PREVENTING THE 'PONG', WHANGANUI'S FIVE YEAR JOURNEY

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ABSTRACT

Whanganui has undertaken a long and interesting journey with wastewater treatment. From 1984, screened wastewater was discharged to a long ocean outfall; subsequently in 2007, the first Wastewater Treatment Plant (WWTP) was commissioned. This design was based on a deep aerated lagoon, which combined liquid stream treatment with in-pond storage and digestion of sludge, followed by the use of a smaller settling pond for additional solids removal, and finally UV disinfection. Significant odour events in 2013, along with ongoing resource consent compliance issues, initiated an investigation process culminating in the design and construction of a new treatment plant.

Cardno was engaged to provide an upgrade solution that would meet the outfall consent requirements, make best use of the existing invested capital assets, and mitigates the risk of future odour events. Through a collaborative investigation and design period followed by a rigorous peer review process, it was determined that a new treatment process would be required to consistently meet effluent compliance requirements and minimise the risk of odour as much as possible.

A significant factor in the Whanganui design is the presence of large wet industries, which comprise a substantial proportion of the wastewater load. At various points in the design and pre-construction phases, the necessity of continuing to treat separable trade waste was raised, based on the precedent set by other wet industries that discharge direct to ocean elsewhere in New Zealand. It was determined that a combined treatment plant for both industrial and domestic waste was the only option as this effectively manages risk related to resource consent compliance, solids disposal, and odour mitigation.

The liquid stream treatment is a covered primary pond, followed by a contact stabilisation process, clarification and finally UV disinfection. The solids stream treatment is co-settlement and stabilisation of sludge in the primary pond, followed by thickening, dewatering and finally drying. Odour is collected from the covered primary pond and treated via a gas flare; bark biofilters treat foul air collected from the inlet works, contact stabilisation, and sludge handling processes.

This paper outlines in further detail the treatment plant options that were considered, selection and development of the final design, design and construction issues encountered, and finally commissioning experiences.

KEYWORDS

Wastewater treatment, contact stabilisation process, UV disinfection, odour control, trade waste control, sludge treatment, sludge drying, commissioning, early contractor involvement, guaranteed maximum price

PRESENTER PROFILE

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1 INTRODUCTION

The city of Whanganui is located on the west coast of the North Island of New Zealand. Although the city has a population of approximately 40,000, significant wet industries result in a wastewater stream with a load equivalent to a population of 200,000.

From 1984, screened wastewater was discharged to the Tasman Sea via a long ocean outfall. The city had a combined sewer and stormwater system.

In 2007, a wastewater treatment plant was commissioned. The first stage in the treatment process was a 10-12 metre deep lagoon with surface aerators, which combined liquid stream treatment with in-pond storage and digestion of sludge. Sludge was expected to accumulate and degrade within this lagoon before desludging every 10 to 20 years. The liquid stream from the primary pond then entered a secondary settling pond or additional solids removal, before UV disinfection prior to discharge to the ocean outfall. Photograph 1 shows the 2007 WWTP configuration.

Photograph 1: The Old Wastewater Treatment Plant

Since its commissioning in 2007, the WWTP never met the treated effluent conditions listed in the resource consent for discharge to ocean. Odour also was a consistent problem during summer months.

The odour intensified during the summer of 2012/13, when a 'foul stench' generated by the WWTP spread across the city; this made life extremely unpleasant for Whanganui residents. It is important to emphasis the scale of the odour issue, as it not only affected those residents in close proximity but over time the entire city was affected. Figure 1 presents a small fraction of newspaper article headlines surrounding the significant odour event.

Figure 1: Various Newspaper Article Headlines on Whanganui's WWTP Odour Issues

Whanganui's battle of the stench continues

29/03/2013

Whanganui's council is turning to short-term solutions to battle its sewage stench, but some locals believe the smell is getting worse.

The city - dubbed "Ponganui" - has stunk since about Christmas due to ongoing issues with its sewage plant.

'Ponganui' delivers summer stench

Pong replaced with stench

NEW ZEALAND / REGIONAL

Ponganui image affecting business

2:23 pm on 24 February 2013

Share this

Some businesses in Whanganui say they're losing customers because of the foul smell emanating from the town's wastewater plant.

There have been problems with the plant since before Christmas and most recently sewage and untreated waste water was pumped into the ocean for two days.

The Whanganui District Council (WDC) decided to investigate options to mitigate the odour issues and address discharge consent non-compliances. It was determined that optimisation or modification of the existing wastewater treatment plant could not eliminate the potential for future odour events or guarantee discharge consent compliance.

A replacement wastewater treatment process was required to ensure compliance with the existing consent. An alternative to this could have been to implement trade waste source separation from municipal waste and treat/'dispose of' the two streams individually. This was originally investigated in 1991 for Council by a previous Consultant, with the decision to proceed with a combined system. For this reason, source separation this far down the track would not be cost effective compared to continuing with a combined system and was not investigated further.

2 THE PROCESS DESIGN JOURNEY

By February 2013, the wastewater odour issue had become so pervasive that a decision was made to bypass the WWTP. Horizons Regional Council allowed the temporary discharge of screened sewage to the ocean outfall until December 2014, while odour mitigation measures were urgently developed by Cardno.

The journey to deliver a new WWTP has taken five years, culminating in the successful commissioning of a new WWTP in 2018, within time and budget.

The wastewater treatment plant upgrade took a natural progression through various project phases: feasibility studies (short and long-term options), concept/developed design, tender design, peer review/s, and early contractor involvement. Outcomes from all of these stages fed into the Final ‘For Construction’ Design.

2.1 SHORT TERM IMPROVEMENT OPTIONS

A Short Term Improvement Options Study report was submitted by April 2013. Significant investigation was undertaken by Cardno to identify short term strategies to mitigate odour issues, and address the underlying cause of odour generation in an attempt to make the existing WWTP operate effectively before the following summer.

Ultimately WDC and Cardno concluded that there was no guarantee that the WWTP would be able to avoid further odour events in the following summer, or be able to achieve the treated effluent discharge conditions all of the time.

