GISBORNE WASTEWATER SCHEME: SUCCESSFULLY RE-DEFINING A COMMUNITY PROJECT

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ABSTRACT

In September 2007, Gisborne District Council (GDC) was granted a 35 year resource consent for a major two-stage upgrade of the Gisborne wastewater treatment system (the Scheme). In preparing the preliminary design and cost estimates, GDC's appointed design consultants, CH2M Beca Ltd, generated an out-turn cost which proved to be significantly greater than previous estimates for the Scheme. Consequently, a period of value engineering and scope re-definition work was undertaken to reduce the cost of the Scheme to a level acceptable for the Gisborne community while preserving the objectives of the original consent.

An analysis tool, the Cost Route Mapping Analysis (CRMA), was developed to assess various wastewater treatment options that could be implemented in stages, alongside options to re-locate the treatment plant. The success of the Gisborne Wastewater Scheme to date, in selecting a Scheme that is economically, technically, socially, culturally and environmentally acceptable to the local community, has resulted from the successful collaboration between numerous stakeholders, the Council and the Wastewater Project Team to achieve a single goal. This is in alignment with the project's motto: "Best for Gisborne".

This paper discusses the background, methodology and challenges in the process of meeting this objective and the way forward.

KEYWORDS

Wastewater treatment, feasibility, analysis, planning, BTF, cost route mapping.

1 BACKGROUND

In 1964, Gisborne District Council (GDC) (through its predecessor Gisborne City Council) constructed a comminutor system, outfall pump station and ocean outfall at the Stanley Road site at Midway Beach for the discharge of domestic and industrial wastewater some 1.83 kilometres offshore into Poverty Bay. A feature of the Gisborne wastewater flows was (and still is) the high proportion and high loads of trade wastes flows from primary process industries based in the city. The pump station and outfall pipeline have served the Gisborne community to the present day, with the addition of 1mm milliscreens in 1990 to reduce the suspended solids load on the outfall.

In 1991, GDC lodged applications seeking coastal permits to continue utilising the ocean outfall. Permits were granted through to 1999 on the provision that GDC would evaluate and implement a long-term wastewater disposal scheme. Upon expiration of the consent in 1999, GDC applied for a seven year extension to the coastal permits, however an extension of only four years was granted. This decision was appealed at the Environment Court by the local tangata whenua, on the grounds that raw wastewater discharge to the ocean broke the relationship of tangata whenua with the moana (sea) and kaimoana (seafood). GDC sought an adjournment to the Court hearing to allow time for consultation and development of a wastewater strategy acceptable to local iwi and other stakeholders.

The initial strategy adopted by Council included the construction of a primary sedimentation treatment plant at a site near Gisborne airport by 2010, with upgrade to high rate activated sludge and UV disinfection by 2016. Consent applications were then made by Council based on these treatment processes and proposed timeframe.

However, at the same time, pilot plant studies were being undertaken at Hastings utilising a trickling filter process with ultra-low BOD loading (per unit volume of trickling filter media), now commonly referred to as the biological or biotransformation trickling filter (BTF) process. The BTF process had the potential to recognise the concerns of tangata whenua associated with the treatment and disposal of human waste:

> "A biological trickling filter (BTF) uses biological processes involving micro organisms to convert solid and fluid (dissolved) human (and other organic) wastes into carbon dioxide, water and excess cell (plant) biomass. The effluent stream from the BTF is no longer considered to be human in character and as a consequence, is inoffensive to tangata whenua and suitable for discharge through the long outfall." (Fraser & Bradley, 2007)

The Gisborne consenting process was adjourned to enable the Wastewater Adjournment Review Group (WARG) to compare the two treatment processes – HRAS and BTF – and to recommend to Council an agreed strategy that was most appropriate for Gisborne. After various investigations, costings, hui and public submissions a decision was reached to upgrade the wastewater treatment scheme in a staged project utilising the BTF process, with further upgrades to remove biological solids and install UV disinfection in the following years The hearing for new consents and treatment plant designation was reconvened and the appropriate consents were granted to GDC in July 2007 and the associated Restricted Coastal Activity permits were approved by the Minister of Conservation in September 2007. Subsequently, design of the Gisborne Wastewater Scheme commenced in October 2007 with CH2M Beca Ltd engaged by GDC as the project consultants.

2 PRELIMINARY DESIGN DEVELOPMENT

The consents granted to GDC in 2007 defined both the level of treatment required as well as the type and characteristics of the treatment process to be installed, recognising the extensive consenting process required to define a suitable treatment solution for the Gisborne community. The key physical components of the Scheme as consented in 2007 are shown in Figure 1 and can be summarised as:

- Undertake works to reduce inflow and infiltration into the existing sewerage network to limit domestic sewage and non-separated industrial wastes flows to the new WWTP to 33,000m³/day, except in extreme events.

