HASTINGS WASTEWATER AN UPDATE OF THIS REMARKABLE 'WIN-WIN' NO SLUDGE WASTEWATER TREATMENT SOLUTION THAT CHALLENGED CONVENTIONAL PRACTICE

R. McWilliams, B Chapman Hastings District Council, J. Bradley, P. Loughran, D. Parkinson MWH New Zealand Ltd

ABSTRACT

Almost three years on from commissioning, the unique $30M domestic wastewater treatment approach developed by Hastings District Council (HDC) and consultants MWH has proven itself to be leading-edge, technically-robust, cost-effective and culturally-acceptable. An innovative "no sludge" solution was adopted that has resulted in a paradigm shift in wastewater planning and treatment in New Zealand.

Unlike many other municipal wastewater treatment plants which traditionally use primary and secondary treatment incorporating clarifiers the project team designed a modified Biological Trickling Filter (BTF) process without clarifiers. This natural biological treatment process incorporates a low organic loaded BTF which sees the wastewater fine screened before trickling through two 10m depth of randomly packed plastic media in 37m diameter tanks. This process transforms the human waste into biomass, carbon dioxide and water which is then discharged through a Papatuanuku (rock lined) channel to spiritually cleanse the treated human waste before disposal via a 2.75km long offshore ocean outfall. The innovative arrangement meets tangata whenua aspirations, complies with resource consent conditions and eliminates the requirement for any sludge treatment and disposal. This paradigm shift solution is a first for New Zealand and probably internationally.

Maori cultural acceptance, plant robustness, low energy use and the avoidance of having to treat and dispose of sludge are significant advantages of this unique approach which has, following Hastings lead, also been successfully implemented by the Gisborne District Council and the soon to be constructed wastewater treatment plant for the Napier City Council.

KEYWORDS

Wastewater, Hastings, Tangata Whenua, Biological Trickling Filter, No Sludge, Innovation, Paradigm Shift

1 PROJECT BACKGROUND

The successful completion of the upgraded Hastings wastewater system and the associated domestic treatment plant commissioned in September 2009 marked the end of a long journey described in 2001 by the Coastal Permit/Resource Consent Hearings Committee in their decision as *"a remarkable and probably historic accord between tangata whenua and local government"*. The journey has resulted in considerable engineering and planning innovation and strengthened ongoing Council relationships with tangata whenua. The domestic treatment plant has proven highly effective since commissioning and has subsequently been adopted by other Councils.

A multi-disciplinary team from MWH worked closely with the Mayor, Councillors and staff from Hastings District Council (HDC) through every stage in the project following engagement in 1998.

The resource consent and investigation project was the subject of a paper and presentation at the NZ Water and Waste Association conference in 2006. The reference list to this paper includes that paper and a number of other papers, presentations and awards the project has achieved to date.

A brief overview of the project together with the key project milestones is provided in the following section.

- 1998-1999. In 1998 HDC lodged an application for a new restricted coastal activity permit (consent) to discharge fine-screened (milliscreen) wastewater to Hawke Bay. In 1999 the HDC, with tangata whenua's agreement, requested that the subsequent hearing be adjourned due to a view by the Commissioners that tangata whenua and community concerns had not been met.

- 1999 to 2000. MWH was engaged to work with HDC and tangata whenua to find a culturally-acceptable and affordable treatment solution. Following the investigations a dual solution was proposed involving the separation of most of the industrial (trade) waste stream for fine-screening (following onsite industrial treatment) and discharge through the ocean outfall, and treatment of the human waste (kuparu) and non-separable industrial waste through fine-screening and natural settlement (primary settlement) before discharging the remaining treated human wastewater via a rock passage (Papatuanuku) to the ocean outfall. While this proposal provided an acceptable interim solution to secure the resource consent, future work would be required to achieve full removal of human waste (kuparu) as required by tangata whenua.

- 2001 to 2002. In 2001 the Consent was issued with unique conditions regarding the proposed treatment solution as well as a specific requirement for equal decision-making between HDC and tangata whenua during the search for a culturally-acceptable treatment and disposal solution. These constitutional arrangements (a committee with equal representation from the Council and tangata whenua representatives, rotating chairmanship and no casting vote) had never previously been implemented in New Zealand, or internationally and resulted in a unique governance arrangement with the establishment (under Section 107 of the Local Government Act 2002) of the Hastings District Council – Tangata Whenua Wastewater Joint Committee (Joint Committee) to oversee the construction and commissioning of a treatment plant to significantly remove kuparu by December 2007 and to then investigate options to completely remove kuparu by December 2009.

- 2003 to 2004. At the request of the Joint Committee, MWH and HDC investigated alternative configurations to better meet tangata whenua and community needs. HDC Wastewater Treatment Plant (WWTP) Manager Bob McWilliams suggested a system using fine screens and biological trickling filters (BTF) prior to discharge. As traditional BTF arrangements include primary treatment before the BTF and secondary clarifiers after the BTF (both of which produce sludge requiring further treatment and disposal, with transportation of sludge past marae, urupa and Maori homes being culturally offensive) this option was considered culturally unacceptable and too costly for HDC. Consequently MWH completed extensive research and field trips to the UK (Leeming Bar wastewater treatment plant) and Spain (Larraga wastewater treatment plant) before proposing an alternative BTF arrangement (shown in Figure 1) that would be acceptable to the Joint Committee and community. The arrangement differs extensively from a traditional trickling filter process in that no primary treatment or secondary clarification is required as the relatively small amount of excess plant biomass material that is flushed off the BTF plastic media can be discharged via the ocean outfall as part of the treated wastewater stream.

