Plants (WTPs) in the Southland District Council (SDC) communities of Te Anau, Mossburn, Otautau, and Winton required improvements to comply with the Drinking-water Standards for New Zealand 2005 (Revised 2008) (DWSNZ). All existing supplies were similar, consisting of shallow bore water sources, primary pumping, and chlorine gas disinfection, followed by secondary pumping into the reticulation where needed.

Excepting for Te Anau each of the upgrades involved cartridge filtration and ultraviolet disinfection to achieve 5 log credits of protozoa protection. Chlorine disinfection systems, pH correction systems, and building modifications were constructed as required. Each of the upgrades included new instrumentation and control systems to automate these processes and their DWSNZ compliance requirements.

Downer as the incumbent operations contractor for the existing WTPs negotiated an early contractor involvement (ECI) agreement with SDC to prepare tender designs and prices for each of the upgrades. Subsequently, this led directly into a design and build contract for the upgrade work. This procurement process brought to the project a strong local knowledge of the design risks and the operational experience to recommend operational efficiencies and ensure continuity of supply. Through this procurement process SDC was able to economically and innovatively deliver the four communities with modern, state of the art, WTP upgrades.

KEYWORDS

Early Contractor Involvement, WTP upgrade, Drinking-water Standards for New Zealand

1 INTRODUCTION

Southland District Council (SDC) is responsible for the operation and maintenance of 11 urban water supplies across the Southland District and has been progressively upgrading the treatment infrastructure over recent years to achieve compliance with the Drinking-water Standards for New Zealand (DWSNZ). The passing of the Health (Drinking Water) Amendment Act 2007 galvanized the requirement of water suppliers to take all practical steps to ensure compliance with the Drinking Water Standards. SDC identified that the water supplies for the communities of Mossburn, Otautau, Te Anau and Winton required upgrading in order to meet the requirements of the DWSNZ.

Downer New Zealand Ltd has been providing comprehensive operation and maintenance services to the SDC since 2010 and the contract has the potential to run until 2022. As a result of Downer and SDC's close working relationship, and aligned objectives through the Operation and Maintenance Contract, the two parties worked together to develop a suitable and affordable solution for the Council and its rate payers for the capital upgrades.

This alternative procurement strategy provided the opportunity for early involvement of not only the construction contractor but also the operations and maintenance contractor in the design for the plants upgrades. This situation created aligned objectives and best for project behavior not possible under a conventional competitive tender approach. The procurement model used for these projects was unprecedented at this value within Council and as such the drivers behind and outputs of this process form the focus of this paper.

2 BACKGROUND

2.1 SDC OPERATIONS AND MAINTENANCE HISTORY

Southland District Council holds responsibility for three waters management services to the Southland region (excluding Invercargill and Gore). The infrastructure base consists of 18 sewerage schemes, 28 storm water networks, 11 urban water supply schemes and 11 rural water supply schemes.

Council has outsourced the provision of these services to specialist contracting firms since 1995. Downer New Zealand Ltd won the Contract for the provision of these services in a competitive tender in 2010. The Downer Contract has a duration of up to 12 years (2+5+3+2).

The Downer utilities team is based out of Invercargill and consists of a team of 14 full time employees who provide a comprehensive service to the extents of the region, from Stewart Island in the south to Te Anau in the north.

2.2 DRINKING WATER STANDARDS COMPLIANCE

The Drinking-water Standards for New Zealand were initially published in 2005 and revised in 2008, the Standards provide the requirements for drinking water safety by specifying the:

- maximum amounts of substances, organisms, contaminants or residues, that may be present in drinking-water
- criteria for demonstrating compliance with the Standards
- remedial action to be taken in the event of non-compliance with the different aspects of the Standards

The Health (Drinking Water) Amendment Act 2007 was passed in October 2007, and supersedes the largely voluntary approach to compliance with the Drinking Water Standards previously employed. Under this Act compliance becomes mandatory from 31 December 2014 [1]. The major focus of the upgrades proposed for the four treatment plants was to provide compliance with the Drinking-water Standards for New Zealand (DWSNZ)

(Revised 2008). The upgraded plants were also required by SDC to achieve a minimum of a ‘C’ grade for source and treatment as defined in the Public Health grading of Community Drinking Water Supplies 2003.

3 EXISTING (PRE-UPGRADE) WATER SUPPLY DESCRIPTIONS

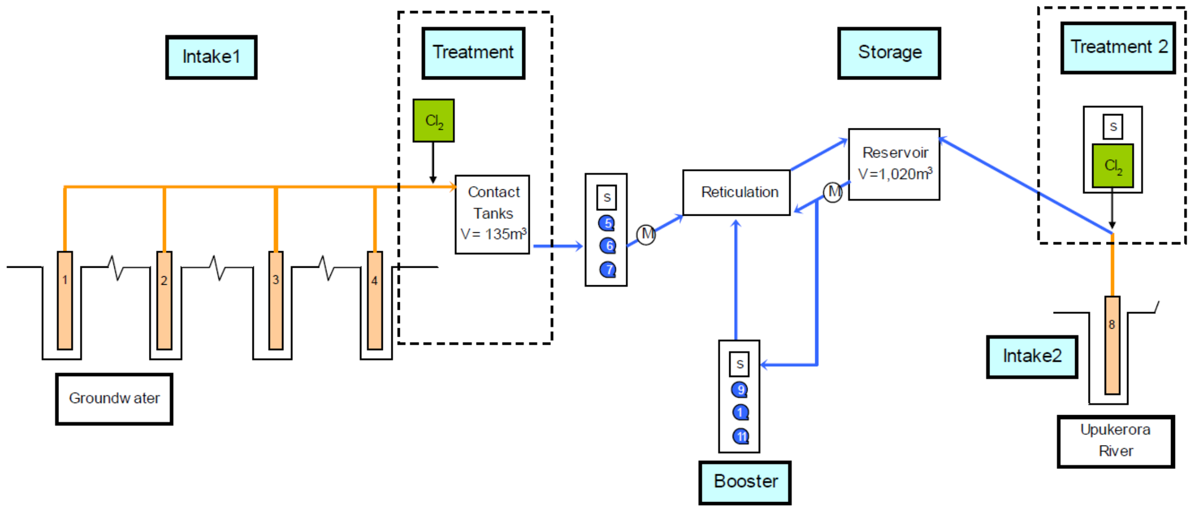
3.1 TE ANAU

3.1.1 COMMUNITY DESCRIPTION

Te Anau township is built next to Lake Te Anau, the South Island’s largest lake. Tourism and farming make up the economic backbone of the area. Te Anau is home to around 1,900 permanent residents however during the summer holiday months the peak population is estimated to swell to between 7,000-10,000 people.