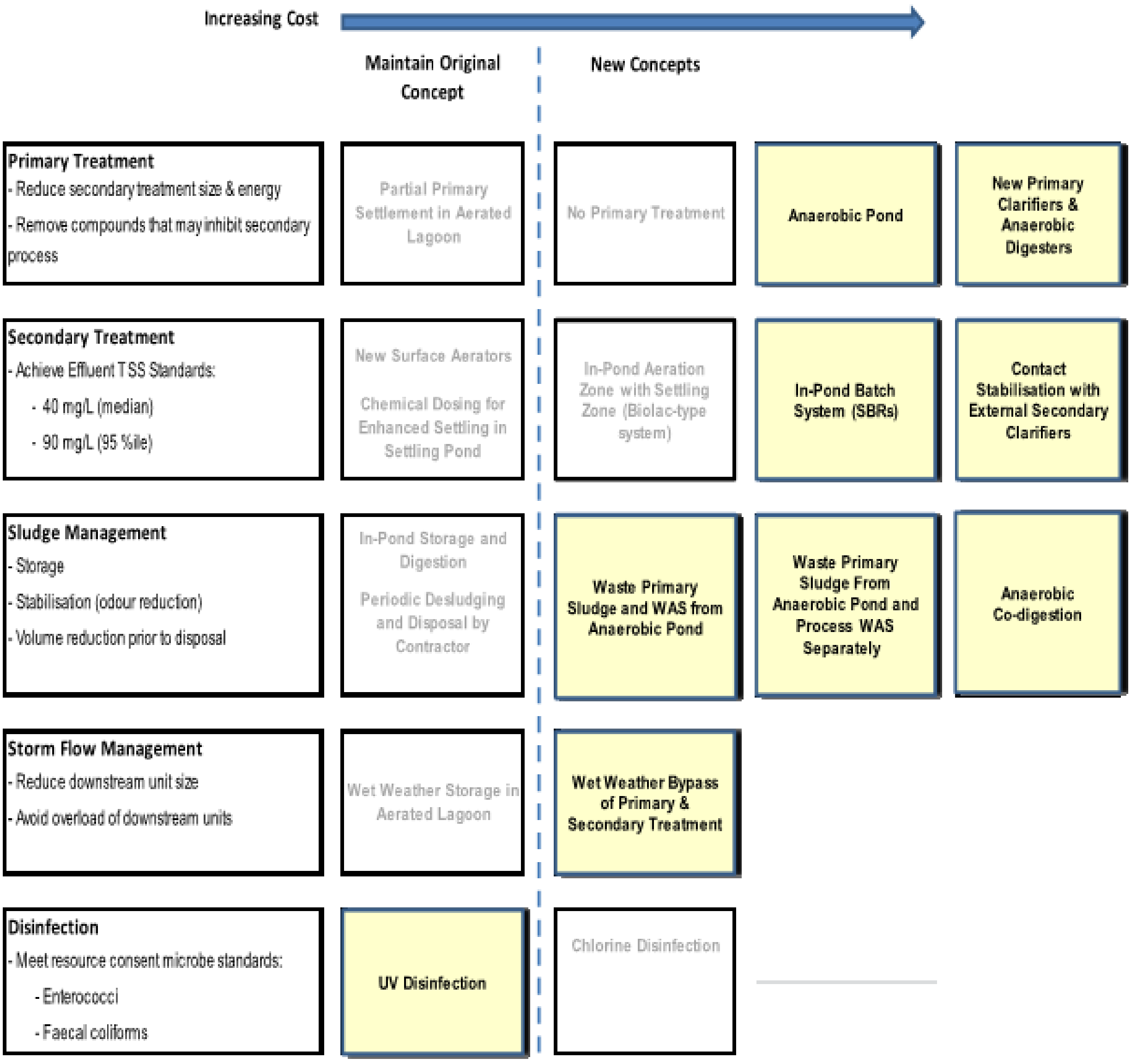
2.2 LONG TERM IMPROVEMENT OPTIONS

A Long Term Improvement Options Study was then commissioned. A key outcome from this report was the development of a set of terms of reference which have driven the WWTP upgrade project ever since. These are:

- Meet the current outfall consent requirements (TSS and faecal contaminants)
- Make best use of existing invested capital assets
- Mitigate odour
- To be commissioned by December 2014

Figure 2 outlines a decision matrix which was used to identify possible long term solutions which met the terms of reference for the new design. Cardno recommended suitable treatment options from the 16 options evaluated in this report.

Figure 2: Development of Long Term Improvement Options for the WWTP



2.3 DEVELOPED DESIGN

A Developed Design Report was completed in September 2013. In addition to a concept design for the entire plant, this report presented preliminary CAPEX and OPEX cost estimates, with a proposed programme which identified a strategy to achieve the ambitious construction phase of December 2014.

2.4 TENDER DESIGN

The Tender Design was completed by December 2013. Meeting the deadline ensured that the WWTP was on track for construction and commissioning by the end of 2014.

2.5 PEER REVIEWS

Due to the issues incurred with the previous WWTP, as well as other failed wastewater treatment schemes in recent times in New Zealand, the Cardno design was peer reviewed at every stage of the project. This included the Long Term Improvement Options, Developed Design, Detailed Tender Design, and a final overall review for additional opportunities to mitigate risk incorporated into the tender design.

WDC also sought an expert opinion from CH2M Beca, of the Final Tender Design, including the Aecom Peer Review results.

This peer review process provided the final design with an unprecedented level of review and approval for a municipal wastewater treatment plant in New Zealand.

Each separate review further mitigated the overall project risk by adding additional 'belts and braces' to the tender design, at an accepted additional cost.

The duration of the peer review process delayed the project by approximately six months, making the original deadline for a constructed WWTP by December 2014 impossible to meet.

Approval was given by WDC to proceed with the approved design was given in June 2014.

2.6 EARLY CONTRACTOR INVOLVEMENT – STAGE 1

During the tendering period (July to October 2014), Hawkins Infrastructure (now known as Downer) was nominated as the preferred tenderer in the Expression of Interest stage of the contractor tendering process. Their tender submission, on the detailed tender design, was in the form of a Guaranteed Maximum Price.

In December 2014, a council decision was made to put the construction project on hold, while community affordability, and wet industry involvement in the wastewater scheme was investigated further.

To manage this, WDC applied for a short-term consent to allow for the discharge of screened sewage to the ocean outfall. The short-term consent was granted with an expiry date of 30 June 2019, at which point treated effluent from the WWTP needed to achieve the resource consent compliance limits.

2.7 EARLY CONTRACTOR INVOLVEMENT – STAGE 2

A second round of early contractor involvement was implemented mid-2016, which focused on the including the additional processes in the approved design, as an outcome of a biosolids strategy (refer to Section 4.2) and the risk reduction measures from the various peer reviews.

2.8 CONSTRUCTION PERIOD

The construction contract was awarded in October 2016 and the site works commenced in December. WDC, Cardno and Hawkins Infrastructure (Downer) worked closely to ensure the project was delivered on time and on budget.

Some design areas were allocated to the contractor to design and construct, Cardno completed the final design for the rest. Cardno were ultimately responsible for upholding the integrity of the process design in all areas.