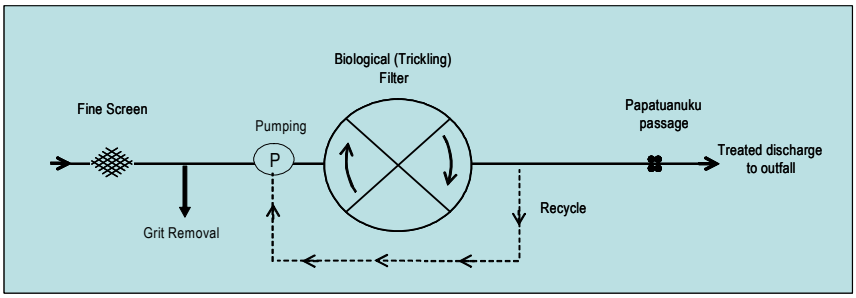


Figure 1: A schematic showing the unique BTF arrangement for Hastings

- The treatment processes comprise fine (milliscreening) screening, screenings washings and compaction; grit removal and grit washing (future provision); wastewater pumping of the screened and grit removed flow; Biological Trickling Filters (BTF) (which comprise a motorised rotary distributor to control the application of wastewater to the filter, polypropylene randomly packed plastic media within the filter structure, support decking which the plastic media sits on, and a number of fans to provide controlled ventilation of the filter); a Papatuanuku (rock) passage to restore the mauri of the treated human waste (kuparu) before discharge through the offshore ocean outfall; and a bark bed biofilter which the captured air discharge from the ancillary structures (milliscreen and pumping chambers) passes through to remove odour.

- 2003 to 2004. To ensure feasibility, the process was tested on full scale plants at Larraga in Spain. Following HDC's request to the NILSA Spanish Authority, their existing primary sedimentation was decommissioned and the proposed Hastings process arrangement as shown in Figure 1 was implemented.
- 2004 to 2005. Following positive results from Spain, the process was then confirmed locally via a pilot plant that was established at the East Clive WWTP.
- 2005. Achieving consensus on the change to the unique BTF arrangement was achieved following further consultation with the tangata whenua, community and statutory agencies. Multi-criteria decision-making analysis (MCA) workshops were also held with the Joint Committee and the Community Liaison Group to compare the earlier consented natural settlement option with the proposed change to the BTF process. The two options were compared and ranked by individual members of the above groups against a variety of social, cultural, public health, environmental, technical and economic factors. The combined scores for each option enabled the clearly preferred option (the BTF) to be identified.
- 2005. Following a site visit to the East Clive pilot plant in November the Joint Committee deemed that the BTF process met the resource consent requirements for attaining "a significant removal of kuparu". The Joint Committee was also satisfied the plant could be future-proofed with further technical enhancements to address population growth and the possible future requirement for the complete removal of kuparu.
- 2005 to 2006. In December following unanimous support for the unique BTF proposal, MWH and HDC prepared documentation seeking a change to the key conditions of the resource consent to allow the BTF process. The consent amendment was approved in March 2006.
- 2007 to 2009. Tendering and construction management was undertaken by MWH using an Engineering Procurement Construction Management (EPCM) method. In all 13 contracts were let involving a range of procurement methods including supply only, supply and install, design and build, and construction contracts. This mix was required to cater for the various lead times for equipment and material supply. Refer Appendix A for the plant photo story.
- 2009 to 2011. The commissioning phase concluded in September 2009 with the plant performing exceptionally well since then. It has exceeded the pilot plant and technical predictions regarding the removal of key wastewater contaminants as shown in the results included in this report. Following the first summer of operation and community consultation and monitoring, a decision was made to add sealed roof covers to the tanks in late 2010 to address occasional, localised odour issues. The geodesic dome covers have functioned well since completion in June 2011.

2 COMPLEXITY

There were a significant number of complexities encountered on this project.

The main complexity associated with the project was meeting the challenging resource consent conditions imposed in a manner that balanced the tangata whenua and wider Maori cultural needs alongside community needs, particularly in terms of affordability. This challenge required the identification of a Best Practicable Option (BPO) solution as defined in the Resource Management Act, namely a solution that takes account of environmental, technical and economic considerations within the local social and cultural environment.

As this Hastings specific situation to "***significantly remove human waste (kuparu)***" had not previously been encountered in New Zealand, in the way it was at Hastings, there was no ready solution available. This made for a very complex technical situation in terms of identifying a robust and affordable treatment solution.

Furthermore, the strength of feeling by tangata whenua regarding the importance of finding a culturally acceptable solution, together with the establishment of the Joint Committee with an express requirement for equal decision-making between HDC and tangata whenua, created additional emotional and governance process challenges. These unique constitutional arrangements had never previously been implemented in New Zealand, or internationally and therefore required fresh thinking in consultation approaches to achieve success.

3 INNOVATION

The unique paradigm shift in wastewater planning and treatment achieved through this Hastings wastewater project incorporates nine major areas of innovation, each of which it is understood were a first for New Zealand. The technical treatment process is also considered to be a first internationally but it has not been possible to know every wastewater treatment plant globally to establish this conclusively. The key project innovations are listed below and outlined further in the remainder of this section.

1. A unique arrangement of a Biological Trickling Filter (BTF) process which eliminates the need for primary (treatment) settling and secondary clarifiers thereby eliminating the need for any subsequent sludge, treatment and disposal. This in effect is a "no sludge" treatment solution.
2. A low organically loaded BTF process arrangement which provides a relatively high degree of biological treatment that results in a relatively small amount of excess biomass (sloughed off the BTF plastic media) that is discharged via the ocean outfall with the treated wastewater without causing significant adverse environmental effects in the marine environment.
3. The media depth in the BTF being 9m comprising three different layers of different structural integrity of the randomly packed plastic media.
4. Use of neutron probes to monitor BTF biomass density through the depth of the BTF plastic media. While this was used during the initial start-up period it is no longer used as the quantity of biomass is too low to measure accurately.
5. Use of motorised curtain effect distributors to control the biomass growth and flushing cycle.
6. Use of a daily flushing cycle to optimise biofilm thickness and process performance.
7. Innovative planning and consultation approaches required to reach agreement on the technical solution and build a historic accord between tangata whenua and local government.
8. The successful on-going working relationship of the Joint Committee since its formation in late 2001.

A number of these innovations are discussed in more detail below along with other key aspects of the project.

The wider local and international interest in this project and uptake of the unique BTF arrangement that has been adopted for Gisborne and Napier's main domestic wastewater streams, is currently being considered for Greymouth and has been adopted at the NILSA Larraga Wastewater Treatment Plant Spain where HDC / MWH initiated full scale trials in 2003-04 as part of this Hastings project.