3.1.2 EXISTING WATER SUPPLY

Figure 1: Te Anau Water Supply Schematic (Existing)



Four wells draw water through sands and gravels from the Waiau catchment adjacent to Lake Te Anau. The bores are shallow (12-15m deep) and are located approximately 100m apart, 30-50m back from the normal lake edge. Water from the lakeside sources is pumped to a series of eight 22.7m^3 contact tanks. The duty primary pump (which is alternated) starts at a pre-set contact tank water level. The other primary pumps are progressively activated as lower water levels are reached. The only treatment is provided by the injection of chlorine through a manifold immediately prior to the contact tanks.

The contact tanks are connected to high lift pumps (housed in a concrete block pump building) which deliver water into the reticulation system. The three high lift pumps are manifolded to operate individually or in parallel when needed at times of peak demand. Water is delivered directly into the town reticulation with the excess continuing to the reservoir.

A second historic source, the Upukerora River Bore, is no longer used to supplement the existing system. The water quality and existing dosing treatment of this source is not at a sufficient standard.

3.1.3 WATER QUANTITY AND QUALITY

Te Anau’s estimated peak daily demand is 12,500m^3/d delivered at a peak pumping flow rate to the reticulation and reservoir of 145L/s.

Records of turbidity showed that for 100% of the time the turbidity was less than 0.3 NTU and for 98% of the time the turbidity was less than 0.2 NTU. The turbidity was less than 0.1 NTU for 43% of the time. Ultraviolet transmissivity had been recorded between 98.4% and 99.5%. Although the water is taken from shallow bores it is considered that the dilution effect of the lake would minimize protozoa contamination therefore requiring 3 log credits of treatment for protozoa.

Limited testing of the pH showed a range of 7.3 to 7.7 pH units.

Photograph 1: Te Anau Water Treatment Plant and Secondary Pumps (Existing)

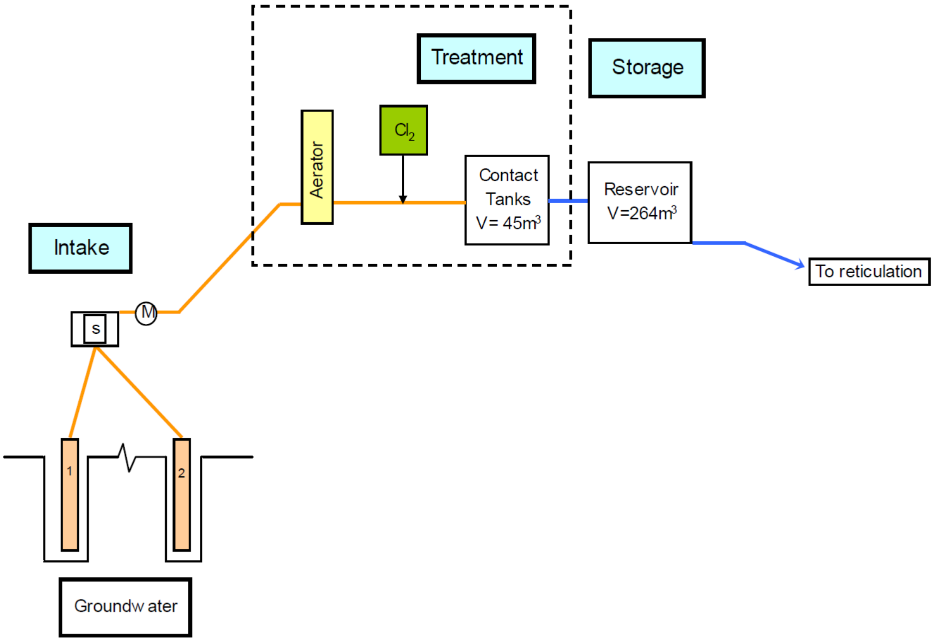
3.2 MOSSBURN

3.2.1 COMMUNITY DESCRIPTION

Mossburn is a rural community of approximately 200 people supported by deer farming and dairying and is located approximately 20km from Lumsden. Industry in the town includes a Silver Fern Farms processing plant and the White Hill wind farm.

3.2.2 EXISTING WATER SUPPLY

Figure 2: Mossburn Water Supply Schematic (Existing)



Raw water is sourced from two wells. The original well is located approximately 300m from the true right bank of the Oreti River and is 5.2m deep. An 8m deep well was installed more recently to supplement the supply and is located 100m north of the original well. The two wells have capacities of approximately 4-6L/s.

The only forms of treatment prior to the upgrades were aeration to raise the pH by CO_2 gas stripping, and chlorination. These treatment processes occurred as the water was pumped into a contact and storage tank farm located approximately 700m away from the bores on an elevated site. Water is supplied to the reticulation network by gravity.

3.2.3 WATER QUANTITY AND QUALITY

Mossburn's estimated peak daily demand is 500m^3/day delivered at a peak pumping flow rate to the reservoirs of 12L/s.

There were no records of turbidity however anecdotal information was that turbidity could get relatively high during the summer peak demand and concurrent low river flow periods. Ultraviolet transmissivity had been recorded between 82.0% and 94.6%. As the water is from shallow bores it is considered surface water requiring 5 log credits of treatment for protozoa.

Limited testing of the pH showed a pH of 6.45 pH units before aeration.

Photograph 2: Mossburn Pump Station and Remote Reservoirs (Existing)

3.3 OTAUTAU

3.3.1 COMMUNITY DESCRIPTION

Otautau is a small farming, forestry, and milling town with a population of approximately 700. It is located approximately 40km north west of Invercargill.

3.3.2 EXISTING WATER SUPPLY

The intake and treatment plant are located on Liemen Street approximately 150m from the true right bank of the Aparima River. The well is constructed to a depth of 9m and contains two submersible pumps (duty/standby) which deliver raw water to three contact tanks at the treatment plant.

The only treatment processes in place prior to the upgrades were aeration to raise the pH by CO_2 gas stripping, and chlorination as the water entered the contact tanks. Water from the contact tanks is supplied through the reticulation network to the town reservoir by two secondary pumps (duty/standby).