2.9 PROCESS COMMISSIONING

Liquid stream commissioning commenced in March 2018, only 17 months after awarding the project to Hawkins Infrastructure (Downer), and the WWTP has been discharging treated wastewater compliant to existing long term consent.

Sludge stream commissioning commenced in July 2018, once sludge had built up in the Primary Pond. The WWTP is currently producing dried biosolids that will be used as fill in the secondary pond remediation.

Section **Error! Reference source not found.** highlights some of the challenges faced during the process commissioning phase.

3 ALTERNATIVE OPTIONS CONSIDERED

3.1 ALTERNATIVE TREATMENT METHODS

Various alternative technologies to rectify the existing WWTP were investigated at the request of WDC. These technologies ranged from advanced pond based treatment systems, odour and corrosion control dosing systems, microbial dosing, and permeable pond covers that provide odour treatment.

The alternative technologies were evaluated for their suitability and ability to manage Whanganui's wastewater requirements. This included the following criteria: wastewater treatment performance, constructability, process, complexity, completion time, cost, and company track record.

The upgrade needed to be robust and proven, not a R&D project which would have an incompatible risk profile with the scope of engagement for this upgrade. These alternative technologies were therefore eliminated.

3.2 PARTIAL OR FULL TRADE WASTE SEPARATION

Partial or full trade waste separation at source is a common strategy for NZ Local Authorities when conditions are appropriate. If this was to be found feasible, it could have reduced or even avoided the upgrade of the failed Whanganui WWTP.

The separated trade waste would require pre-treatment prior to blending with treated municipal wastewater effluent and discharge out the ocean outfall. The level of pre-treatment would be determined by ensuring that the blended ocean outfall effluent was compliant with WDC's effluent consent conditions, currently in place.

This was originally investigated in 1991 for Council, but a combined system was eventually built. For this reason, the feasibility study proved that to go back on the 1991 decision and implement industrial source separation would not be the most cost effective from this point onwards.

3.3 INDUSTRIAL PRE-TREATMENT

An investigation was carried out to consider the viability of requiring industries to pre-treat their loads. It was estimated that industrial pre-treatment could reduce the organic and solids loads by 35% and 40% respectively. If this was to be found feasible, it could have reduced or even avoided the upgrade of the failed Whanganui WWTP.

It was determined that industrial pre-treatment was not the preferred option due to fact that a WWTP upgrade would still be needed to ensure effluent compliance and minimise the risk of future odour events. Industrial pre-treatment would carry an increased level of odour risk from the sites and add complexity to the management of trade waste.

4 INTEGRATED STRATEGIES TO FURTHER REDUCE PROJECT RISK

The following strategies were also developed to reduce the project risk as much as possible:

- Biosolids Strategy (to reduce the risk around operational cost accuracy and escalation)
- Trade Waste Strategy (to protect the wastewater treatment plant from overloading or shock loadings)

4.1 TRADE WASTE STRATEGY

WDC needed a strategy to manage Trade Waste Dischargers, in order to:

- Protect the performance of the Council asset:
    - No damage to the assets
    - No more odour events (prevent 'the return of the pong')
    - Resource consent compliance
- Charge fees to recover costs on a fair and justified basis

A trade waste strategy was commissioned in 2017/18 and completed the following:

- New trade waste bylaw.
- New discharge permits (including discharge limits, charging basis, and monitoring requirements).
- Implementation of online monitoring of trade waste, to allow real time decisions to be made to ensure that the WWTP is protected.
- The future option for WDC to install 'process protection units' if industry prove to be non-compliant on a consistent basis.

The implementation of the new trade waste strategy is ongoing, but relationships with local industry have improved compared to in the past which will hopefully lead to more collaborative and successful outcomes.

4.2 BIOSOLIDS STRATEGY

A Biosolids Strategy was completed in June 2015.

Transportation and disposal (or beneficial use) of biosolids will be the largest operational cost of the WWTP. The end use also dictates the sludge treatment process requirements, and therefore the overall capital costs.

Various biosolids treatment and disposal or 'beneficial use' options were been considered, including the following:

- Digestion (for volatile solids reduction): None, partial digestion (in the Primary Pond, or a larger Anaerobic Pond), or full digestion (in a Conventional Anaerobic Digester)
- Sludge volume reduction: Thickening, Dewatering, Drying (thermal or solar), and Incineration
- Sludge stabilisation processes: Lime, Heat
- Biosolids disposal options: Various landfills, a Council purpose built monofill
- Biosolids beneficial use: Composting, Application to Land, and Energy Recovery

Combinations of the various treatment and disposal/'beneficial use' options were collated into overall biosolids treatment and disposal/reuse options, so only viable options were considered further.

A multi-criteria analysis was conducted to determine the best solution in terms of a modified quadruple bottom line with factors including: economic, functional, 'environmental and regulatory framework', and 'social and cultural'.

The preferred strategy was a thermal sludge dryer that produces dried biosolids. A thermal sludge dryer is a proven and reliable technology, which allows various disposal options to be a possibility, minimising the financial risk around future sludge transportation and end use costs. The various dried biosolids disposal/reuse options include:

- In the short term – Dried biosolids to fill in the now redundant secondary settling pond to make the land more useable.
- In the medium term – Dried biosolids application to land. Land selection, community engagement and consenting requirements will be explored to see if this will be able to be made a reality.
- The backup option – Dried biosolids to landfill.

5 DESIGN BASIS

The general design basis for the new WWTP consisted of the following design parameters:

- Influent Quality
- Effluent Quality
- Stormflow Management
- Odour Management

5.1 INFLUENT QUALITY

Table 1 presents the design flows and loads of the new wastewater treatment plant.

Table 1: Design Flows and Loads

Parameter	Units	Average	95th Percentile
Dry Weather Flows	m^3/day	27,600	
BOD_5 Load	kg/day	15,100	32,700
COD Load	kg/day	32,600	70,600
TSS Load	kg/day	14,800	36,600
TKN Load	kg/day	2,800	6,000
NH_3-N Load	kg/day	1,400	3,000

5.1.1 DESIGN AND CONSENTED EFFLUENT QUALITY

The wastewater treatment plant was designed to meet the effluent requirements as stated in the existing resource consent, as summarised in Table 2.

Table 2: Whanganui WWTP Consent and Design Effluent Standards to Ensure Consent Compliance

Parameter	Units	Basis	Consent Value	Design Value
Total suspended solids	g/m^3	Median	n/a	40
		95th percentile	100	90
Faecal coliforms	cfu/100ml	Median	10,000	1,000
		90th percentile	25,000	10,000
Enterococci	cfu/100ml	Median	4,000	500
		90th percentile	-	4,000
		Maximum	12,000	-

The effluent standards in the existing resource consent that are relevant to the design of the treatment plant are the total suspended solids and microbiological standards; there are no organic or nutrient standards in the consent.