3.1 Innovative Biological Trickling Filter (BTF) Process Arrangement and Low Organic Load

The concept of the Trickling Filter (BTF) process was originally developed in the United Kingdom by observing an improvement in water clarity in a stream as it flowed over slime-covered rocks on the streambed in the late 1800s. Traditionally Trickling Filters used stone media however in the 1940s plastic media was introduced and remains one of the most widely used biological secondary wastewater treatment processes in the world because of its simplicity, reliability and low energy requirement. It has been widely adopted previously in New Zealand using plastic media at Christchurch, Invercargill and formerly Mangere (Watercare Auckland) and stone media at for example Taupo, Mosgiel. Akaroa and Whangarei and 20 other significant sized plants.

The Hastings BTF application incorporates the plastic media trickling filter process in a different manner to conventional and existing New Zealand approaches and results in a very cost-efficient treatment process train by eliminating the need for primary treatment and associated sludge treatment as well as secondary humas (biomass) sludge clarification and associated biomass (secondary sludge treatment). Similar, but not the same approaches eliminating the primary treatment have been applied at full scale plants at least four locations in the USA and Europe. The Hastings process (shown earlier in Figure 1) comprises:

- Fine (milliscreening) screening, screenings washings and compaction;
- Grit removal and grit washing (future provision);
- Wastewater pumping of the screened and grit removed flow;
- Biological Trickling Filters (BTF) which comprise 2-37m diameter and 10m deep media tanks with a motorised rotary distributor to control the application of wastewater to the filter, a polypropylene plastic media packed randomly within the filter structure, support decking which the plastic media sits on, and a number of fans to provide controlled ventilation of the filter and geodesic cover for odour management.

- A Papatuanuku (rock) passage to restore the mauri of the treated human waste (kuparu) before discharge from the2.75 km offshore ocean outfall.
- An odour collection system and bark bed biofilter which captures the air discharge from the ancillary structures (industrial system milliscreen, domestic plant inlet and pumping chambers) passes through to remove odour.

To satisfy the Joint Committee that the amended BTF approach rather than the earlier consented natural settlement (primary treatment) (with sludge) approach would be effective, MWH and HDC negotiated with the operators of the NILSA Larraga Wastewater Treatment Plant in Spain to reconfigure their BTF arrangement to run in a similar mode to that proposed at Hastings. The trial involved on-line process monitoring on a representative installation that had a fully developed biofilm community on the BTF media over a period of six months including a very cold winter. The trial proved so successful that since then trickling filters without primary clarification have been installed at several NILSA new and other existing treatment works in Spain. While these trials proved highly effective, it was vital to also assess the method in local (Hastings) conditions to satisfy the concerns of tangata whenua.

To assist in the consultation process and provide a direct platform for tangata whenua and other stakeholders to determine whether the biological trickling process achieves a significant removal of kuparu, a pilot plant was constructed and commissioned at HDC's East Clive site in September 2005. The pilot plant, (shown in the photo story included in Appendix A) comprised a 1.7m diameter shell randomly packed with polypropylene plastic media. Finely screened wastewater in a low (organic) load mode was pumped and discharged onto the media using a rotary distributor. The results from the pilot plant were broadly consistent with those achieved at the Larraga plant. They confirm that the amended BTF process outperformed the natural settling alternative on all criteria other than in trace metals. These positive trial results not only ensured the universal support from the Joint Committee and the Hastings community but also provided compelling evidence for other stakeholders, including local authorities and iwi from other regions.

3.2 Innovative Planning and Consultation Approaches

Over a period of eight years MWH environmental and public health engineer Jim Bradley and MWH planner Paula Hunter along with Councils Legal Advisor Mark von Dadelszen were extensively involved assisting HDC in an innovative consultation and planning process with iwi in close collaboration with the Joint Committee to successfully secure the amended Consent conditions and strengthen the understanding and relationships between Maori and HDC. The references to this paper include reference to papers and presentations on these consultation and planning processes presented by Mark von Dadelsen, Paula Hunter and Jim Bradley. This process involved multiple hui and hikoi and was based on an approach of open communication. As such all Joint Committee meetings were held in public (with the exception of the final meeting which discussed Consent conditions). Community Liaison meetings were held on the evening following Joint Committee meetings and were also open to the public.

Presentations were also given to the Department of Conservation and Ministry for the Environment. An effort was also made to meet with individuals with specific concerns that couldn't be resolved in the open forums.

The Joint Committee was a historic accord established in a partnership way that established trust, respect, understanding and goodwill shown by all parties. The approach built capacity through the sharing of information to ensure other points of view were listened to and an understanding of different paradigms and a willingness to alter proposals to accommodate deeply held concerns. Searching questions were asked and answered and robust debate occurred with neither side dominating. Most importantly decisions of the Joint Committee were required to be, and all have been, unanimous. The approach was widely regarded by the Council and tangata whenua as an outstanding success.

4 TANGATA WHENUA CONSIDERATIONS

Earlier sections of this Paper highlight the critical role tangata whenua played in partnership with HDC to develop a culturally acceptable and affordable treatment solution. This solution resulted in the separation of most of the industrial (trade) waste stream, and the treatment of human waste through the BTF and Papatuanuku passage before discharge via the offshore ocean outfall. This system was devised to meet the significant removal of kuparu from the human waste stream.

The view of tangata whenua in regard to how the treatment system integrates natural processes into the wider environment is depicted in the extract set out below from the public consultation material for the current consent project. The current consent project is further discussed in section 9 of this paper.