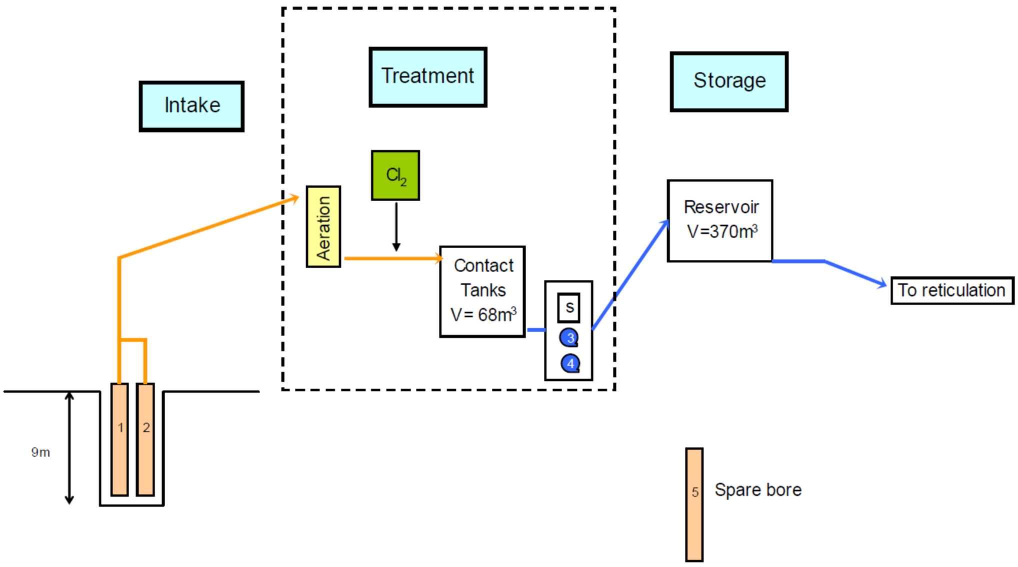
3.3.3 WATER QUANTITY AND QUALITY

Otautau's estimated peak daily demand is 1200m^3/day delivered at a peak pumping flow rate into the contact tanks of 14L/s.

Records of turbidity showed that for 100% of the time the turbidity was less than 1.0 NTU and for 92% of the time the turbidity was less than 0.3 NTU. Ultraviolet transmissivity had been recorded between 96.6% and 97.7%. As the water is from shallow bores it is considered surface water requiring 5 log credits of treatment for protozoa.

Limited testing of the pH showed a range of 6.82-6.87 pH units after aeration.

Figure 3: Otautau Water Supply Schematic (Existing)



Photograph 3: Otautau Pumping Station and Contact Tanks (Existing)

3.4 WINTON

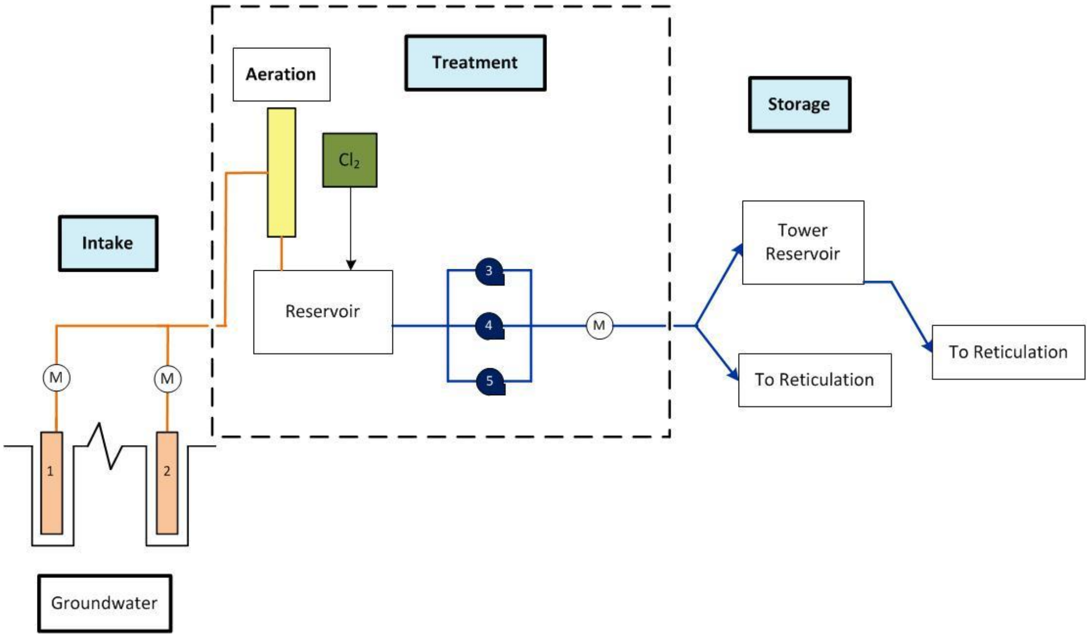
3.4.1 COMMUNITY DESCRIPTION

Winton is a busy agricultural service town. It lies in Central Southland, around 30km north of Invercargill and is home to approximately 2,200 people.

3.4.2 EXISTING WATER SUPPLY

The Winton intake is located remotely, 2.6km away from the Winton Water Treatment Plant and storage reservoir. At the intake site where there are two wells, the contributing aquifer consists of clean sandy gravels, up to 4m thick, associated with the Oreti River. The original 750mm diameter ‘east’ well, constructed in 1975, is located inside a concrete block building which also contains the electrical and control equipment. A second 600mm diameter, 10m deep well, installed in 2011, is located approximately 100m to the west. The rising main from the well to the treatment and reservoir site is a 225 mm diameter asbestos cement pipe.

Figure 4: Winton Water Supply Schematic (Existing)



Gas chlorination equipment is housed in the treatment building located next to the main reservoir. Chlorine carry water is dosed directly into the reservoir. The pH is raised by forced fan aeration located on top of the reservoir. The treatment building contains three water tower delivery pumps (in parallel) and surge protection equipment. The tower secondary pumps are used to pump water from the reservoir into the reticulation network and when the inflow from the pumps is greater than the demand outflow from the reticulation network, the tower reservoir fills.

Photograph 4: Winton Water Treatment Plant and Secondary Pumps (Existing)

3.4.3 WATER QUANTITY AND QUALITY

Winton's estimated peak daily demand is 2,400m^3/day delivered at an estimated peak pumping flow rate into both the storage and tower reservoirs of 35L/s.

Records of turbidity showed that for 98% of the time the turbidity was less than 1 NTU and for 85% of the time the turbidity was less than 0.3 NTU. Ultraviolet transmissivity had been recorded between 93.6% and 95.2%. As the water is from shallow bores it is considered surface water requiring 5 log credits of treatment for protozoa.