There are other effluent limits for total grease, metals and sulphide concentrations. It is expected that the consent limits for total grease will be met if TSS concentration limits are met. The consent limits for metals and sulphides are expected to be managed as part of an effective trade waste strategy to protect the wastewater treatment plant from overloading or toxic loads.

5.1.2 STORMFLOW MANAGEMENT

Whanganui experiences infiltration and inflow into its wastewater network during storms and work to separate stormwater from the sanitary sewer is ongoing. The contribution of wet weather flows to the wastewater system results in high flows to Beach Road PS during storm events. This can result in Whanganui's wastewater system receiving over three times the typical dry weather flow during a storm. Presently, this is managed by the following process:

- When the flow is below 1,120L/s, it is sent to the WWTP for treatment
- When the flow exceeds 1,120L/s, the entire flow is diverted directly to the sea outfall as a consented activity.

The effluent falling main from the WWTP limits the flow by gravity to around 700L/s. The new WWTP needed to have a stormflow management system to cope with the difference between the maximum WWTP inflow and outflow of 420L/s (1,120 – 700L/s).

5.1.3 ODOUR MANAGEMENT

The project scope states that the risk of a future odour event should be minimised as much as possible. Therefore, all odour sources from site requires adequate containment, collection and treatment.

In addition, treatment process selection needed to take the risk of odour emissions into account, which eliminated various treatment options from being a realistic upgrade possibility.

6 FINAL PROCESS DESIGN OVERVIEW

The final 'For Construction' Design consists of the following treatment processes:

- Preliminary — Fine (1mm) rotary drum screens and vortex grit removal
- Primary — Covered Primary Pond with continuous sludge extraction
- Secondary — Contact Stabilisation Tanks with Secondary Clarification
- Tertiary — UV Disinfection
- Sludge — Extraction, Thickening, Dewatering and Drying
- Odour — Biogas flare and biofilters
- Stormflow Management — Primary Pond and Wet Weather Pumping Station

Photograph 2 shows an aerial view of the new WWTP, Figure 3 shows the process flow diagram of the WWTP, and Figure 4 shows the plant layout. The layout shows how the new WWTP makes best use of the existing assets.

Photograph 2: Aerial View of the new WWTP

Figure 3: The new WWTP Layout

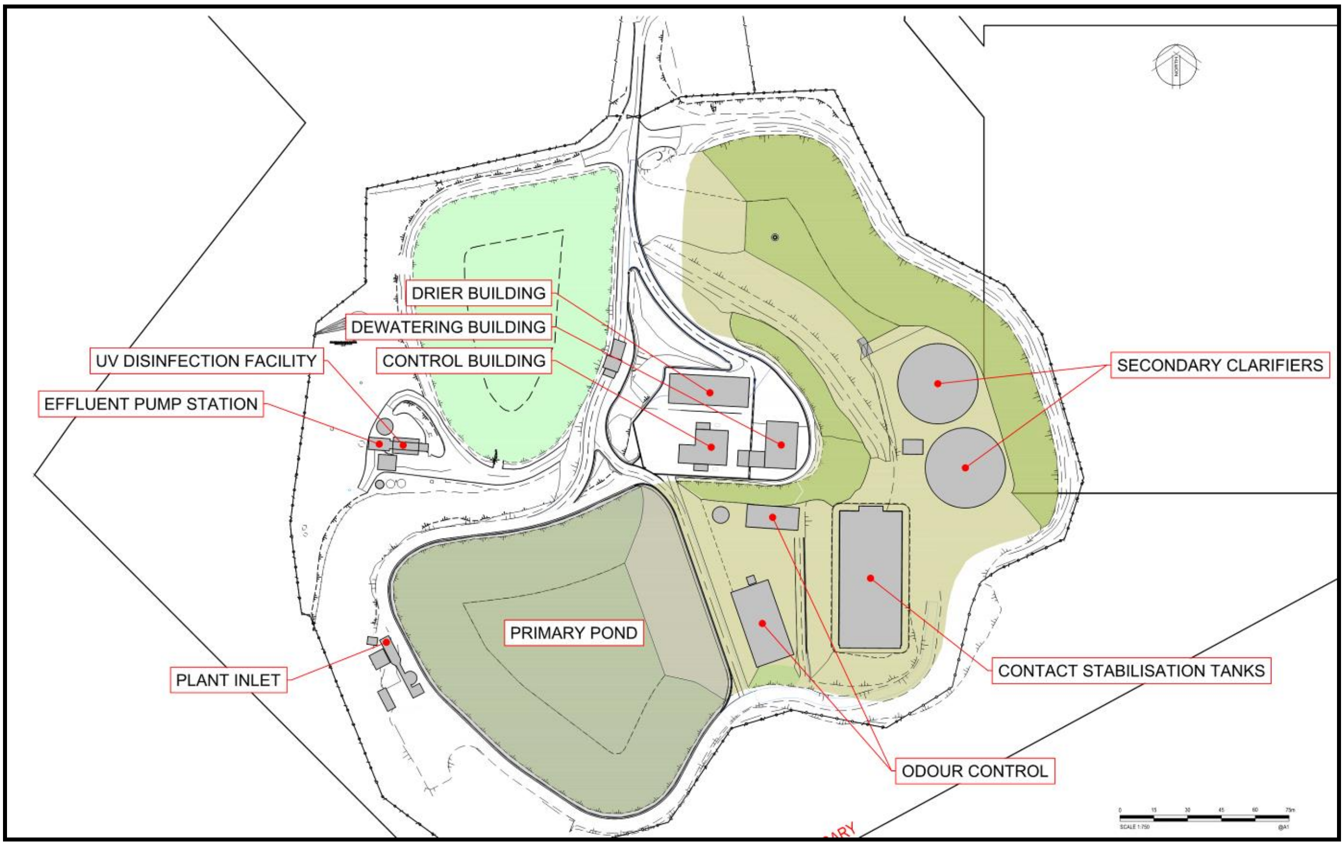
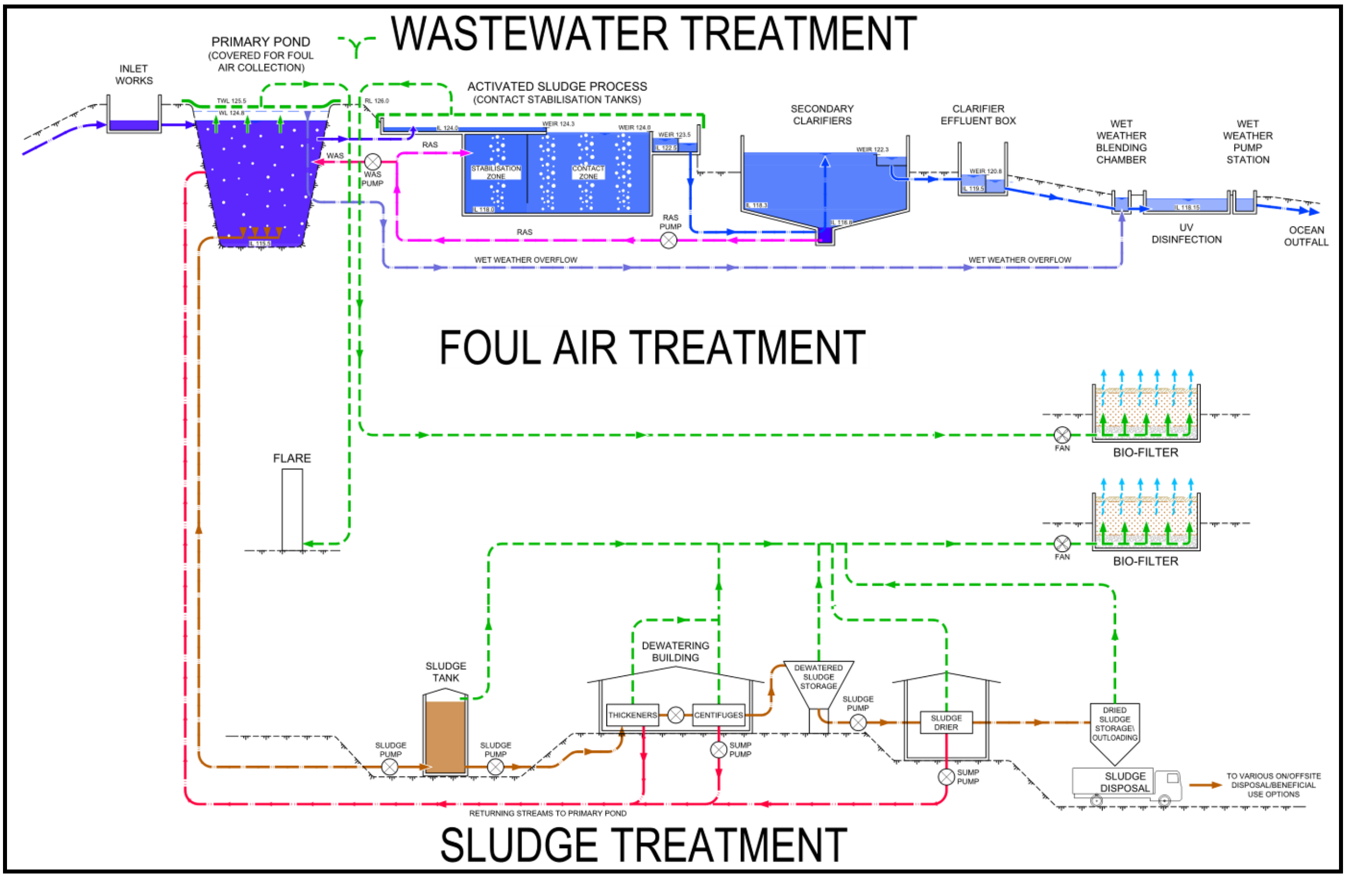