HERETAUNGA TANGATA WHENUA VALUES

"Heretunga Hauku nui, Heretaunga Ararau, Heretaunga Haaro o te Kāhu, Heretaunga Takoto noa! Heretaunga of the life giving dew, of the hundred pathways, the vision of the far-sighted hawk, left to us the humble servants"

The current wastewater treatment process combines:

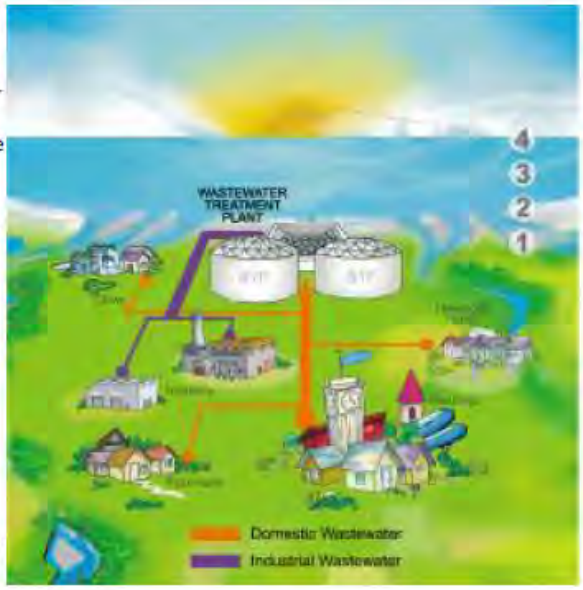
- innovative engineering infrastructure,
- applied science, and
- the customary practices and values of mana whenua.

The diagram below attempts to show the Maori dimension being expressed in an integrated form, against a backdrop of the current wastewater system.

1 Tane Mahuta - **The deity of the flora and fauna.**
Provides the bugs in the biomass in the biological trickling filter. Through the biomass, the kuparu is transformed by the removal of the *mauri* (life essence) of the human wastes.

2 Papatuanuku - **The earth element in the creation; the female element.**
The earth mother, receives the transformed waste and the contact with papatuanuku proceeds to re-establish the *mauri* (life essence) to the transformed waste.

3 Tangaroa- **The male deity of the oceans.**
Receives the transformed waste (after passage through Papatunuku), and in his vastness, tidal movements and currents he makes himself clean. Tangaroa has the natural capacity to cleanse himself.



4 Tamanui te Ra and Tawhirimatea - **The deity of the heavens and the deity of the winds**
By agitating the surface of the ocean (Tangaroa), and through the very synthesis of air and water, the cleansing process is completed with any odours being dissipated aerobically

- the discharge of wastewater from the WWTP into the sea, including specific cultural values that may be affected.
- To identify the potential effects (both favourable and adverse) on cultural values of the proposed activity.
- To identify appropriate measures to avoid, remedy or mitigate, where practical, any adverse effects of the proposed activity on cultural values.

Do you have any thoughts on this view?

WASTEWATER RESOURCE CONSENT

HASTINGS DISTRICT COUNCIL

5 ENVIRONMENTAL CONSIDERATIONS

5.1 Natural and Physical Environmental Benefits

The environmental benefits of not having to treat and dispose of sludge are considerable. These include elimination of many adverse effects associated with transporting sludge and of land filling, or disposing via beneficial reuse on land.

In addition there is a significant reduction in the carbon footprint of the treatment operation compared with that originally consented. This benefit is in the main, achieved through the low energy use of the plant, and also the minimisation of greenhouse gas emission through not having sludge treatment and disposal requirements that emit methane and other greenhouse gases.

Due to the nature of the combined treated wastewater streams, and the considerable dilution and dispersing of treated wastewater that occurs with the ocean outfall discharge, the resource consent monitoring shows that there are no adverse effects in the marine receiving environment outside the agreed mixing zones that cannot be appropriately remedied or mitigated under the Resource Management Act (as required in the resource consent conditions).

5.2 Cultural Benefits

The tangata whenua – Maori cultural benefits delivered through this project cannot be understated. The establishment and functioning of the Joint Committee has seen consultation and partnership building taken to new levels of trust, integrity, respect, understanding and goodwill and has proven that cultural values can unite and not divide a whole community. There is considerable potential for this unique governance arrangement to benefit other complex and contentious consent projects as long as the spirit of engagement is the same as that shown at Hastings.

5.3 Social Benefits

The engagement of the wider community and the Community Liaison Group resulted from the thorough and effective consultation approach adopted, as well as the compelling visual nature of the pilot plant trial results. The pilot plant ensured a much higher level of community interest and involvement with the Consent process and a very high level of acceptance of the BTF method than is typically experienced in New Zealand. In addition, the use of multi-criteria decision analysis workshops proved very effective in understanding and quantifying the relative benefits of the two alternative options. The value of this approach as an education tool for uptake on other complex and contentious consent projects is significant.

5.4 Economic Benefits

The project has built in future proofing at about the same capital cost as the originally consented natural settling (primary treatment) approach. While the capital costs of the scheme were similar to the originally proposed primary treatment scheme, the savings of around $1 million in operating costs annually through the elimination of the sludge treatment and disposal processes are substantial. From an industrial wastewater discharge perspective, the separate industrial waste system also provides a cost effective solution for industry by allowing onsite treatment and / or HDC's industrial wastewater discharge costs which are some of the lowest charges in the country. If the industrial wastewater had required treatment through a Secondary - Biological Treatment Plant the costs to industry would be extremely high, and in some cases may have been cost prohibitive, thereby potentially resulting in a loss of industry within the Hastings District.

6 CONSTRUCTION APPROACHES AND CHALLENGES

The construction of the plant was delivered using an Engineering Procurement Construction Management (EPCM) method. In all 13 contracts were let involving a range of procurement methods including supply only, supply and install, design and build, and construction contracts. This mix was required to cater for the various lead times for equipment and material supply.

The main civil contract, undertaken by DownerEdi ,was constructed in the 2007-2009 period but prior to that separate contracts were let for the supply of the inlet screens and equipment, pumps and VSD's and the Grit Classifier equipment. Also contracts were let for the manufacture of more than 6,000,000 random pack plastic

media pieces for use in the BTF process along with the distributor and ventilation components, and ground strengthening under the tanks to mitigate any seismic risk using specialist Italian plant to achieve deep soil mixing.

Equipment contracts for switchboards, stand-by generator, BTF and bio-filter fans ran parallel with the construction of the two BTF structures which were each 37m diameter and 11m high to accommodate 10m depth of plastic media initially, but allowed for a future depth of 11m should additional demand require this in future.