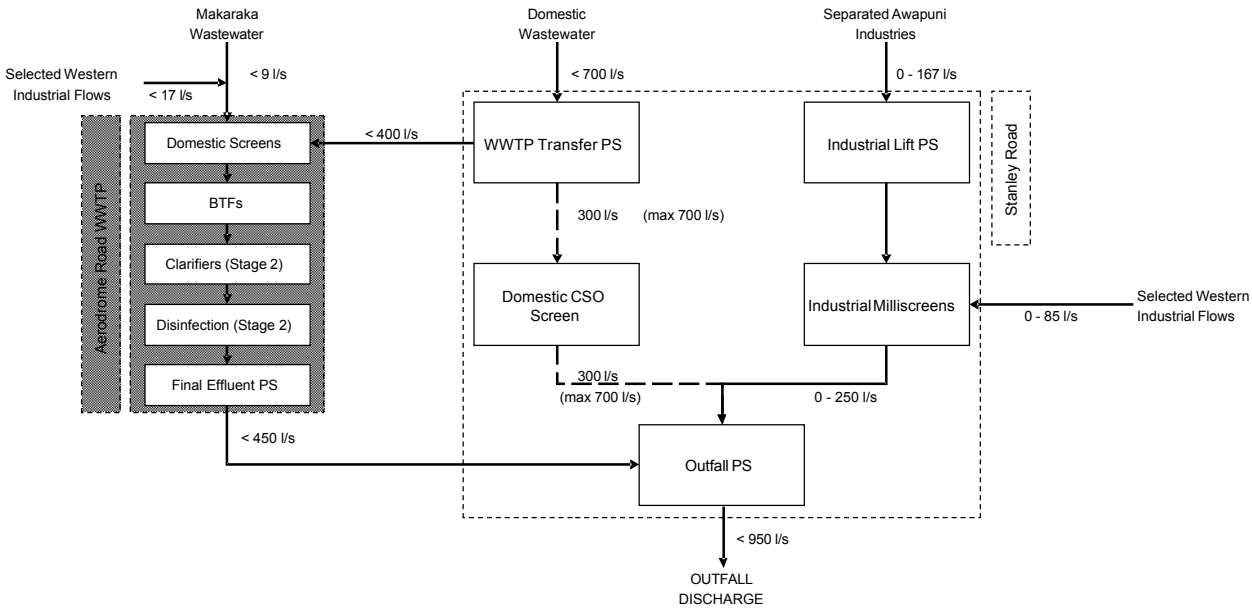
- The separation and milliscreening (to 1mm aperture) of wastewater from significant industries for direct discharge through the existing marine outfall (bypassing the new secondary treatment process), to be completed by end of 2010.

In addition, the consent required:

- The installation, In Stage 1, of milliscreening (to 1mm aperture) and BTFs with a BOD loading of 0.4kg BOD/m³ media/day for the secondary treatment of domestic wastewater, to be completed by the end of 2010 and to be located at a defined site located on Gisborne Airport land, some 4 km from the existing Stanley Road milliscreening plant and ocean outfall.

- Subsequently, in Stage 2, the installation of clarifiers (and therefore a solids handling and disposal system) and UV disinfection at the airport WWTP site, ideally to be completed by the end of 2012, but no later than the end of 2014.

Figure 1: Flow diagram illustrating major components and estimated flow rates in the Gisborne Wastewater Scheme following preliminary design and based on the 2007 consent requirements



Following a period of preliminary design by CH2M Beca, final project out-turn capital costs for the fully consented staged scheme were estimated to be approximately $84.4 million including early value engineering, risk items and escalation through to completion of Stage 2, but excluded improvement works in the sewerage network. This was significantly greater than initial estimates provided to and considered by Council during the consenting process of approximately $30 million – which did not include the full scope of the preliminary design nor escalation or risk items. Gisborne has one of the highest deprivation levels in the country and in consideration of the significant costs and the relatively small rates base of the Gisborne community, the consented Scheme was deemed by elected members to be unaffordable. Council tasked the project team to identify a more affordable scheme for their consideration. .

As a result, in May 2009, GDC and CH2M Beca Ltd commenced an extensive period of value engineering and re-definition of the Scheme's scope to reduce the capital and operating cost burden of the wastewater treatment plant and industrial separation scheme, as the significant cost components in the overall Scheme budget.

3 EARLY VALUE ENGINEERING AND SCOPE RE-DEFINITION

Early efforts to reduce the cost of the Gisborne Wastewater Scheme focussed on options to partially reduce the scope of the industrial separation scheme and/or treatment plant, and to re-locate the proposed WWTP site to the existing GDC-owned Stanley Road site adjacent to Midway Beach at the landward end of the ocean outfall. As part of this evaluation, it was essential that any proposed options would need to meet either the "letter" of, or at least the "intent" of, the consents for the Scheme.

In this respect, four key consent criteria were identified from the consent and the associated Commissioner's report as follows:

- The biotransformation of human wastes into plant matter, as per the low-loaded BTF process, must be achieved.

- The Enterococci contamination in the discharge to Poverty Bay must be limited to 1000cfu/100ml, but how the limit is met is more flexible.

- Ultimately achieving a suspended solids limit and mass load limit of 600mg/l and 10,800kg/day in the combined industrial and treated domestic wastewater discharge to Poverty Bay, Note that a suspended solids limit of 30g/m³ was also placed on the discharge of the WWTP only (prior to mixing with the screened industrial wastewater stream, and following implementation of Stage 2 WWTP works). This "up the pipe" suspended solids limit was placed on the Stage 2 WWTP discharge largely to achieve an effluent quality suitable for UV disinfection. Alternative disinfection options such as chlorination or ozonation, or UV disinfection at higher dosing intensities could also be considered for WWTP effluent with higher suspended solids content. Therefore, the ultimate discharge requirement at the outfall is considered to be most important, providing some flexibility on the scope of the WWTP process.