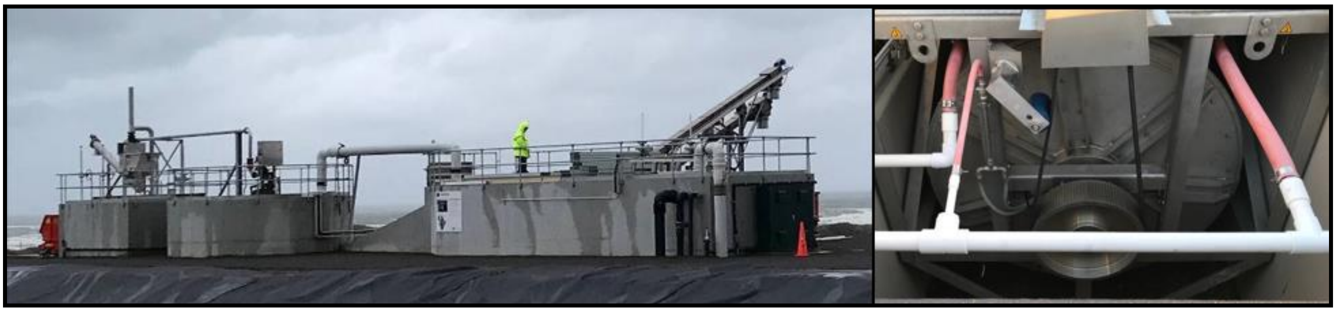
Figure 4: The Final WWTP Process Flow Diagram



6.1 PRELIMINARY TREATMENT

The inlet works consists of two 1mm rotary drum screens operating in a duty/assist configuration, and a vortex grit removal system (refer to Photographs 3/4).

Photographs 3/4: Inlet Works Structure (left), Rotary Drum Screens (right)



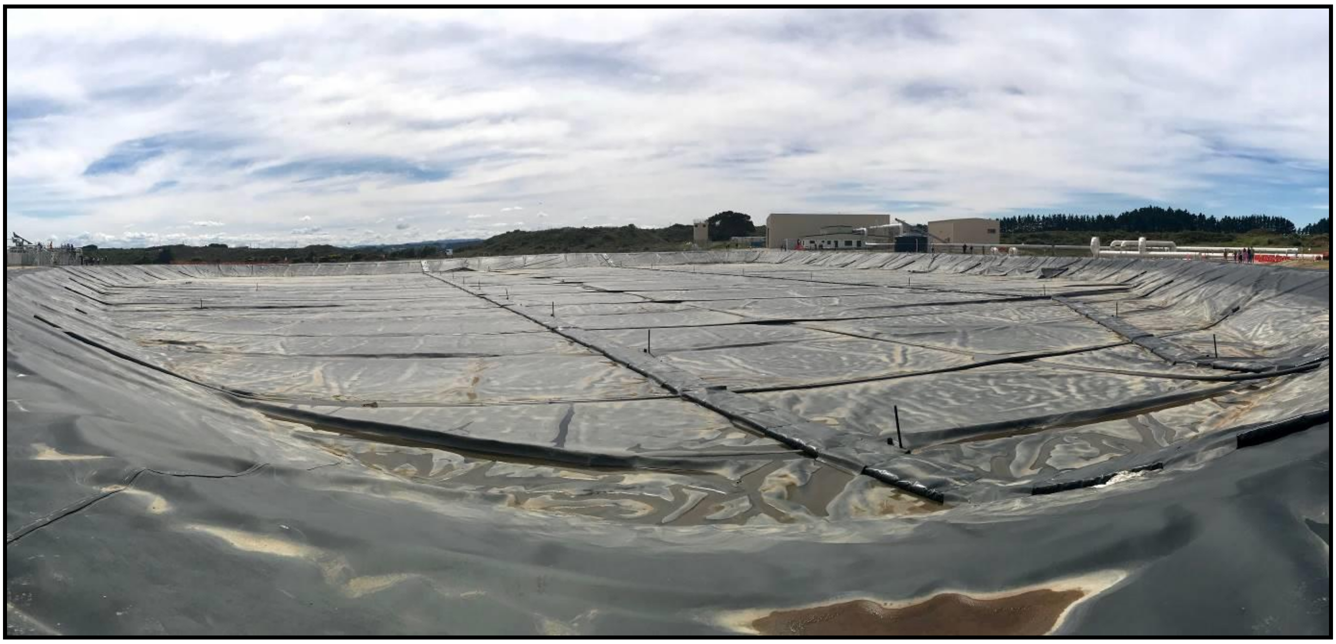
The inlet fine screens primary inclusion is to prevent blockages of the primary pond sludge extraction pipework. The vortex grit removal system protects downstream sludge handling equipment from excessive wear and tear. The inlets works is sized to treat the maximum expected flow to the WWTP of 1,120L/s.