The main civil contract was for the construction of the plant incorporating all of the contract elements. The treatment plant was completed by 30 June 2009, the date set in the resource consent for treatment via the BTF process.

The EPCM method was chosen as it allowed for the staged procurement necessary to cater not only for the various lead times, but it also provided the level of flexibility needed by the procurement team and the Hastings District Council to stage the design and to generate cost savings through major equipment being purchased directly by HDC which were then supplied free-issue to the installation contractor. This method best allocated the risk between the Contractors and the Council.

EPCM does require a strong emphasis to be placed on the management of the multiple interfaces between the contracts, sub-contracts and supply contracts. The responsibility for the success of this ultimately rested with MWH which proved to be one of the most challenging aspects of the project.

7 OPERATIONAL MATTERS

Operational Experience Overall

From an operational perspective the BTF wastewater plant has been shown to be relatively straight forward to operate and provides a high degree of reliability confirming the simplicity of the BTF system.

There are no special operational requirements. The key mechanical components of pumping, screening and the BTF motorized distributors are standard type operation particularly when compared to some of the more complex systems and plant involved in suspended growth activated sludge and BNR type plants.

Notwithstanding the above the biomass has been impacted by some toxic slugs of chemicals encountered at the plant recently. While some immediate biomass die off has resulted, the effects have been short term, typically within 24 hours to achieve full recovery. These incidents have shown the BTF biomass to be a robust and resilient process as compared to some other types of secondary biological treatment systems.

Motorised BTF Rotary Distributors and Flushing the Media

The motorised rotary distributors are key to the successful operation of the BTF's in that correctly operated they allow the development and maintenance of a healthy biomass that thereby leads to a consistent level of treatment. During normal operation (21 hours per day) the distributor rotates at a constant rate of 1 revolution every 1.5 minutes. This maintains the correct irrigation rate to provide good uniform application of the wastewater and to dislodge some of the "worked out" biomass which flows out of the BTF together with the treated wastewater.

The other 3 hours is the flushing cycle where the distributor rotates much slower at 1 revolution per 30 minutes thereby flushing the excess biomass out of the media. This results in an increase in biomass leaving the BTF with the treated wastewater and being discharged out the ocean outfall. Investigations show this increased level of biomass discharged does not cause significant adverse effects outside the 500 and 750 m mixing zones from the center of the outfall diffuser.

Recent investigations being undertaken as part of the new resource consent project (section 9 below) investigates the flushing cycle in detail including its effects on the marine environment following discharge out the ocean outfall. In terms of the ocean outfall discharge to the marine environment, the industrial flows dominate the joint treated wastewater discharge characteristics. With this being the case, the increase in biomass discharge during the flushing cycle is therefore relatively insignificant.

Separated Industrial Flows

As set out above the BTF treatment arrangement caters for all of the domestic and smaller non-separable industrial wastewater flows in Hastings. A dedicated industrial wastewater network has been constructed to service the major industrial areas in the City with the bulk of our seasonal discharges consisting of relatively high organic loading and suspended solids flows principally from food industries. Of note is the requirement for all industrial discharges to specifically exclude any wastewater of human origin. All discharges are controlled through Council's Water Services Bylaw and any new or changed industrial (trade) waste discharge is managed through an individual trade waste agreement with HDC in order to discharge into the separate industrial system.

Monitoring

Specific on-site monitoring at the treatment plant is provided via two automatic S::can monitoring units. These units are easily transportable and their location can be easily varied as required to monitor the inlet and outlet characteristics on the domestic and non-separable industrial or combined waste streams. To date the unit has been invaluable in confirming the BTF treatment performance and more recently in the detection of and analysis of the toxic slug investigations. This proactive monitoring approach has allowed investigations to also take place further upstream in the trunk network targeting contaminants such as sulphides, targeting the sources of trade waste and also monitoring chromium discharges.

External PC Plant Operation

The entire treatment plant was upgraded to provide full remote PC operation working through a VPN connection. This provides both flexibility and operating reliability and enables remote monitoring on a 24/7 basis for plant operators.

Snails

Biological Trickling Filter operations have often been associated with the growth of small snails and this has also occurred in the BTF's at the Hastings plant. The majority of these are settled out and removed in the grit channel of the earlier treatment plant arrangement. The reuse of this channel was always part of the proposed BTF plant for conveying the BTF and Papatuanuku channel treated wastewater to the ocean outfall pumping station.

Commissioning Issues

- Screen Performance

  The 3mm hole screens have required operational adjustment to minimise amounts of fine paper that can pass through the screen. This has occurred when there is an excessive buildup of screenings on the screen surface and a positive driving head from the incoming liquid entering the screen face.

- Control Incompatibility of BTF feed Pumps

  The integration of the control system initially had setting difficulties recognizing the minimum speed of the variable speed pumps. This was rectified by modification to the control system.

- Odour from the BTF's and installation of covers

  Initially, the BTF plant was commissioned without covers to the BTF tanks. During the concept design and economic and risk appraisal of the BTF's, odour was not deemed to be significant and the decision was made to omit the installation of covers to the BTF tanks although the design of the BTF structures allowed for covers to be fitted at a later date if operating experience found this necessary. The biological treatment process is also very effective at treating odours and with forced fan ventilation operating in a top to bottom arrangement the risk of odour was deemed to be minimal.

  During summer, a series of odour complaints from adjoining properties led to detailed investigations into odour generation at the wastewater plant and in the reticulation network upstream. The investigations concluded that the following factors were contributing to unacceptable odours:

- The incoming wastewater was acidic in nature with increased levels of hydrogen sulphide in the liquid and gas phases.

- Certain ambient wind conditions created air flow patterns that swirled over the open BTF surface and then onto adjacent residential properties.

- A one metre plus cascade from the distributor to the top of the media surface causing increased release of hydrogen sulphide and other odorous compounds. This gap was intentional and had been provided for future treatment capacity (to be achieved by a media top up of this 1 m depth). This 1 m gap meant that the downward airflow through the media (induced by the BTF fans) had limited effect at the level of the distributor where the H_2S and other odours were being released.