- The installed treatment standard must be sufficient to allow GDC to investigate and implement alternative use/disposal methods for the treated wastewater in the future.

The options considered and evaluated against these criteria included:

a) Reduce the scope of the Industrial Separation Scheme so that a greater load is placed on the domestic wastewater treatment process, and therefore increase the load of the BTFs. Any options which increased the BOD load to the WWTP were recognised to have a significant impact on the size of the BTF process required and/or increase the BOD load on the BTF process, plus would ultimately result in more sludge being produced, while requiring industries to implement some preliminary treatment to enhance the suitability of wastewater discharges for secondary treatment.

b) Delay or remove the clarification treatment stage from the WWTP process. It was quickly recognised that any option that reduced or removed the need for solids clarification would have a significant impact on overall Scheme capital and operating costs, due to the significant clarifier structures, large mechanical equipment and ongoing disposal costs for transport of the sludge to a remote landfill close to Paeroa in Hauraki District. In addition, the clarification treatment process has the greatest impact on suspended solids discharge limits, which were considered to compromise the letter of the consent but not its intent, as disinfection to remove microbial contamination and biotransformation via the BTF process could still be achieved.

c) Increase the BOD loading rate on the BTF media. To meet the requirements of the consent for biotransformation, which was thought to be achieved at a BOD loading rate 0.4kgBOD/m³ media/day, a comparison of BOD removal against theoretical models and WWTPs with higher loading rates (in the order of 0.6 – 0.8kgBOD/m³ media/day) were undertaken. The analysis indicated no significant detrimental impact in BOD removal, and therefore biotransformation, although it was recognised that any such option to increase loading rate would require revision of the consent in consideration of the importance placed on biotransformation and the corresponding BTF loading rates specified.

d) Reduce the flow to full treatment (FFT) rate of the WWTP process. Reducing the FFT rate would increase the potential for plant bypasses in wet weather events, so an analysis of flow exceedance in such events was undertaken. The consented WWTP capacity of 33,000m³/day had been set such that bypass events would occur less than approximately 1% of the time, or 3.65 days per year. A reduction in FFT to 26,000m³/day was shown to increase bypass events to 1.2% of the time (4.25 days per year).

e) Amalgamate the construction programme of Stage 1 and 2 works into a single project. This option was shown to increase the efficiency of the project and therefore reduce costs, although would require greater capital expenditure in an earlier timeframe, and potentially cause the implementation of Stage 1 works to run over the desired deadline of 31 December 2010, as stipulated in the consent.

f) Re-location of the WWTP to the existing Stanley Road site. The consent requirement to locate the WWTP at the airport site increased the cost of the Scheme significantly due to the pumping and pipelines required from/to the existing Stanley Road site where the sewerage network currently terminates and the outfall pipe begins. However, the Stanley Road site is located adjacent to significant recreational assets, and relocation of the WWTP to this location would require additional architectural design, odour management and public consultation prior to implementation.

As a result of this analysis, the recommended option was a combination of (a), (b), (c) and (f), to generate capital cost savings of approximately $32 million while minimising changes to the key consent criteria. However, the savings realised were considered by elected members to be insufficient for the Gisborne community and increased the risk of public acceptance of the treatment plant due to its proposed location at the Stanley Road site. Therefore, a significant re-evaluation of the redefined scope options was undertaken, including a combination of new treatment process options, and utilising a newly developed "cost route mapping" analysis (CRMA) tool specifically developed for this exercise.

4 COST ROUTE MAPPING ANALYSIS (CRMA)

Following the early value engineering and scope re-definition exercise, and in consideration of GDC's desire to further enhance the affordability of the Wastewater Scheme to the Gisborne community, the Cost Route Mapping Analysis (CRMA) tool was developed to assess further scope re-definition options. An important requirement of the CRMA tool was for the outputs to be easily understood by elected members and key stakeholders when a wide range of alternatives were being presented to them.

The analysis was based on an evaluation of the option against GDC's 'quadruple bottom line' requirements of serviceability for the Wastewater Scheme, with the following objectives:

Economic: The wastewater treatment process must be affordable to the Gisborne community.

Environmental: Reducing gross solids (including grit) and floatable material of obvious sewage origin which would visually contaminate beaches and swimming waters. Removal of these solids is achieved by milliscreening all waste streams.

In addition, reducing the organic carbon (particulate and soluble BOD5) in the wastewater (i.e. the BTF process) and meeting ANZECC guidelines through trade waste controls and colour/clarity requirements in discharge mixing zones.

Social: Discharging wastewater with an acceptable quality to maintain public health (i.e. by disinfection).

Cultural: Providing a treatment process that meets the cultural objectives for the community (i.e. the use of low-loaded BTFs to provide "biotransformation" of human waste and eventually alternative use of domestic wastewater).