6.2 PRIMARY TREATMENT

A Primary Pond (Photograph 5) was selected as the preferred primary treatment step over the more traditional method of a primary settlement tank to make use of the existing assets as much as possible in order to reduce the overall upgrade cost.

The covered primary pond provides flow and load buffering to downstream treatment processes, and co-settling and storage of primary and secondary solids.

Photograph 5: Primary Pond



The Primary Pond has a 2.5 day hydraulic residence time and a 40-60 day solids retention time. The maximum flow of primary pond effluent to the secondary treatment process is 700L/s, inflows above this are buffered in the pond until it overflows to the tertiary treatment system.

The settled solids volatile fraction undergoes partial digestion, providing a reduction in sludge volume. Sludge is continuously withdrawn for sludge treatment via a pipework lattice that extracts from various floor positions.

Odourous gas is captured under the cover, and treated through a gas flare.

6.3 SECONDARY TREATMENT

The purpose of secondary treatment is to form a settleable biomass that can be removed prior to tertiary UV disinfection. For the Whanganui WWTP the only secondary treatment requirement is to meet the TSS limit; there are no BOD or nutrient standards. However, if the solids limit is not met, then it is probable that the pathogen limit will also not be met, due to ineffective UV disinfection performance.

Photograph 6: Contact Stabilisation Tanks

A low sludge age activated sludge process was considered to ensure the formation of a settleable biomass. Options considered included contact stabilisation, high rate activated sludge, and sequencing batch reactor technology. Contact stabilisation was chosen as the preferred technology, due to it having the lowest footprint, lowest aeration requirements, and lowest cost.

Contact stabilisation is a type of high rate activated sludge process where return activated sludge is aerated in a stabilisation zone prior to mixing with influent wastewater in the contact zone. Creating a separate aeration zone for the return activated sludge reduces the total aeration volume (and cost). A short sludge age is maintained, which avoids nitrification occurring, further saving on aeration costs. Refer to Photograph 6.

The process is operated as two continuously fed treatment trains, with a combined hydraulic capacity of 60,480 m^3/day (700 L/s).

The removal of solids from the Mixed Liquor Suspended Solids (MLSS) are effected in circular clarifiers before the wastewater goes to further treatment. Secondary clarification allows the MLSS to settle into a sludge blanket with a clear water zone above. Flocs settle out of the clear water zone, and thicken in the sludge blanket before removal as clarifier underflow.

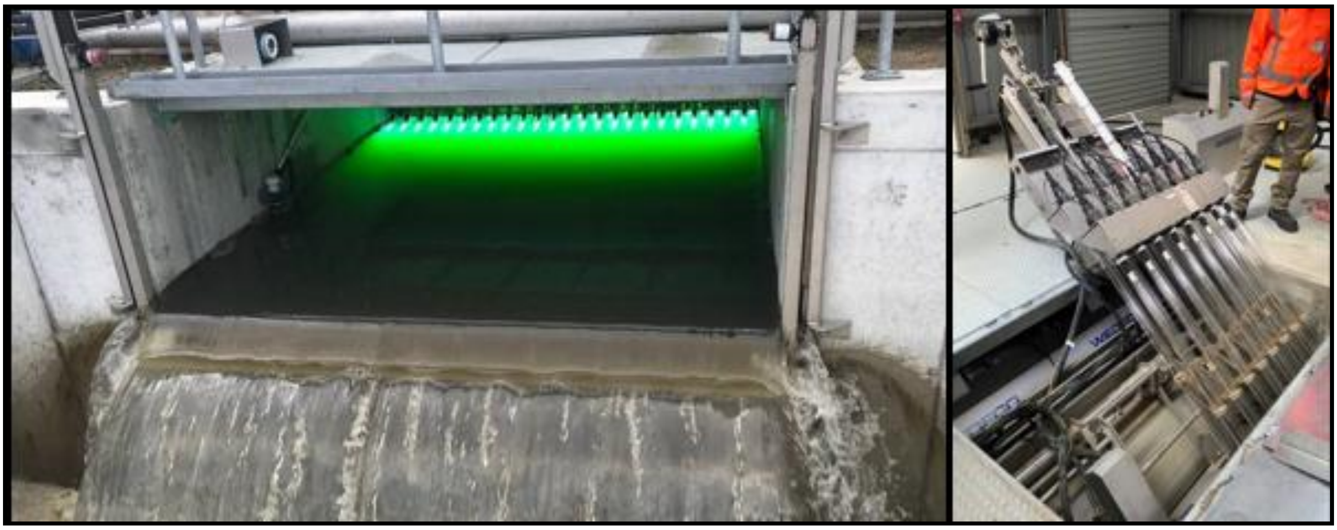
Two clarifiers (Photograph 7) were selected to provide redundancy. One clarifier is able to cope with ADWF flows and loads, while two clarifiers allow for 95th percentile flows and loads. In addition, the total clarifier capacity will be adequate if an additional contact stabilisation train is added in the future.

Photograph 7: Secondary Clarifiers

6.4 TERTIARY TREATMENT

Effluent from the secondary clarifiers passes to the ultraviolet (UV) system for disinfection in order to meet consent bacteriological standards. Other forms of disinfection were considered, such as chlorine disinfection but not progressed further due to potential harmful by-products, public perception and the effects on the receiving environment.