After consideration of alternatives to address the periodic odour nuisance along with meetings with local neighbours and the Hawkes Bay Regional Council (consent authority), HDC decided to proceed with the installation of geodesic dome covers on each of the two BTF's and to install two continuous odour treatment stations within the reticulation to dose sodium nitrate into the wastewater stream. This work was completed and operational by June 2011.

Since this work has been instigated the odour nuisance has not re-occurred. The effect of the uninterrupted down flow of the air from under the covers (which contains released odours from the distributor wastewater irrigation onto the media) through the biomass on the media sufficiently removes (treats) the odours before the fan discharge to atmosphere through external extraction chimneys.

Recent Toxic Slug Discharges

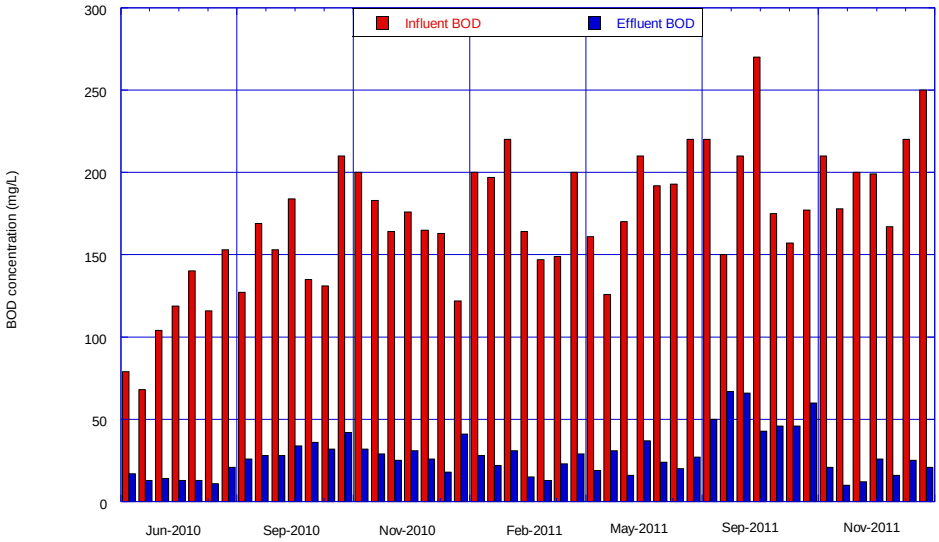
The BTF domestic plant has recently experienced an unusual occurrence of the almost instantaneous loss of part of the biomass from the media. The cause of this occurrence appears to be a slug of highly toxic chemical in the incoming wastewater. Investigations by HDC staff using the on-line UV-VIS spectroscopy and also off site wastewater sampling have identified increased concentrations of toluene and xylene. Also under investigation is the possibility of prohibited trade wastes being illegally discharged in non compliance with the terms of HDC's Water Services Bylaw.

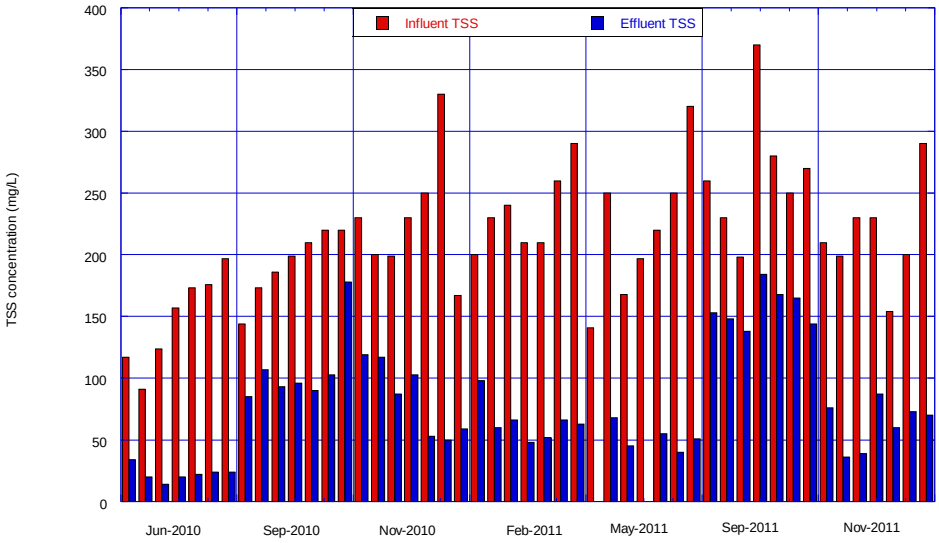
Despite the almost instantaneous effect on biomass growth and health from these yet unknown discharges, it has responded very quickly and within 24 hours is back to normal. This highlights the robustness and resilience of a lower loaded BTF system as compared to many suspended growth secondary biological treatment systems.