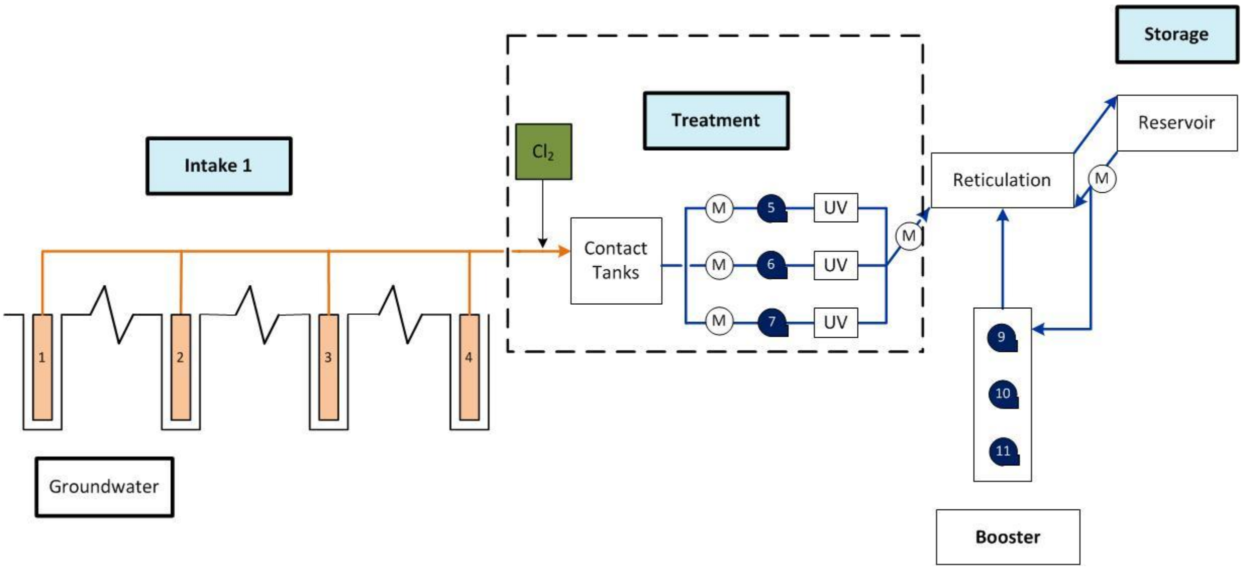
Limited testing of the pH showed a range of 6.05 to 6.10 pH units before aeration.

4 DESCRIPTION OF UPGRADES

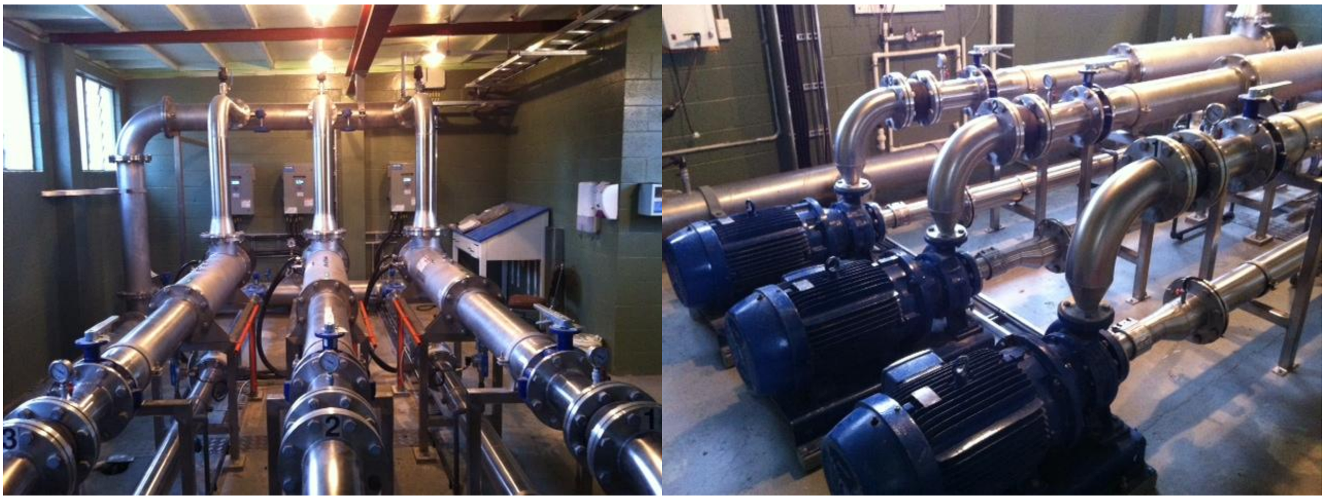
4.1 TE ANAU WTP UPGRADE

The upgrade to the Te Anau WTP to achieve DWSNZ compliance was able to be very basic. It involved introducing ultraviolet disinfection after the secondary pumps to provide 3-log credits of protozoa treatment. Associated with this upgrade has been the addition of instrumentation to ensure process monitoring compliance and control software modifications to ensure the ultraviolet disinfection process is operated and alarmed within its validated limits.

Figure 5: Te Anau Water Supply Schematic (Upgraded)



Photograph 5: Te Anau Water Treatment Plant and Secondary Pumps (Upgraded)



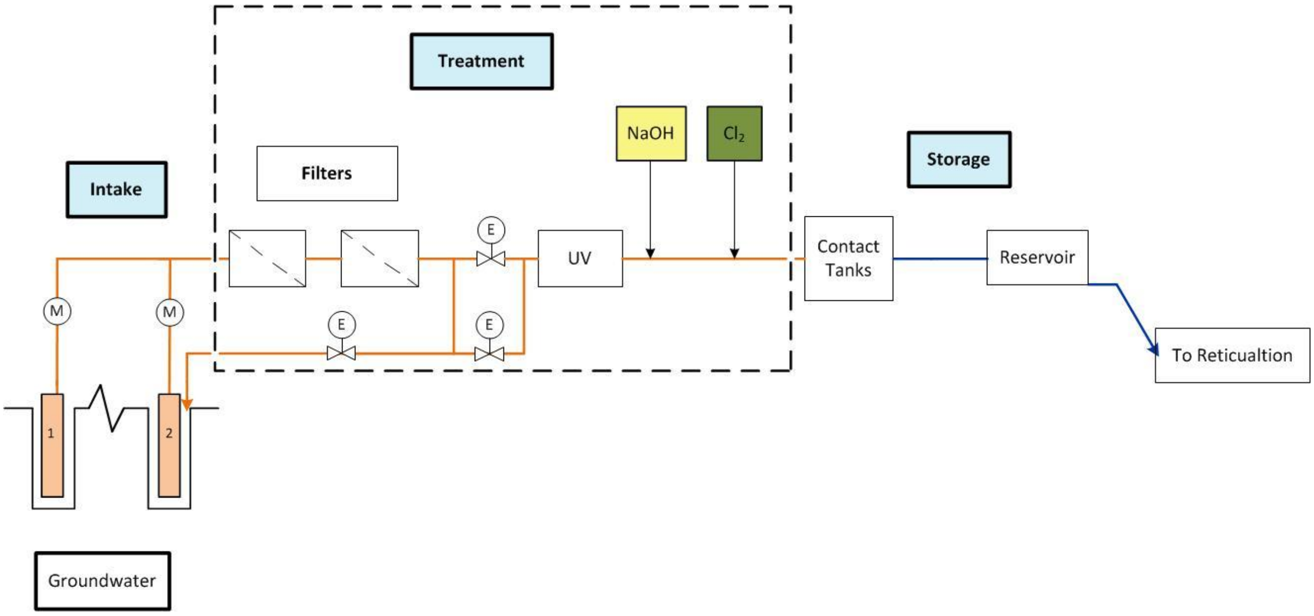
4.2 MOSSBURN WTP UPGRADE

Despite being for the smallest community, the upgrade to the Mossburn WTP needed to be the most extensive to comply with the DWSNZ. Cartridge filtration and ultraviolet disinfection were chosen as the processes to achieve the required 5 log credits of protection against protozoa. Caustic dosing was chosen as the method for raising the pH to within the range of 7.0-8.0 pH units and it was decided to provide the chlorination dosing and control systems down at the new WTP site near the existing bores rather than at the remote reservoirs.