Photograph 8: Tertiary UV Treatment System



6.5 STORM FLOW BUFFERING

Whanganui WWTP's outfall consents require that all flows equal to or less than 1,120L/s must be treated before discharge to the outfall (a diversion exists for flows higher than this, which bypasses the entire treatment plant). The capacity of the secondary treatment system and the gravity falling main from the plant back to the outfall pipeline is 700 L/s.

The primary pond is designed to buffer diurnal peak flows and partially buffer wet weather events. To increase the capacity of the system a bypass line and booster pump station on the effluent falling main was considered the most cost effective option.

The pump station design consists of a wet well and two pumps in duty/standby configuration.

6.6 SLUDGE TREATMENT

Primary sludge and Waste Activated Sludge (from the secondary treatment process) co-settle in the primary pond, where the volatile solids fraction undergoes partial digestion, providing a reduction in sludge volume.

The solids handling facility is comprises of primary pond sludge extraction, mixing, thickening, dewatering, drying, polymer storage/make-up, dewatered sludge storage, dried sludge storage and outloading, as well as conveyance equipment.

The design performance basis for sludge treatment is as follows:

- Primary pond sludge extraction and mixing to between 1.5-4%DS.
- Rotary drum thickeners thicken the sludge to between 4-6%DS.
- Decanter centrifuges dewater the sludge to between 17-22%DS.
- Thermal sludge drying dries the sludge to at least 90%DS.

This sludge treatment system produces a Grade A stabilised biosolid at over 90%DS, which allows various disposal options to be a possibility, while minimising the financial risk around future sludge transportation and end use costs.

Photograph 9/10:   Sludge Mixing Tank (left), Rotary Drum Thickeners (right)

Photograph 11/12: Decanter Centrifuges (left), Dewatered Sludge Silo (right)

Photograph 13/14: Thermal Sludge Dryer (left), Dried Sludge Storage/Outloading (right)

6.7 ODOUR TREATMENT

A main project driver was to minimise the risk of a future odour event as much as possible. Therefore, all potential odour sources from site required adequate containment, collection and treatment.

The odourous locations identified and the implemented mitigation are the following:

- Inlets works – Covered, extracted and treated via biofilter (Photograph 16)
- Primary Pond - Covered, extracted and treated via combustion in a gas flare (Photograph 15)
- Contact Stabilisation Tanks – Covered, extracted and treated via biofilter
- Entire Sludge Treatment System – Covered, extracted and treated via biofilters

Photograph 15: Primary Pond Biogas Flare

Photograph 16: Biofilters

7 LOCAL GOVERNMENT PERSPECTIVE

The design of the new WWTP was more than just an Engineering process. It was also a test of Local Government processes and procedures to get to a position where Councillors could make a decision while at the same time minimising the risks that comes with a decision as complex as this one.

7.1 POLITICAL INFLUENCES

From the time of the first odour event in the summer of 2012/13, all the way through the design phases of the project, up until the signing of the final contract with the preferred Contractor, there was a constant struggle aligning Political influences and good Engineering. Politicians have different priorities to Engineers, and things such as cost can have a much higher importance when a wastewater project competing with others that are more visible and pleasing to the voting public. The insight gained from this project is that if the Engineering is done well, it will pass all the unforeseen tests that political influence will throw at it.

7.2 COUNCIL

The Whanganui District Council had to take a detailed look at its decision-making processes and procedures to prevent a repeat of the conditions that led to the design and construction of the first WWTP. WDC initiated an independent review of the facts pertaining to its decision-making processes from 2003 to 2012, leading to the failure of the WWTP. The report was completed in September 2016. The following were some of the recommendations from this review:

- Reform of Procurement Policy for Major Procurements.
- Reform of the Tenders Board. In order to enhance good governance, the review of the Tenders Board should include consideration of whether the outcome of all Major Procurement tender processes should be considered by all Councillors.
- It was recommended that current reporting practices be formalized into Council policy which includes that independent peer reviews and risk assessments related to major projects must be considered and approved by the full Council.
- It is recommended that Local Government New Zealand and Central Government consider the development of consistent national development guidelines for water and wastewater treatment.
- It is recommended that Council revise and strengthen its Trade Waste By-Law to enhance the best practice and social responsibility of wet industries in their operational relationships with Council's wastewater treatment plant infrastructure.

7.3 INDUSTRY

WDC created a new more robust Trade Waste Bylaw to assist in the management of Industrial effluents entering the new WWTP. The new Trade Waste Bylaw was created in two parts.

The first part was a more generic portion of the Bylaw that describes the rules and expected behaviour of Industry and Council, and specifies what types of contaminants cannot be accepted into the new WWTP. The second part covers the issuing of Trade Waste Discharge Permits for each major industry.

In our negotiations with Industry we made it clear that the focus of the new Trade Waste bylaw was not the collection of money from Industry, but rather protecting the new WWTP process. This created a common goal between WDC and Industry and created a more cohesive environment to determine parameter limits.

The discharge permits specify the maximum allowable limits that can be accepted from each industrial site without putting the WWTP process at risk. Calculation of trade waste charges will be on actual real time flow, organic, and solid contributions from Industry and be invoiced on a quarterly basis. In this way, Industry pays for what discharges and if they behave well and discharge good quality effluent, they pay less.

7.4 GOVERNMENT

In light of other Territorial Authorities experiencing serious problems with the design and construction of new WWTPs, this project attracted a lot of Central Government attention. There were constant enquiries and communications from the Department of Health, the Department of Internal Affairs, and the Office of the Auditor General. There were also many requests for information via the Local Government Official Information and Meetings Act and even a complaint to the Office of the Ombudsman.

7.5 CONTRACTUAL

The construction contract was tendered as a standard NZS 3910 contract, but for potentially the first time in Local Government it was put to the market as a Guaranteed Maximum Price (GMP) contract with a substantial Early Contractor Involvement (ECI) phase. The reason for this was to protect WDC against a price blow-out in a contract where there were many unknown conditions that could severely influence the final cost. These unknown condition included things such as the quality of the fill to be used in substantial earthworks, the condition of the existing site after construction of the previous plant and the full decommissioning and demolition of the old plant. Hawkins Infrastructure (now Downer), the contractor that won the tender had substantial experience in ECI processes and GMP contracts, but for WDC it was a very steep but valuable learning curve

The ECI phase of the project was to allow the contractor to have input into the construction best practice to create savings for WDC and simplify the construction. In this project it created savings of well over a million dollars and ensured a project that was easier to construct with further savings in total construction time and avoiding extension of time delays in completing the project.

As described earlier, the way in which the contract was set up and tendered delivered a construction contract that produced unrivalled value for money. Despite the fact that this was a complex construction, the contract was completed on time and well under the original contract value.