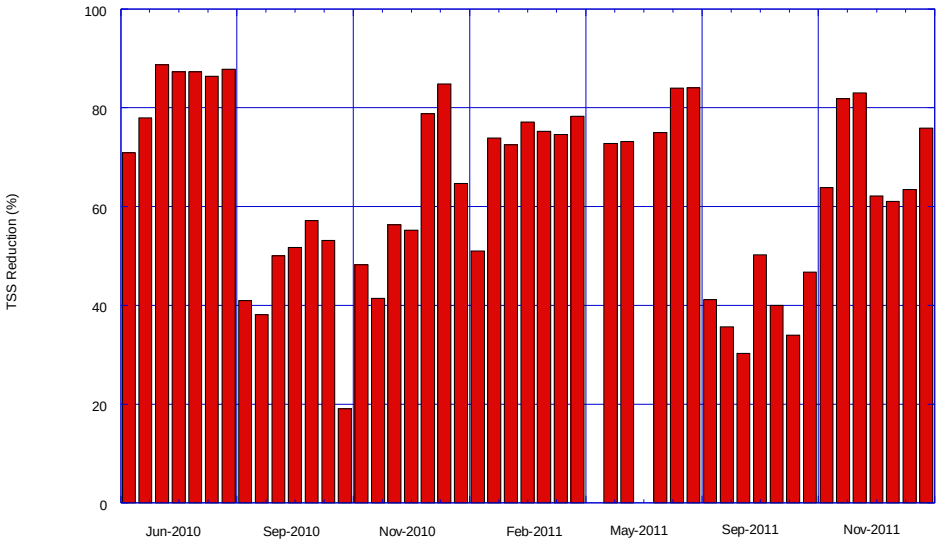
8 OPERATIONAL RESULTS

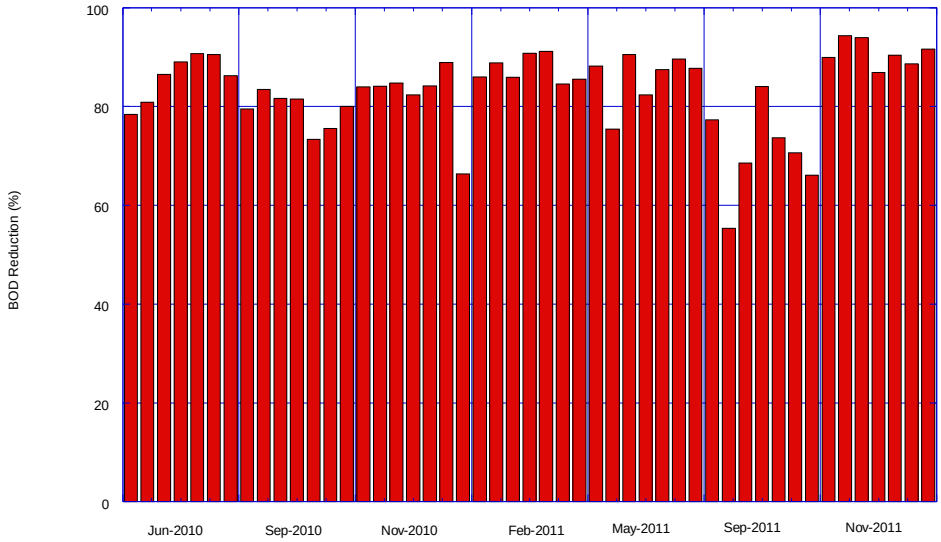
The performance of the full scale BTF plant has been consistent with expectations from the original pilot plant work. The concentration of the key indicators of organic contamination in the raw wastewater applied to the BTF and treated wastewater discharged from the BTF and the reduction observed in these key indicators (BOD[1], COD[2], TSS[3]) is presented in the following figures.

[1] BOD BOD = Carboneous Biochemical Oxygen Demand (5 day standard test)
[2] COD = Chemical Oxygen Demand
[3] TSS = Total Suspended Solids


Influent BOD
Effluent BOD
BOD concentration (mg/L)
300
250
200
150
100
50
0
Jun-2010
Sep-2010
Nov-2010
Feb-2011
May-2011
Sep-2011
Nov-2011


Influent TSS
Effluent TSS
TSS concentration (mg/L)
400
350
300
250
200
150
100
50
0
Jun-2010
Sep-2010
Nov-2010
Feb-2011
May-2011
Sep-2011
Nov-2011


TSS Reduction (%)
100
80
60
40
20
0
Jun-2010
Sep-2010
Nov-2010
Feb-2011
May-2011
Sep-2011
Nov-2011



In addition to the removal of contaminants of organic pollution, the treated wastewater discharged from the BTF also contains low concentrations of ammoniacal nitrogen (typically less than 3 mg/L) resulting in a reduction of approximately 50 percent in terms of total nitrogen. The BTF also achieves a reduction in indicator bacteria (i.e. faecal coliforms and enterococci) of between 99% to 99.5% during normal operation of the BTF.

9 NEW RESOURCE CONSENT PROJECT

The existing Resource Consent for the Coastal Discharge Permit expires in March 2014. The project team tasked with putting together the consent application and AEE involves most of the original MWH and HDC personnel, a decision based on the recommendations from the Wastewater Committee who saw advantages in *"retaining the services of MWH and in particular those personnel within MWH that have familiarity with the treatment plant and have established relationships with Tangata Whenua through this committee."*

In doing so, the committee has recognised the value to Tangata Whenua and the Council from the significant amount of historical and institutional knowledge the parties share forged from their long association with the wastewater consent and the BTF treatment project. This translates to a high degree of conceptual understanding of the issues as Council progresses with the next consent and enables work to proceed efficiently on the back of previous knowledge and work already undertaken. Relationships between MWH personnel, HDC and the committee are already well established and there is a high level of trust and integrity attached to these relationships providing continuity and stability as we transition to the next consent phase.

HDC has embarked on a full community consultation process. A key element underpinning Council's application and consultation plan is that the BTF process is delivering the cultural and spiritual aspirations of Maori through the removal of kuparu and that through consultation with the wider community, to establish that the biological treatment of human waste is meeting environmental requirements and cultural aspirations.

The project is well advanced and Council has progressed with a number of specific tasks and investigations including the following:

Technical Studies

- Future wastewater demand projections.
- Alternative treatment and discharge alternatives assessment.

Scientific Studies

- Oceanographic current studies.
- Water quality and ecology studies in the vicinity of the ocean outfall.

- BTF flushing cycle study.

Social and Cultural Studies

- Recreational and commercial surveys.
- The public health risk assessment.
- A cultural impact assessment relating to tangata whenua matters.
- Four well-beings assessment (environmental, social, cultural and economic).
- Assessment of Environmental Effects (AEE).

10 CONCLUSION: ELEGANCE OF SOLUTION

The elegance of the solution is best reflected in it being a notable example of a treatment plant that is fit for purpose both in terms of design and operability and a "no sludge" solution, thereby eliminating the need for a costly sludge treatment process and associated sludge disposal. By way of conclusion, these points are expanded on below.