To do this a new WTP building with associated civil works needed to be built, new bore pumps on variable speed drives were required to overcome the variable pressures of the cartridge filters, a new transformer was procured to cope with the additional electrical load and a new switchboard was installed. A process water system for dumping first flush water from the cartridge filters and for providing cooling water to the ultraviolet disinfection reactors to limit the numbers of starts per day was introduced.

Associated with this upgrade has been the addition of instrumentation to ensure process monitoring compliance and the provision of new control hardware, software, and communications systems to ensure the plant and processes are operated and alarmed within their validated limits.

Figure 6: Mossburn Water Supply Schematic (Upgraded)



Photograph 6: Mossburn Treatment Plant (Upgraded)

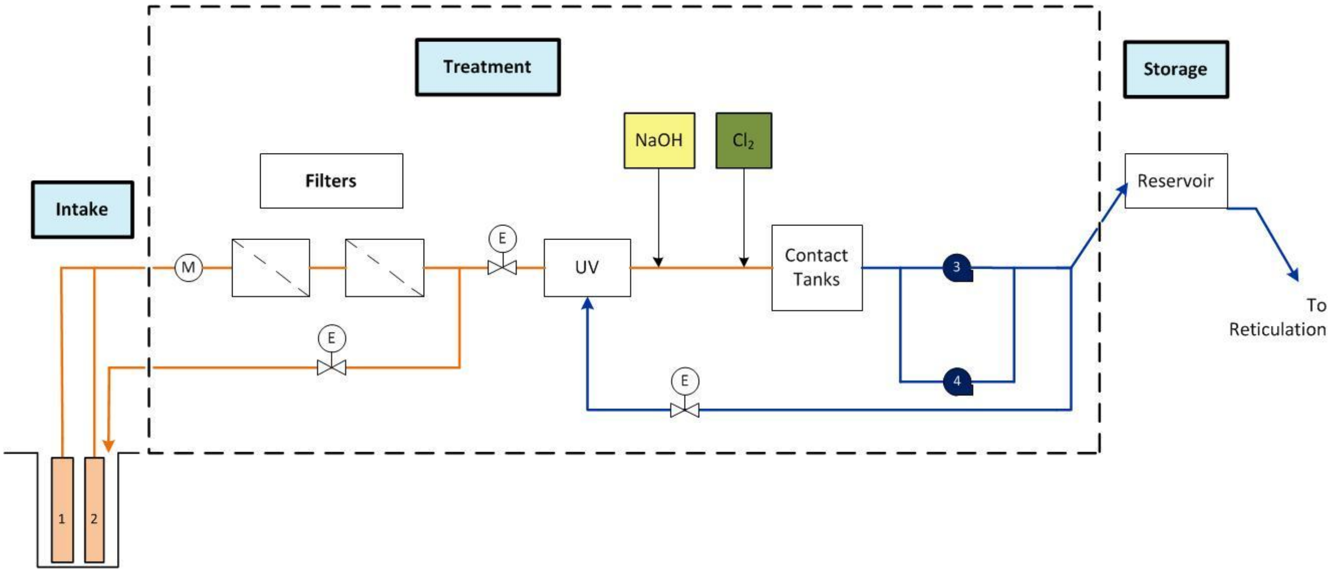
4.3 OTAUTAU WTP UPGRADE

At Otautau, cartridge filtration and ultraviolet disinfection were chosen as the processes to achieve the required 5 log credits of protection against protozoa. Caustic dosing was chosen as the method for raising the pH to within the range of 7.0-8.0 pH units.

To do this, an extension to the existing WTP building needed to be built, new bore pumps on variable speed drives were required to overcome the variable pressures of the cartridge filters, a new transformer was procured to cope with the additional electrical load and a new switchboard was installed. A process water system for dumping first flush water from the cartridge filters and for providing cooling water to the ultraviolet disinfection reactors to limit the numbers of starts per day was introduced.

Associated with this upgrade has been the addition of instrumentation to ensure process monitoring compliance and the provision of new control hardware, software, and communications systems to ensure the plant and processes are operated and alarmed within their validated limits.

Figure 7: Otautau Water Supply Schematic (Upgraded)



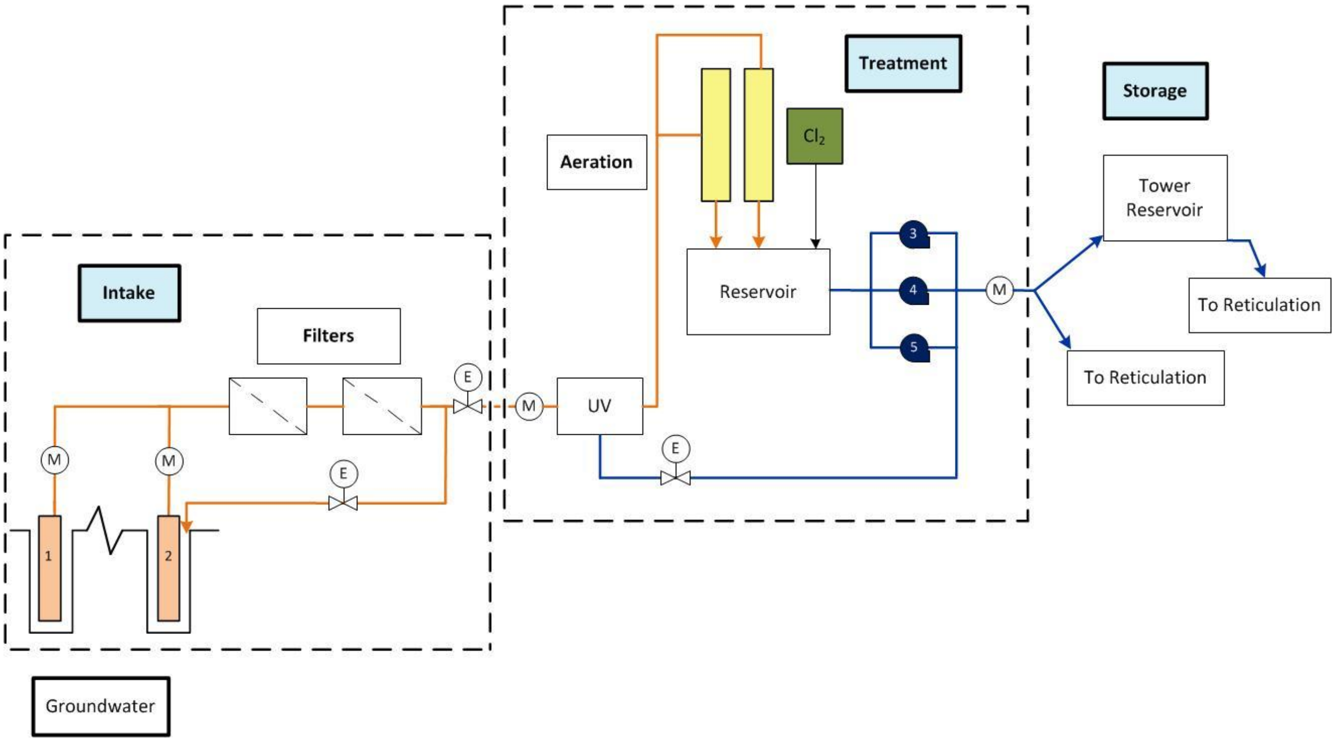
Photograph 7: Otautau Treatment Plant (Upgraded)