Based on an evaluation of the consent conditions in relation to these objectives, four stages of the treatment process were identified which progressively achieve the objectives in alignment with the intent of the consent:

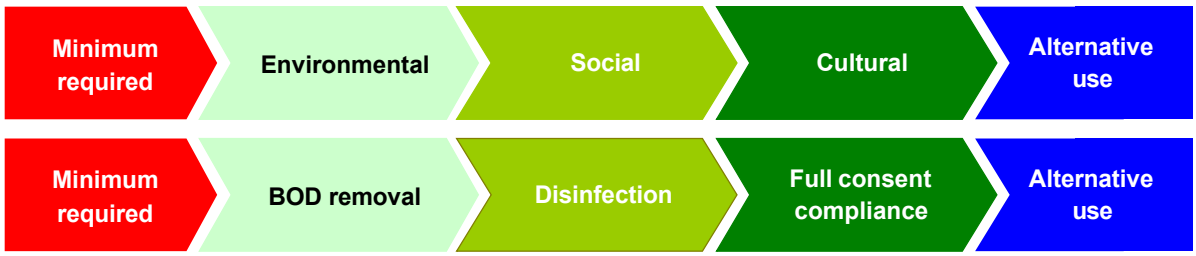
- "Minimum required treatment" – to remove gross and floatable solids and grit from the wastewater as currently undertaken in Gisborne.

- "BOD removal" – to broadly achieve the environmental objectives of treatment, generally associated with the secondary treatment of wastewater.

- "Disinfection" – to broadly achieve the social/public health objectives of treatment, generally associated with the disinfection of wastewater.

- "Full consent compliance" – to provide a scheme that is fully compliant with the conditions of the resource consent (except the location of the treatment plant) and provides all of the treatment steps required in the compliant Scheme (i.e. includes industrial wastewater separation, screening of all flows, low rate BTF treatment, clarification and disinfection).

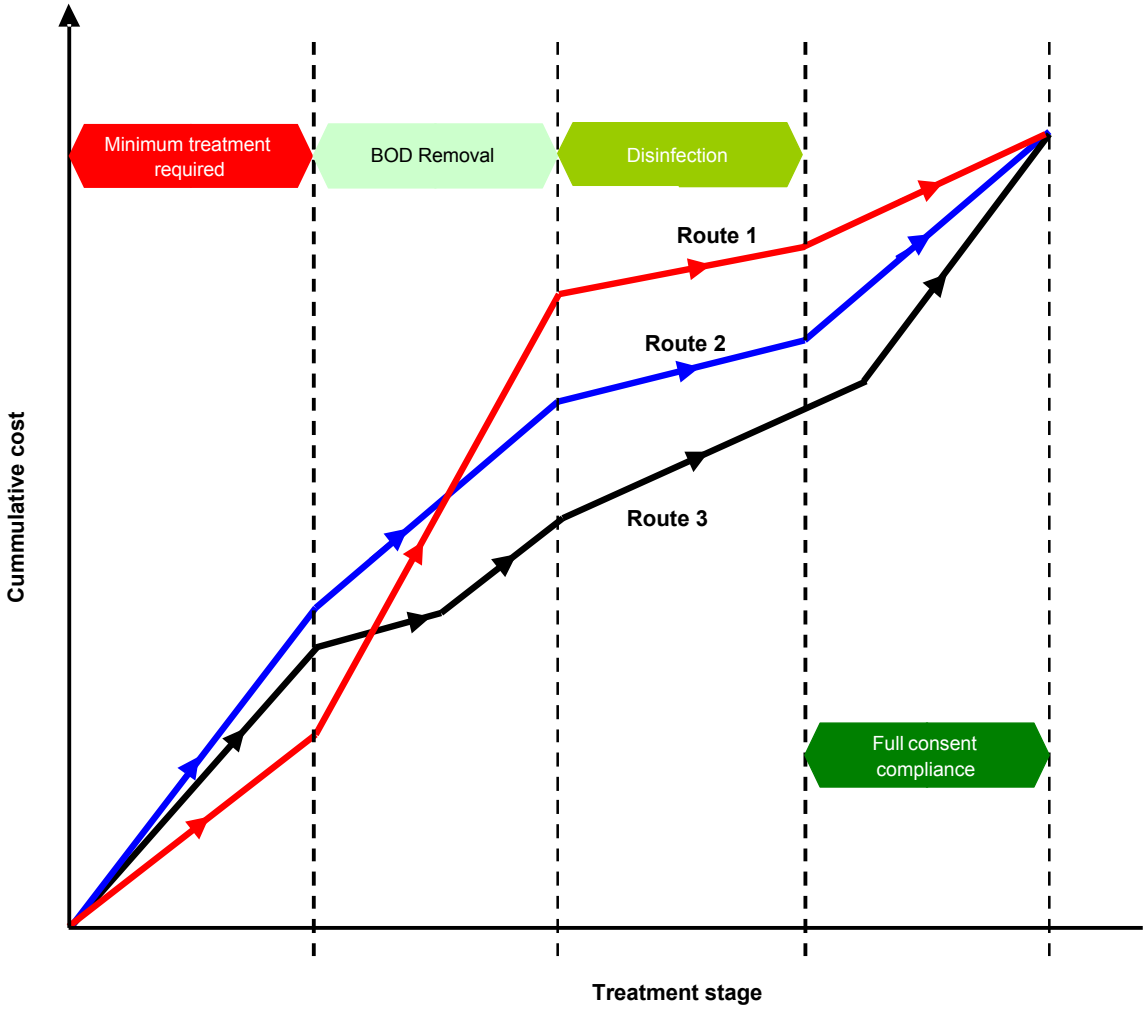
Figure 2: The path from most economic treatment to fully consent compliant treatment and alternative wastewater disposal options.