10.1 A Plant Fit for Purpose

The Hastings plant is an outstanding example of plant that is fit for purpose. Its design and construction is particularly cost effective in respect of many features, including:

- The plant and its governance meet the sustainable management requirements of Part 2, Resource Management Act 1991, particularly the relationship of Maori and their culture with their ancestral water, Kaitiakitanga, the efficiency of the end use of energy, and the principles of the Treaty of Waitangi.
- The separation of the domestic (human waste) and non-separable waste stream from the industrial waste stream, thereby allowing different treatment procedures for each of the streams.
- The layout and hydraulic profile of the overall treatment plant with provision for future proofing by allowing additional treatment units and greater flow rates to be accommodated in the future if required.
- The cost-effective integration of the new treatment plant components with the previously existing components particularly the milliscreening plant, outfall pumping station, various pipes and channels.
- The integration of the controls with the existing plant.
- Locating all of the main services above ground benefitting on-going operations and maintenance.
- The ground strengthening works below the key structures, particularly the screens and BTF structures.
- The overall plant layout and its hydraulic efficiency.
- The arrangement of piping and other plant items above ground, not required to be housed in buildings.
- The approach to odour management by initially not including covers on the BTF but designing for their inclusion if required, at a later date as occurred.
- A cost effective approach to the tendering of key plant items and the integration of these into the main construction contract.
- The mix of supply only, supply and install, design and build and construction contracts maximising the value of the specialist technical expertise in the supply chain.
- The high quality of the construction finish achieved by DownerEdi.

10.2 A "No Sludge" Solution

The elegant solution to avoid sludge generation, treatment and disposal has a number of substantial benefits including:

- The capital and operating costs savings that would otherwise be required for sludge drying and transportation and landfill disposal or beneficial reuse on land.
- Finding a solution that deals with Maori abhorrence of sludge being trucked past houses and waahi tapu sites.
- The only available landfill for disposal of the sludge within a reasonable distance of the treatment plant site is the Hawkes Bay Regional Landfill. Detailed technical and operational investigations of this showed that considerable difficulty would result from the disposal of sludge at this landfill.
- While the Joint Committee and Community Liaison Group were initially enthusiastic about using appropriately treated sludges (biosolids) for beneficial reuse on horticultural land in the Hawkes Bay discussions with the exporting horticultural companies made it clear that this would not be an acceptable practice in terms of their meeting national and international market regulations.

The no sludge solution was made possible following the environmental effects assessment at the outfall discharge. This showed that the BTF treated wastewater which contains the excess biomass would have no significant adverse effects on the marine and receiving environment outside the agreed mixing zones. Results from recent benthic surveys would appear to support this. Further long term assessment of the benthic environment and water quality in and outside the mixing zones will be ongoing as part of the resource consent conditions. This will further identify and changes associated with the BTF discharge compared with the original milliscreen operations.

ACKNOWLEDGEMENTS

The valued input of the HDC Tangata Whenua Wastewater Joint Committee, the Community Liaison Group, other key stakeholders and Council staff and Council's legal advisors is greatly acknowledged.

REFERENCES

- HDC's Rachel Landon winning the Ingenium Hynds Paper Award in 2006 for "*Hastings: An Innovative Wastewater Project"*
- A presentation by Jim Bradley and Paula Hunter of MWH and HDC's legal advisor Mark von Dadelszen to the joint Australian and New Zealand Planning Institute Conference held in the Gold Coast Australia in 2006 *"A Paradigm Shift in Wastewater Management in NZ – Planning to meet Maori Cultural Values The Hastings Case"*
- HDC winning the inaugural SOLGM NZ Post Management Excellence Awards (Technical Innovation Category) in 2006 for the *Hastings WWTP: A New Configuration for Wastewater Treatment*
- An article in NZ Planning Quarterly in June 2006 *"How a Historic and Probably Unique Accord Works"* by HDC's legal advisor Mark von Dadelszen.
- A paper and presentation to the NZWWA Conference in 2006 by Ngahiwi Tomoana, (Tangata Whenua member of the Joint Committee), Bob McWilliams and David Fraser (HDC) and Pete Loughran and Jim Bradley (MWH) titled *"Hastings Wastewater – a Remarkable 'Win Win' Solution by Challenging Conventional Practice"*.
- A paper and plenary address to the International Water Association Conference in Monckton Canada in 2007 by Jim Bradley (MWH) on the project titled *"Four Wellbeings Social, Economic, Environmental and Cultural: A sustainable development approach to Biosolids Management"*
- A paper to the Ingenium Conference in Napier in 2007 by MWH's Jim Bradley and HDC's David Fraser Titled "*Cultural Dreams Become a Technical Reality with Innovative Wastewater Treatment*"
- Jim Bradley being selected as a Plenary Speaker at the 2012 International Water Association (IWA) Conference in Brisbane presenting as a case history the Hastings Wastewater Journey.
- ACENZ Conference 2012 Merit Award for theis Hastings Wastewater project.

APPENDIX A: PHOTOGRAPH STORY

View of top surface of Plastic Media in Pilot Biological Trickling Filter showing screened wastewater distribution onto the Media, December 2005

View of a Plastic Media (Petal) piece showing biomass growth (with 1 – 2mm covering) – taken from the full scale Biological Trickling Filter Plant

HDC's Bob McWilliams at the East Clive pilot plant, December 2005

A deep soil mix column is removed and core for testing as part of the ground strengthening work, February 2008

Construction of the BTF tanks commences, August

BTF construction with the pump station under construction in the photo foreground, August 2008	***2008***
	
BTF tank panel construction, October 2008	***Construction of the Papatuanuku channel, March 2009***
	
Bark Biofilter construction, February 2009	***Random packed media showing the distributor arms, July 2009***

	
Completed Papatuanuku channel, June 2009	***Plant under construction, May 2009***

Installation of the geodesic dome covers, June 2011

Completed domestic treatment plant with the milliscreen plant and outfall pump station, October 2011

Bob McWilliams, HDC's Wastewater Treatment Plant Manager holding two of 6,000,000 pieces of plastic media used in the two BTF tanks, October 2011

The HDC/MWH project team in front of the completed plant. Left to right: Matt Kneebone, MWH's Engineers Representative; David Fraser, HDC's Group Manager Asset Management; Rachel Landon, HDC's Wastewater Treatment Programme Manager; Bob McWilliams, HDC's Wastewater Treatment Plant Manager; Des Parkinson, MWH's Project Manager; Brett Chapman, HDC's Water Services Manager, October 2011