4.4 WINTON WTP UPGRADE

At Winton, cartridge filtration and ultraviolet disinfection were chosen as the processes to achieve the required 5 log credits of protection against protozoa. To implement this upgrade a new building for the cartridge filters was constructed at the remote bore well site while the ultraviolet reactor was installed within the existing blockwork building at the Winton WTP and reservoir site. Separate process water systems for dumping first flush water from the cartridge filters and for providing cooling water to the ultraviolet disinfection reactors to limit the number of starts per day were introduced at each of the sites.

A second forced fan aerator located on top of the Winton reservoir was chosen as the method for raising the pH. Although it was uncertain as to whether this would raise the pH sufficiently to within the range of 7.0-8.0 pH units it was evaluated that this would be the best first stage approach to avoid at best or at least reduce, the need for expensive pH correction chemicals in the quantities that would be required without any aeration. This approach was taken with the approval of the Drinking Water Assessor.

Figure 8: Winton Water Supply Schematic (Upgraded)



The secondary pumps were deemed to have reached the end of their asset life and these were renewed with new pumps on variable speed drives that may allow the future decommissioning of the Tower Reservoir if required. New switchboards were installed to accommodate the new equipment and rationalize previously decommissioned equipment.

Associated with this upgrade was the addition of instrumentation to ensure process monitoring compliance and the provision of new control hardware, software, and communications systems to ensure the plant and processes are operated and alarmed within their validated limits.

In this case the upgrade was able to be achieved without new bore pumps to manage the variable pressures of the cartridge filters, and without a new transformer which had previously been identified as being loaded to its limit at peak times. This was done by mutual agreement of the parties on the level of risk to the system.

Photograph 8: Winton Treatment Plant (Upgraded)

5 CONTRACT PROCUREMENT METHOD

Council elected to procure the upgrade of the four treatment plants as a negotiated Early Contractor Involvement (ECI) process with Downer, Council's incumbent utilities contractor. The ECI model of procurement is becoming more common within the construction industry to harness the benefits of collaboration and drive out the adversarial behavior traditional 'lowest price' contracting is commonly associated with. The ECI model provides the contractor with the opportunity to influence the project at the time when greatest value can be realized, the design phase. Enabling the contractor involvement early in the life of the project creates ownership of the outcomes and aligned 'best for project' behavior by all involved.

The ECI procurement model also has significant advantages in regard to risk management. The involvement of the contractor early in the project provides another perspective of the project risks, allowing a more comprehensive risk identification to be completed which in turn allows mitigation measures to be created and ownership of the risk to be allocated between the parties well before the events come to fruition.

Moving beyond a traditional procurement model was unprecedented within the Southland District Council and as such demonstrating that this process would deliver value on these upgrades was a key focus. The key drivers for SDC in selecting an ECI process were as follows:

- Collaborative Relationships
- Time Constraints
- Value for Money
- Effective Extended Maintenance Period

5.1 COLLABORATIVE RELATIONSHIPS

One of the most important factors in selecting Downer for these upgrades is their position as the incumbent O&M Contractor. The Downer Utilities Team has a history of close collaboration with SDC and hence understands their requirements and expectations intimately. This institutional knowledge held by Downer provided Council with added confidence that the final outcome would meet with their expectations even in the absence of a specific requirement within the Contract for the upgrade works.

As the utilities contractor, Downer holds the responsibility for the operations and maintenance of the upgraded WTPs for the next 10 years. By providing Downer with full involvement in finalising design and equipment selection Council could expect minimal construction and subsequent operational issues. As a result of this shared commitment to the long term outcomes, the drivers of Council and Downer in regard to this project are aligned.

At the time of award of the O&M contract it was identified that letting a long term contract would provide the opportunity to form a strong, open, and trusting relationship between SDC and the selected Contractor, with the express intention of creating collaborative opportunities that benefitted SDC, the local communities and the selected O&M Contractor. An extract from the original Request for Tender document identifies that:

"The Council is seeking a contractor who can work in an open and collaborative approach, who will work with the council to obtain best value for the ratepayers of Southland and who will invest to deliver the highest possible service to the District for the accepted contract price over the 12 year term of the contract".

Two years into the O&M contract Council identified that Downer had invested heavily into the contract, was performing to a very high level and had demonstrated commitment to an open and collaborative approach.

5.2 TIME CONSTRAINTS

The funding for the upgrades was a mix of Council funded loans repaid through rates. As such there were considerable requirements to ensure these treatment facilities were upgraded to meet DWSNZ in a timely and professional manner. The negotiated ECI procurement method streamlined the design and procurement phases and enabled the work to commence with minimal delay.

5.3 VALUE FOR MONEY

The negotiated process allowed various upgrade options to be priced and evaluated in a number of iterations such that the best outcome could be achieved whilst staying within the project budget. The process allowed for an open book arrangement, providing Council with full visibility of all costs, overheads and margins, therefore ensuring the budgets were used to the maximum effect.

A significant challenge of the chosen procurement method is the potential difficulty in demonstrating value for money. An important consideration when assessing value for money is the definition of 'value'. For a long term asset, value should be assessed based on a holistic, whole of life approach to the costs. The aim is to achieve 'True Value for Money' rather than 'Perceived Value for Money' as defined below.

- Perceived Value for Money. Procurement of infrastructure involves multiple stages and costs, including; in house costs, design, production of contract documents, tender review and evaluation, construction (head contractor, subcontractors and equipment), variations, operation and ongoing maintenance costs. The largest single cost is typically the construction costs so the perception is that value is achieved through getting this large cost as low as possible. However, there are often significant risks associated with achieving this. Whilst low construction costs may be achieved through competitive tendering, this can result in a higher overall cost with variations actively sought and secured, and operation and maintenance costs increasing due to the disconnect and lack of whole of asset life analysis when the infrastructure was procured. Low cost does not necessarily equate to best value.