Therefore, a series of staged treatment process options were selected, considering the BTF process and new treatment process options, designed to progressively move from "minimum required treatment" to "full consent compliance" with increased cost. Alternative uses for the treated wastewater stream, rather than discharge to sea, are considered to be the ultimate objective of the Gisborne Wastewater Scheme. However, it is recognised that current wastewater treatment technologies cannot provide a land-based disposal option for the Scheme. As such, the analysis focussed on options that would eventually lead to full consent compliance, although any options that provide sufficient flexibility for adaption to a land-based wastewater disposal system in the future were considered favourable.

Figure 3 below illustrates the CRMA concept of mapping options. Each treatment option is considered to be a "route" on the progressive path from most economic treatment to fully consent compliant treatment against cumulative cost. The CRMA technique allows a comparison of each route option, and the most favourable route is likely to be the option that meets the most treatment objectives at least cost, such as "route 3" in Figure 3. However, it is also important to consider the end objective of fully consent compliant treatment, as some options may lead to the installation of treatment processes that are not in alignment with the ultimate consent compliant treatment process. For example, it may be more economic in the short term to install primary sedimentation and activated sludge treatment to provide BOD removal treatment, but the infrastructure required may be of no use for a fully consent compliant scheme incorporating BTFs and clarifiers, unless the infrastructure can be re-used. In this case, the ultimate cost of the Scheme in the long term would be higher should GDC wish to eventually pursue fully consent compliant treatment..

Figure 3: Illustration of the Cost Route Mapping Analysis (CRMA) technique.



The 12 options that were identified for application of the CRMA tool were divided into four categories as follows:

Options 1, 2 & 3: Implement the Industrial Separation Scheme and install one BTF first to provide initial particulate and soluble BOD5 reduction of domestic flows to partially achieve the "transformational"/cultural objectives of the Scheme. Beyond the installation of one BTF, these options considered the installation of either clarification, disinfection or a second BTF.

Options 4 & 5: Implement the Industrial Separation Scheme and install one clarifier first for primary sedimentation treatment (for the removal of settleable solids and particulate BOD from domestic flows) prior to BTF treatment and/or disinfection.

Options 6, 7 & 8: Partially implement the Industrial Separation Scheme initially to remove significant and/or year-round particulate and soluble BOD5 load from the municipal wastewater stream. Implement the remainder of the Industrial Separation Scheme after the domestic treatment system is constructed to reduce the BOD5 load on the BTFs (to provide full compliance with the consent).

Options 9, 10, 11 & 12: Install an alternative treatment process with view to installing low-loaded BTFs eventually to meet the cultural treatment objective.

Under all options, replacement of the existing Stanley Road plant assets (considered after a thorough condition assessment to be beyond their useful life) with a new domestic and industrial pre-treatment facility, influent pump station and outfall pump station was always considered to be part of the first stage to achieve minimum required treatment.

The Cost Route Mapping Analysis for these options, provided in Figure 4, immediately indicated a preference for up to four options that achieved BOD removal and disinfection at least cost. As a minimum, it was deemed preferable to provide particulate and soluble BOD removal and disinfection to meet social (pubic health) treatment objectives in the short term. Over and above this, the CRMA indicated that significant additional capital expenditure would be required to implement a fully consent-compliant scheme.

Based on achieving disinfection in the most affordable manner, the preferred options selected from the CRMA were, in order of affordability:

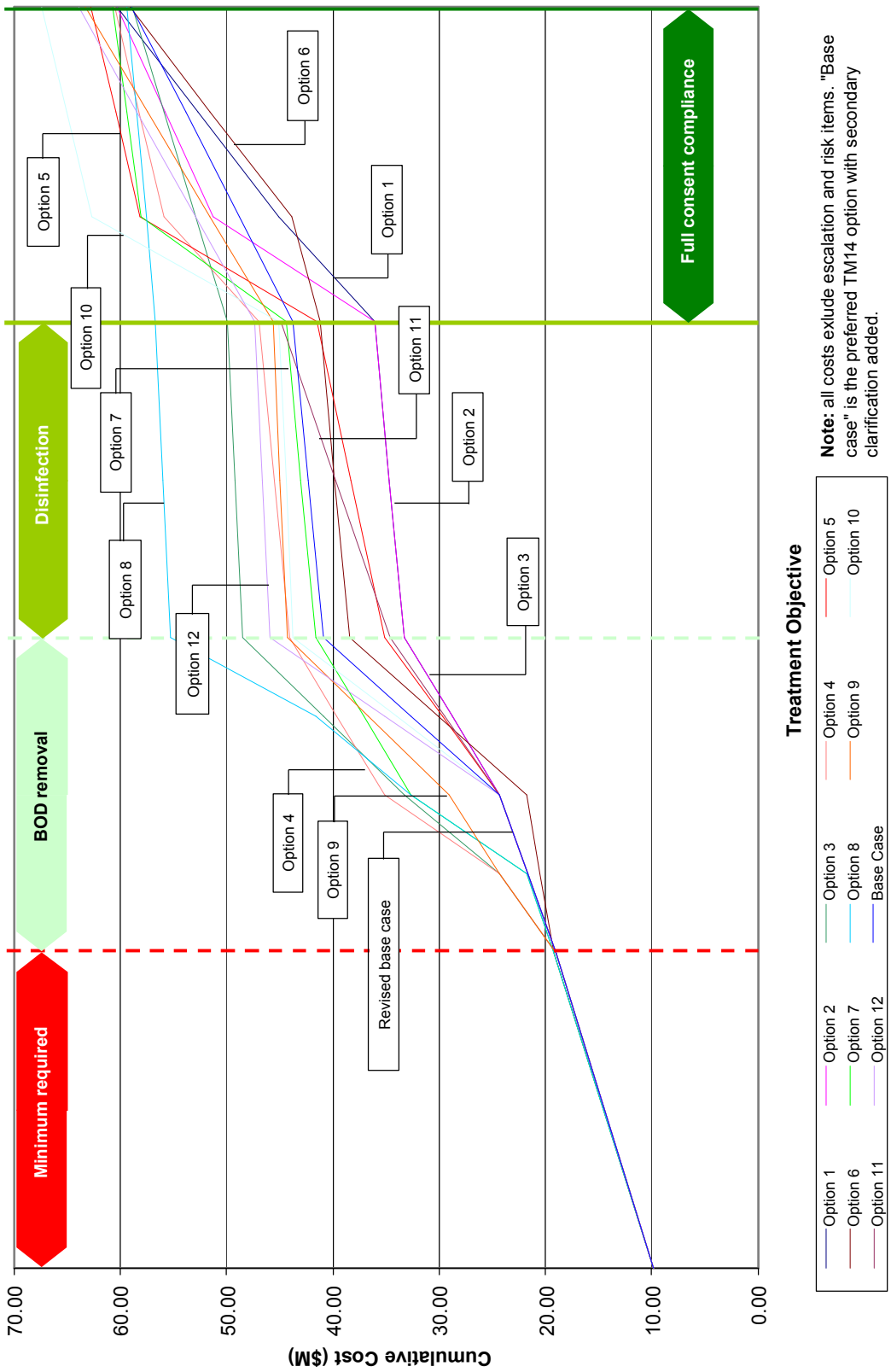
Option 1: Fully implement the Industrial Separation Scheme and initially install a domestic and industrial pre-treatment facility plus one BTF to remove the bulk of particulate and soluble BOD from the domestic wastewater only. Note that the BTF media would carry a loading of at least 0.8kg BOD/m³ media/day, which does not meet the 'cultural' treatment objective of full biotransformation (assumed to be met at 0.4kg BOD/m³ media/day) in the first instance. To meet the social (public health objectives), disinfection would be installed on the BTF effluent. Finally, a second BTF could be installed to reduce the media BOD loading, and clarifiers could be installed later to fully comply with the conditions of the consent.

Option 2: As per Option 1, except install the clarifiers ahead of a second BTF in later stages of the Scheme implementation.

Option 6: The Industrial Separation Scheme would be only partially implemented to remove significant and/or year-round BOD contribution from industrial wastewaters. A pre-treatment facility for all flows would be installed at the Stanley Road site, along with two BTFs loaded at approximately 0.8kgBOD/m³ media/day to provide bulk particulate and soluble BOD removal from all flows except the selected separated industrial wastewaters. Following the installation of disinfection, the remainder of the Industrial Separation Scheme would be implemented to reduce the BOD load on the BTFs to within acceptable limits as per the resource consent. Finally, clarifiers could be installed should Gisborne District Council wish to pursue a fully compliant wastewater scheme.

Option 5: Fully implement the Industrial Separation Scheme and install a domestic and industrial pre-treatment facility at the Stanley Road site. In addition, one clarifier would be installed as a primary sedimentation tank to provide rough BOD and suspended solids removal in preparation for disinfection. To provide a fully compliant scheme, the BTFs would be installed later along with the second clarifier (the initially-installed PST would be modified as a secondary clarifier at this point).