8 PROCESS COMMISSIONING / LESSONS LEARNT

Liquid stream commissioning commenced in March 2018, only 17 months after awarding the construction contract to Hawkins Infrastructure (Downer), and the WWTP has been discharging treated wastewater compliant to existing consents.

Sludge stream commissioning commenced in July 2018, once sludge had built up in the Primary Pond. The WWTP is currently producing dried biosolids that will be used as fill in the secondary pond remediation.

This section highlights some of the interesting challenges faces during the process commissioning phase.

8.1 SITE ACCEPTANCE TESTING – AERATION SYSTEM

A key learning is that a specified test method needs to be practical to implement in the field, and have appropriate fixed/portable equipment and instrumentation available to measure to an adequate degree of accuracy.

For the Whanganui WWTP commissioning, this was particularly important in regard to the aeration system site acceptable testing.

Aeration performance and reliability was very important for the Whanganui WWTP for the following reasons:

- The WWTPs capacity and performance will be tested within the first 12 months of operation. The peak load design is expected during primary industry peak season (normally December to February).
- If the aeration system was unable to perform to the specified contractual performance, the WWTP could breach its effluent consent compliance, as well as increase the potential for an odour event.
- The aeration system is one of the more expensive areas of the WWTP.
- WDC has had a chequered history in regard to aeration equipment reliability and performance with the previous WWTP.

The site acceptance test method specified in the contract was robust, but obtaining adequate data to validate site acceptance proved to be very difficult. Various factors contributed to this, including but not limited to:

- There was no way uniformly mix the tank without aeration.
- The aeration control valves were inadequate to control the air flow rate to the accuracy required to test.

This was resolved by the use of an offsite test facility to validate the performance of the Whanganui WWTP aeration system. The diffuser depth, density, and individual diffuser flowrate were replicated accurately to that installed at the Whanganui WWTP, and adequate measurement equipment and flow control systems were in place. The tests were witnessed by both the client and the contractor, and were deemed to adequately validate the performance of the aeration system.

8.2 DESIGN ENVELOPES - OVERPERFORMING SLUDGE TREATMENT

Most peer review comments around risk minimisation focus on the potential for underperformance of treatment processes. For the Whanganui WWTP, this was particularly the case for the expected primary pond sludge quality in terms of dry solids content. However, during commissioning there has been more issues with over performance of the sludge treatment systems than under performance.

A peer review highlighted that it could be possible to get primary pond sludge as low as 1.5%DS. At this quality, the ability of the decanter centrifuge to achieve the minimum dewatered sludge quality of 17%DS for the thermal sludge drying process could be at risk. To mitigate this, rotary drum thickeners were installed to ensure that the centrifuge feed quality would be adequate to ensure that the minimum requirement for the sludge dryer would be met.

During solids stream commissioning, the primary pond sludge has been very consistent at around 3.5-5.5%DS, much higher than the worst case scenario of 1.5%DS. Therefore the rotary drum thickeners are not required at this stage, and the design allows for bypassing of the rotary drum thickeners to feed the decanter centrifuges directly.

However, with the 3.5 to 5.5%DS feed into the decanter centrifuges (bypassing the rotary drum thickeners), the optimised dewatered cake can be as high as 28%DS.

This is great in terms of reducing the heat load required by the thermal dryer, but the pumped dryer feed pumps that feed dewatered sludge to the dryer are unable to pump sludge over approximately 22%DS. At 28%DS, the viscosity of the sludge becomes too great, increasing the friction head above the pumps capability.

The dewatered sludge conveyance to the dryer had a specified operating envelope of 17%-22%DS, therefore it was never designed to convey dewatered sludge above 22%DS. For commissioning purposes, the dewatering process was 'detuned' to ensure that dewatered sludge within 17-22%DS is produced, to allow conveyance to the dryer on a consistent basis, and to prove the dryer at the contracted design basis.

In the long term, we are currently investigating sludge lubrication with polymer and/or water to decrease the friction head. It is hoped that this will allow maximum dewatering performance to reduce the heat load required by the thermal dryer.

9 CONCLUSIONS

Due to an extreme odour event from the existing Whanganui WWTP in the summer of 2012/13, Whanganui District Council decided to commission an investigation into options to mitigate the odour issues and address discharge consent non-compliances. It was determined that optimisation or modification of the existing wastewater treatment plant could not eliminate the potential for future odour events or guarantee discharge consent compliance, and a new WWTP was required.

From this point, the wastewater treatment plant upgrade project took a natural progression through the normal phases of a typical engineering upgrade project: a feasibility study, preliminary / developed / tender designs, two independent peer reviews and early contractor involvement (two separate phases). In addition to this, Biosolids and Trade Waste Strategies were commissioned to further reduce project risk. Outcomes from all of these stages led to the final 'For Construction' design.

The final 'For Construction' Design consists of the following treatment processes:

- Preliminary — Inlet fine screens (1mm)
  Vortex grit removal
- Primary — Covered Primary Pond with continuous sludge extraction
- Secondary — Covered Contact Stabilisation Tanks
  Secondary Clarification
- Tertiary — UV Disinfection
- Sludge — Extraction, Thickening, Dewatering and Drying
- Odour — Biogas flare and Biofilters
- Stormflow Management — Primary Pond and Wet Weather Pumping Station

It has been proven through two independent peer reviews, and finally the process commissioning, that the final 'For Construction' design is a proven, robust and cost effective design, based on the projects governing scope:

- To minimise odour
- Utilise existing assets

- Meet discharge consent compliance

The design of the new WWTP was more than just an engineering process, it involved key stakeholders from local government, central government, ratepayers, and the wet industries. It was also a test of Local Government processes and procedures to get to a position where Councillors could make a decision while at the same time minimising the risks that comes with a decision as complex as this one.

The construction contract was tendered as a standard NZS 3910 contract, but for potentially the first time in Local Government, it was put to the market as a Guaranteed Maximum Price (GMP) contract with a substantial Early Contractor Involvement (ECI) phase. This contractual setup enabled the delivery of the complexed construction contract to be completed on time and well under the original contract value.

The liquid stream was commissioned in March/April 2018 and the sludge stream in July/August 2018. There were many learnings during commissioning, the most notable being that there can never have enough redundancy and safety built into plant operations. A prime example of this is the over performance of the primary pond sludge extraction and dewatering system causing conveyance issues to the sludge drying process.

ACKNOWLEDGEMENTS

Cardno would like to acknowledge the collaborative nature of the relationship with WDC and Hawkins Infrastructure (now Downer) throughout this journey to delivering a WWTP that is compliant with resource consent and resolving the significant odour issues.