- True Value for Money. True value for money is obtained when both costs and risks are understood and a whole of life project cost approach is taken that covers all stages of procurement through the life of the asset. Collaboration between the project parties (SDC, Downer and Cardno) ensures that risks, which have a financial implication, are owned and managed by the most appropriate party. With Downer (responsible for the construction and the long term operation and maintenance) having active input into the finalisation and optimisation of the designs, it significantly reduces the risks for construction related variations and long term O&M cost blow-outs.

ECI and collaboration between the parties, coupled with an open book approach to cost, including supplier costs and margins was adopted to ensure that risks were minimised and True Value for Money achieved.

In addition to the 'open book' approach adopted, a third party review of the pricing was performed to provide further confidence around the final contract value.

5.4 EFFECTIVE EXTENDED MAINTENANCE PERIOD

The Operations and Maintenance (O&M) contract with Downer is long term, with the potential to run until 2022. Council identified that by awarding the upgrade works to Downer via a negotiated arrangement, they could align the objectives of the project team and minimise future financial exposure to Council, as a result of defects outside of the Contract Defects Liability Period.

Downer, under the O&M contract has significant ownership of the costs of replacement equipment. The selected procurement model places accountability for the selection of the new equipment onto the contractor, and as such, Downer has a vested interest in ensuring the highest quality outcomes. Should another contractor have undertaken this work instead of Downer, the risk of equipment failure would remain with Council beyond the Defects Liability Period.

6 DESIGN PROCESS

6.1 DESIGN APPROACH

The design stage of the project was initiated following the release by SDC of a set of draft upgrade concepts and specifications for the treatment stage in each of the four water supplies. Design by Downer and Cardno BTO was broadly undertaken in three phases prior to construction. The first phase was design for tender pricing, the second phase was design for design review / HAZOP and the third phase was design for construction.

A streamlined approach to design documentation was taken, never-the-less consisting of process and instrumentation diagrams, major mechanical procurement datasheets, mechanical schedules, electrical line diagrams, mechanical and civil layouts, control philosophy descriptions and alarm lists. The documentation took into account the fact that the project team comprised experienced and competent contractors.

6.2 VALUE ENGINEERING OUTCOMES

Through each of the design phases an increasing degree of value was engineered into the project. This was done collaboratively and contributions were made by all parties to the project.

In the first phase the design concepts were extensively revised in recognition of some of the technical hurdles that had to be accounted for, such as the existing pumps being inadequate for the variable pressure losses across cartridge filters due to filter blinding, the limitations on the numbers of starts per day on the ultraviolet reactors and the inadequacy of the existing aeration towers to provide adequate pH correction. Prior to the second phase it was realized that some significant cost reductions were required to meet budgets therefore changes in pumping configurations, reductions in equipment redundancy provisions and postponements of pump renewals were agreed. In the third phase a number of operational realities were optimized particularly with respect to the logistics and costs of dosing chemicals for pH correction.

Overall more cost effective and complete upgrade solutions were achieved through this process. Some of the key value engineering outcomes for each of the four sites are described below:

6.2.1 TE ANAU

The key item of value engineering in the Te Anau design was choosing to install one ultraviolet reactor in line with each of the three secondary pumps capable of treating the peak flow from that pump only. This change in configuration from concept significantly reduced the pipework, eliminated the need for control valves and meant that large duty and standby reactors each capable of treating the full plant flows were not required.

6.2.2 MOSSBURN

The key item of value engineering in the Mossburn design was accepting that, despite the remoteness of the location, major equipment redundancy in the cartridge filters and ultraviolet reactors was not economic. The bore pumps were upgraded to provide additional head rather than adopting secondary pumping. Minor changes such as working through the logistics of caustic dosing and implementing Modbus controls on the variable speed drives provided some additional savings.

6.2.3 OTAUTAU

For Otautau providing major equipment redundancy in the cartridge filters and ultraviolet reactors was considered not economic. The bore pumps were upgraded to provide additional head rather than attempting to totally reconfigure the system at the present time to include renewal of the secondary pumps. Minor changes such as working through the equipment layouts and the logistics of caustic dosing to minimize building upgrades, and implementing Modbus controls on the variable speed drives provided some additional savings.

6.2.4 WINTON

A number of items of value engineering were adopted for the Winton upgrade. These were:

- The bore pumps, which were both already and recently installed on variable speed drives, were not replaced in this upgrade. They were tested for spare head capacity against the cartridge filter pressure losses and it was mutually agreed that they would be adequate for the time being.

- Installing the cartridge filters in their own low cost building at the bore site ensured more complex modifications of the existing block work building at the WTP site were not required.

- A single ultraviolet reactor without redundancy was installed based on the site reservoir providing enough capacity and hence response time for the operators.

- New end suction pumps were retrofitted into the existing secondary pump manifold despite the unusual existing inlet and outlet configuration. This saved on space and costs compared with an equivalent vertical multistage booster pump set.

- The new secondary pumps were installed with interlocks to ensure that two only could run together. This ensured that a transformer upgrade was not required. Similarly an interlock was proposed on the new aeration fan temporarily shutting it down prior to the surge tank compressor running.

- A caustic dosing facility was postponed indefinitely in favour of doubling the aeration capacity. The cost of the capital works for a bulk caustic soda handling and dosing facility and the on-going operational costs for chemical dosing were considered too great at the present time compared with the benefits.

7 EXECUTION

7.1 OVERVIEW

The upgrades were undertaken in a staggered approach with the work at Te Anau being completed first. The other three plants were approached on a discipline by discipline basis to maximize the efficiency of the work crews. This allowed a focus on completing the civil and building works at one site before the construction crew moved on to the next location. This then provided a clear work face for the subsequent mechanical and electrical trades.

The upgrades utilised standard equipment and techniques which helped to keep costs down and streamline construction. The key challenge faced during the construction of the plants was in maintaining the continuity of supply when replacing essential infrastructure in communities with restricted storage capacity.

The upgrades were due for completion in April 2014, however actual completion was not achieved until June 2014. The delay resulted from early delays in the award of the building consents as a result of unanticipated flood plain considerations. The projects were completed within the original contract value.

The following sections detail some of the more challenging aspects of the upgrade works, with a focus on the interactions with the existing infrastructure. Downer’s operational knowledge of the communities greatly assisted the smooth implementation of these critical tie ins.

7.2 CRITICAL TIE INS

7.2.1 TE ANAU WTP

Due to Te Anau’s substantial increase in population over the summer months ensuring the upgrade was completed during the low demand period was essential. In the peak demand period instantaneous demand can exceed the capacity of the plant and as such the plant could not accommodate having even one of the pumps unavailable for any period.