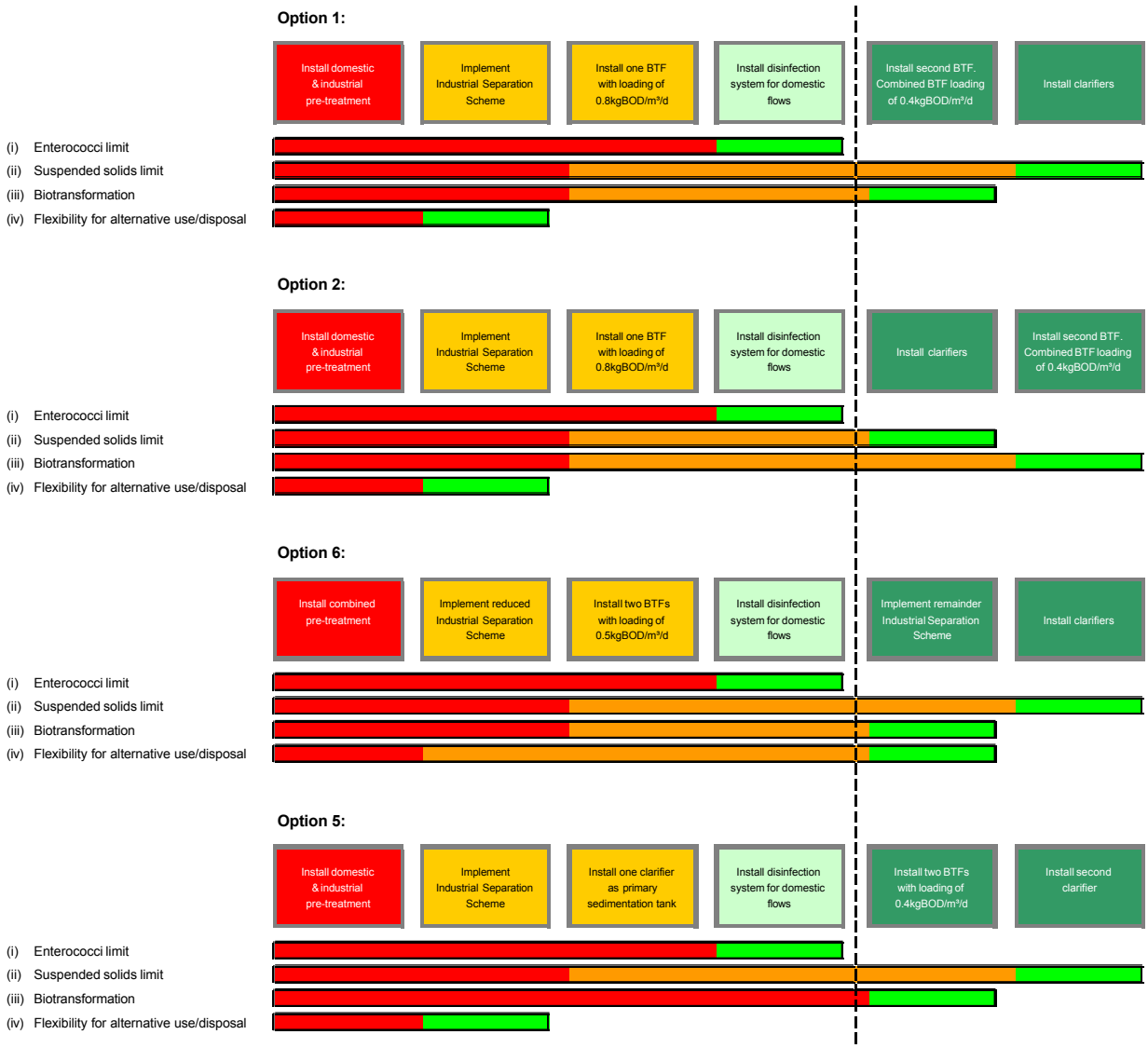
Figure 4: Cost route mapping diagram for all options.



Block diagrams of the options were also generated to show the progressive implementation of process units in moving from “minimum required treatment” to a fully compliant scheme, and are provided in Figure 5. To determine the preferred option, a further assessment of the impact of each option after the implementation of each process unit against the key consent criteria (as previously

described) was also undertaken, using a simple colour coding system. For example, the key consent conditions to reduce Enterococci limits in Poverty Bay from the discharge of wastewater could not be met until disinfection was installed, denoted by the red bar turning green once disinfection is installed for the Enterococi limit criteria below each block diagram. In some instances, orange bars were used to denote progression towards meeting key consent criteria, such as installing one BTF on the path to meeting the biotransformation conditions. Therefore, at the point at which disinfection is installed (the 'yardstick' for treatment), the options which go furthest to achieving the four key consent criteria are preferred. In this case, Options 1 and 2 are therefore preferred.

Figure 5: Block diagrams for the preferred options from the CRMA process.



The final assessment to determine the preferred of Options 1 and 2 was based on operating costs. In effect, Options 1 and 2 are similar to the point that disinfection is installed, and only differ by the proposed route to full consent compliance, of either installing clarification first or a second BTF first to meet the biotransformation requirements.

As previously discussed, any option that includes solids separation process(es) will incur significant operating costs owing to the high sludge disposal costs. Previous investigations of sludge disposal options had revealed that disposal to Gisborne's nominated landfill site, near Paeroa in Hauraki District, was still the favourable option, albeit at a relatively high cost to other sludge disposal

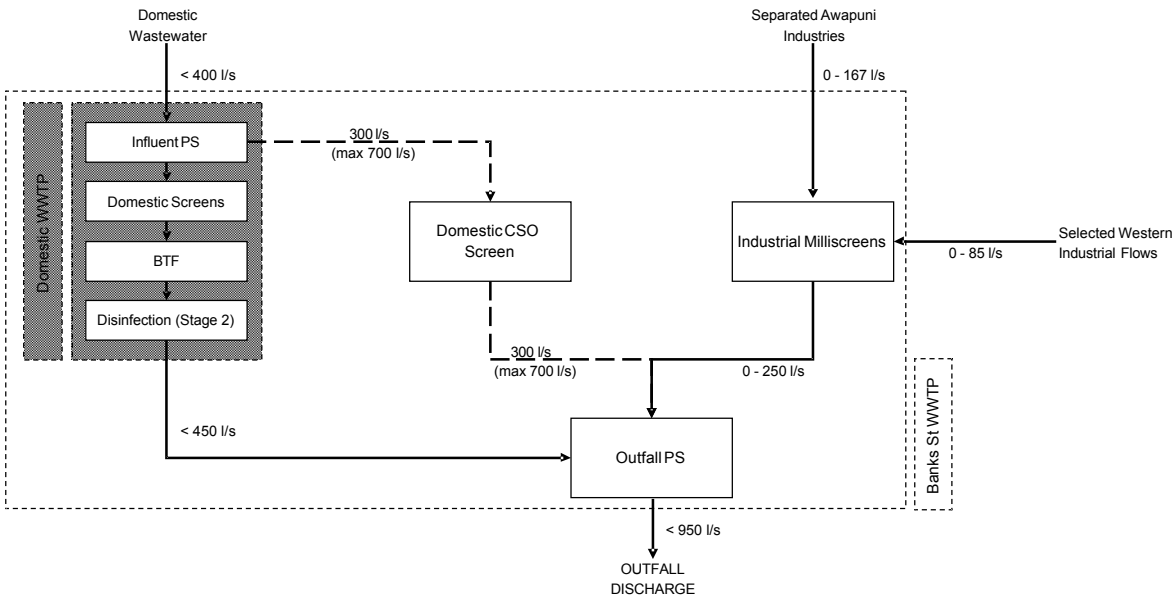
operations in New Zealand. Therefore, Option 1 was preferred over Option 2 in the event that GDC were to install further treatment process units beyond disinfection.