The design and construction philosophy for the upgrade at the Te Anau facility were focused around minimizing the disruption to the operation of the existing plant. The final design enabled the work to be completed with only one full stoppage of the plant for a duration of 7 hours.

The plant consists of three secondary pumps which pump treated water to the reticulation. To facilitate the upgrade each of these pumps had to be shifted back to accommodate the installation of dedicated flow meters and the ultraviolet reactors themselves. During the winter months two pumps are sufficient to meet peak demand, thus it was possible to undertake the required work on one of the pumps without disrupting the ability of the plant to match demand. This pump was relocated to the new position and the pipework modifications completed as far as possible without taking the system offline.

At this time a night time shut down of the plant was arranged such that the required modifications could be made to the discharge manifold to allow the first UV unit to be connected and tested. Also at this time a temporary connection was made from the discharge of one of the pumps in its original location to the modified manifold. With this work completed the system could be brought back on line with two operational pumps, and subsequently the remaining upgrade works could be completed without a requirement for any further plant outages.

Photograph 9: Update in progress – first pump in new configuration, second pump being worked on and third pump with temporary connection to relocated discharge manifold

7.2.2 WINTON WTP

The work at Winton was divided over two sites and as such included the requirement for a number of essential tie ins into the existing reticulation system:

- Cut in to the bore rising main
- Redirection of bore rising main at treatment plant through UV
- Replacement of electrical switchboard

The first critical work required was the tie in to the existing rising main from the bores to facilitate the installation of the cartridge filter units. This work needed to be carried out prior to the construction of the foundation for the new building as it required a deep excavation adjacent to the new building which would risk undermining the foundation if completed at a later stage. To enable this, the pipe was excavated and a temporary pipe loop installed to bring the rising main above ground to allow the connection to the filters later in the project. The temporary interconnection was simply removed and replaced with the permanent piping to the filters on completion.

Photograph 10: Left hand photo shows temporary arrangement of rising main during construction of filter building. Right hand photo shows the final configuration

At the treatment plant site it was necessary to modify the existing rising main from the bores such that it was redirected to the treatment building, through the UV reactor and back to the reservoir. At this time the line to the reservoir was also split and the provision for the connection to the second aeration tower made. Limited as built details of the buried services meant that excavation in this area was slow with several existing lines crossing the excavations.

The work on the raw water side of the treatment process included the luxury of working upstream of the reservoir which provided in excess of 8 hours of storage. When it came to the replacement of the existing switchboard the only capacity for outage was provided by the town's water tower, which only holds approximately 3 hours of storage at average demands. To facilitate the work a temporary generator was used to supply one of the secondary pumps directly which was then run at full speed continuously. This provided the ability to move the old switchboard off the wall and bring the new switchboard into the building. The incoming supply was connected to the new board with a temporary sub-main run to the old board and the plant brought back on line. From this position the plant equipment could be systematically changed over to the new board in a controlled manner.

7.2.3 OTAUTAU WTP

The upgrade at Otautau included two challenging aspects where disruption to the water supply had to be carefully managed:

- Replacement of the electrical switchboard and transformer
- Replacement of the bore pumps and rising main

The two aspects of the upgrade mentioned above were interlinked in that it was not possible to install the new pumps until the necessary electrical upgrade works had been completed. A key factor in the approach was that the water supply comes from a single bore and as such work in this area has the potential to jeopardise the availability of raw water.

To address these challenges the bore was modified in stages. Initially the new rising main to the building was installed and one of the two existing pumps in the bore modified to pump through the new pipework. On completion of the mechanical fit out of the building the new pump could convey water to the contact tanks independently of the second pump.

Photograph 11: New rising main to new treatment equipment installed within existing building

In parallel to this the electrical works were progressed including the upgrade to the transformer and the installation of the new switchboard. In a similar approach to that described for Winton above the existing switchboard was brought off the wall and temporarily secured in the centre of the plant room. The new panel was then fastened in place and connected to the upgraded supply, with a temporary sub-main supplying the old board. Again this approach allowed the changeover from the old electrical system to the new configuration to be completed in a controlled manner with minimal risk of unanticipated operational difficulties.

7.2.4 MOSSBURN WTP

At Mossburn the existing rising main from the two raw water bores ran directly beneath the proposed location of the new treatment building. Due to the flood level at this location it was necessary to build a platform for the new building approximately 1m above the natural ground. The construction of this platform on top of the existing rising main would have created substantial risk of damage and as such a temporary redirection of the main was undertaken to take the pipe outside of the construction zone. The Mossburn reticulation includes minimal storage and as a result careful coordination of any outages with the area’s largest water user, the Silver Fern Farms processing facility, was necessary. The temporary main was run above ground using mechanical couplings at the tie in points so as to minimize the overall duration of the outage.

Photograph 12: Existing rising main from bores temporarily redirected around construction site

Once again the coordination between the electrical upgrade work and the replacement of the bore pumps was a key challenge of the work. Again the existing board was used to provide a temporary supply to the new panel for testing and commissioning purposes. Once surety was achieved on the performance of the new equipment the power supply was shifted to the new panel and the two bore pumps replaced in sequence. Scheduling this work to avoid the peak supply periods/low bore production periods, when both bores are required to meet demand, was essential. During the replacement of the pumps the supply was limited to a single bore. A delay was allowed for between replacing the pumps to ensure the performance of the new pumps was robust and again to minimise the risk of unexpected outcomes through the initial operation period.

8 CONCLUSIONS

The upgrade works were completed successfully across the four sites, lifting four basic treatment plants to modern, state of the art, treatment facilities compliant with the DWSNZ. This was done without disruption to the communities' water supplies.

This project has demonstrated the potential benefits of the Early Contractor Involvement (ECI) procurement model and also the advantages of aligning operational and construction contracts even for relatively small sized projects. The key advantages of adopting this approach for similar projects are the abilities to:

- Focus on the long term implications of the project work (rather than simply the lowest upfront cost solution).
- Avoid the adversarial behaviors common under traditional procurement models.
- Allocate the risks robustly, resulting in risk ownership sitting with the most appropriate party
- Streamline the design and procurement phases, enabling work to be commenced without undue delay.
- Provide a strong basis to further foster the desired collaborative relationship with the long term O&M partner contractor.
- Ensure the continuity of the water supply by involving the O&M contractor in the upgrade works.

This project also demonstrated the major challenge of the procurement process, namely ensuring and demonstrating value for money in a negotiated environment. Ultimately true long-term value was achieved challenging the conventional thinking that lowest cost is equivalent to highest value.

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NOMENCLATURE

ECI	Early Contractor Involvement
DWSNZ	Drinking-water Standards for New Zealand
WTP	Water Treatment Plant