5 SCHEME RE-CONSENTING AND FINAL OUTCOME

Based on the CRMA process and additional assessments against consent impacts and operating costs, Option 1 to implement the Industrial Separation Scheme, one BTF and disinfection in the short term was selected, with preference to install a second BTF to reduce the loading rate on the trickling filter media rather than the installation of solids separation processes. GDC also showed preference to this option as it tends towards the important intention of the consent in resolving cultural requirements for biotransformation of human waste to plant matter, as previously described. In doing so, the Scheme is closely aligned with the recently completed Hastings WWTP insomuch that wastewater containing BTF solids are discharged via an ocean outfall.

During the CRMA evaluation, GDC investigated options to relocate the WWTP to other locations relatively close to Gisborne City but excluding the previously proposed Stanley Road site, owing to the potential public perception of an extensive wastewater treatment operation in close proximity to valuable recreational facilities. A potential site was identified on Banks Street in the Awapuni Industrial Estate, approximately 500m from the ocean outfall pipeline at the existing Stanley Road site, and adjacent to one of the large municipal sewerage interceptors as well as wastewater sources from major industries that are to be included in the Industrial Separation Scheme. Through the end of 2008 and into early 2009, GDC undertook significant consultation with the public on WWTP site options, with the majority of the feedback favouring the Banks Street site over either the Stanley Road or Airport sites. On this basis, and to futureproof the adopted Option 1 for possible expansion of treatment processes in the future, Council purchased the Banks Street site. The site currently accommodates two large warehouse buildings - one of which will be re-located prior to construction of the new WWTP - but with a total land area that can accommodate a second BTF, two clarifiers and solids thickening/dewatering plant should these be required in the future.

Figure 6: Flow diagram illustrating major components, consented water quality discharge limits and estimated flow rates in the revised Gisborne Wastewater Scheme.



Following the CRMA process and the selection and purchase of a new WWTP site, a revision of the consents and designation granted in July 2007 was required before any construction work on the re-scoped project could proceed. A new AEE and applications for a variation to the existing consents and for a designation over the Banks Street site were prepared and lodged with the GDC Regulatory division in November 2008.

The applications were advertised in February 2009, and a hearing before independent commissioners was held in May 2009. In this case, being a variation rather than a new consent, the Minister of Conservation's delegated officer approved (under s119A of the Resource Management Act 1991) that the Council could exercise its powers under s 127 to 132 (inclusive) of the RMA, in relation to any change of Restricted Coastal Activity conditions.

In June 2009, GDC successfully obtained a revised consent for the Gisborne Wastewater Scheme, in alignment with proposed Option 1 from the CRMA process and located at the Banks Street site

The consent also contains conditions to see the formation of the Wastewater Technical Advisory Group (WTAG). The WTAG will have the responsibility to continuously monitor the new WWTP and assess how well the WWTP is working in relation to the concept of "biotransformation". In selecting this option and including such a condition, GDC has proved its intention to meet the aspirations to achieve biotransformation of human waste in alignment with its cultural objectives of treatment, while providing the flexibility and foundations for multiple further wastewater treatment if necessary and/or disposal options.

The process undertaken by GDC demonstrates the importance of taking affordability into account at the "optioneering" and pre-consent consultation stage, to ensure that the impacts of funding such large wastewater projects at an individual ratepayer level are fully realised. This project has also highlighted the importance of including all components required to fully implement and commission a project, including risks and escalation, such that the total out-turn costs and annual Operating and Maintenance costs are included in funding requirement calculations and appreciated by all stakeholders.

While this paper has addressed the technical approach to CRMA, it is noted that a key component to the success has been the collaborative approach taken by tangata whenua and other interest groups in attempting to reach a solution that took into account the wider matters of cultural, social, environmental and economic well beings of the Gisborne community.

Through its process of extensive collaboration and structured assessment techniques, including the application of the CRMA tool, GDC has proven its desire to seek a solution for the Gisborne community in line with its project motto: "Best for Gisborne".

ACKNOWLEDGEMENTS

We wish to thank and acknowledge the support Gisborne District Council, CH2M Beca Limited and the Gisborne community, whose contributions have all made this project possible.

REFERENCES

Fraser D. & Bradley J. (2007) *Cultural Dreams Become a Technical Reality with Innovative Wastewater Treatment*. Proceedings of Ingenium Conference.

French C., Berry N. & Macdonald G. (2008) *Gisborne Wastewater Scheme TM14 – Project Scope and Budget Reduction Options*. CH2M Beca Limited.

French C. & Macdonald G. (2008) *Technical memorandum 15 – Mapping Treatment options for the Gisborne Wastewater Scheme*. CH2M Beca Limited.