Masterton District Council

Riversdale Beach Community Sewerage Scheme - Suitability of Sequencing Batch Reactor

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Contents

1 Executive Summary

A new wastewater treatment plant (WWTP) is planned for the township of Riversdale Beach, a small community with a population that swells over the summer holiday period. A number of options have been investigated to date. Currently the preferred options comprise either a pond system or a recirculating filter system (as produced by Innoflow) with disposal to land on Mr Tim Tathams property.

It has recently become known that Himatangi Beach will soon be serviced by a sequencing batch reactor (SBR) wastewater treatment system, utilising grinder pumps and small-bore pressure pipes. As Himatangi Beach is similar to Riversdale (in that it is also a small community with a relatively large holiday population), an NPV analysis has been conducted on an SBR arrangement for Riversdale. The whole-life cost of such a system is estimated at $12.4m. This compares with $11.4m for an Innoflow system, and $11.5m for a pond system.

Notwithstanding the results of the NPV analysis, we have significant concerns about the suitability and appropriateness of an SBR system at Riversdale. Namely - that the receiving environment is likely suitable for a far less complex system, and that the holiday population is substantially higher than the resident population with subsequent high operational difficulty and risk. This report details our concerns.

2 Introduction and Background

Riversdale Beach is a small community around 70km east of Masterton. The resident population is very small, currently numbering around 70, and predicted to number 200 in the future. However, over the summer holidays the population increases dramatically, and it is estimated that the future peak summer population will number 3681 People Equivalents (PE), around eighteen times the future resident population. While the township is currently serviced by septic tanks, a number of these are failing and offensive odours have been reported. The Greater Wellington Regional Council also has concerns about groundwater contamination. Work is currently being conducted on selection and design of a new wastewater treatment plant to be located near Riversdale. Several options have been investigated, including a pond system and an Innoflow recirculating filter plant, both with spray irrigation at land around 2.4km from the town. In July 2007 Opus produced a report showing updated costs for a number of the options.

In early 2008, the Riversdale Beach Sewerage Steering Group asked that a scheme similar to that being installed at Himatangi in the Manawatu be investigated. Himatangi is similar to Riversdale – it is a beachside community with a population that swells over the summer. The Himatangi Scheme comprises grinder pumps being installed on all properties and small bore, pumped reticulation. Wastewater from the township will be pumped to a continuous flow Sequencing Batch Reactor (SBR), which will biologically treat the wastewater. The treated water would then be irrigated over nearby farmland. While SBRs can produce very good quality wastewater, they are more difficult and expensive to operate than ponds or Innoflow systems.

MDC has asked MWH to investigate the feasibility of an SBR system for Riversdale. In order to assist with the report, a site visit to Riversdale, Himatangi, and a meeting with Manawatu District Council was undertaken by MWH on the 9th and 10th of April, 2008.

This report provides a concept design and capital and operating costs for an SBR similar to that at Himatangi. An NPV analysis has been conducted and the whole life costs of an SBR assessed against the ponds option and Innoflow option. Comment is also made on the suitability and appropriateness of an SBR compared with the pond and Innoflow options.

3 Flows, Loads, and Number of Properties

Design Flows and Loads have been taken form the Opus Report “Riversdale Beach Sewerage Scheme Cost update – July 2007” and are shown in Table 1 below.

Table 1: Riversdale Flows and Loads

Description	Design People Equivalent (PE)	Flow/PE (m^3/PE.d)	Total Flow (m^3/d)	BOD/PE (kg/PE.d)	Total BOD (kg/d)
Normally resident[1]	200	0.15	30	65	14.6
Peak Population (excluding Riversdale Terraces 1)	3681	0.15	552	65	239.3

The current normally resident population is around 70PE. However, there are a number of developments planned for Riversdale and this is expected to increase, as reflected in the figure of 200 PE given above. Note that we have included the development Riversdale Terraces 2 in the flow figures above, but not Riversdale Terraces 1, which is already served by an Innoflow plant.

There is clearly a large variation in flow, with peak flow occurring for two to three days over New Year. This is demonstrated graphically in Appendix A.

4 Summary of Site Visit

A site visit to Riversdale was undertaken by Ian Steer and MWH on 9 April, 2008. The township was visited, and the Reserve land, where a treatment plant has been previously mooted, was viewed. The visit took in the Riversdale Terraces 1 treatment plant (an Innoflow installation), and continued on to the Tatham land. Tim Tatham, the owner of the land, accompanied us to the site of the proposed ponds.

Initial impressions of the Reserve land were that the proposed site for a compact treatment plant near the end of Blue Pacific Parade was not suitable. The available area adjacent to the carpark was small, with houses no more than 50m away. It was also in a highly visible location, adjacent to a main beach access road, and would be at risk of vandalism. This site would not be appropriate for an SBR system.

The land proposed for ponds is located approximately 2.4km south west of the township on Mr Tatham's property. The site is well shielded from nearby properties, on flat land which drops off sharply into small gullies. Previous work by Opus has indicated that there is sufficient land for a wastewater treatment system and subsequent disposal to land at this location. Despite the pumping distance from Riversdale, the area is large, flat, and distant from any occupied houses.

On 10 April we visited Richard Kirby, Assets Group Manager for the Manawatu District Council, to discuss the Himatangi sewerage scheme. Richard described the history of the Himatangi scheme and why a pumped reticulation system (as manufactured by E-one) and SBR was chosen. The success of the E-one system in Australia was highlighted, with Richard describing communities serviced by Sydney Water where 2000 E-one grinder pump units had been installed. The ease with which the E-one system can be installed was described, as was the relatively low capital cost of the system. A better desription of the E-one system is given in Section 6.2. Following the meeting a visit was made to Himatangi. In particular, it was hoped to visit the site of the

[1] Derived from update population data in the Opus Report "Riversdale Beach Sewerage Scheme Cost Update – July 2007"

proposed SBR and irrigation fields. However, these were located some distance from the township, were only accessible on foot, and the precise location could not be found.

5 Description of Sequencing Batch Reactors (SBR)

The SBR is a form of "activated sludge" wastewater treatment. Activated sludge is used to describe methods where micro-organisms are grown in suspension, feeding on and degrading wastewater in the process. The micro-organisms are then settled out to clarify the wastewater. In order to maintain the correct concentration of microrganisms, the collected solids ('biomass') are returned to the head of the treatment reactor. Typically activated sludge systems will have separate reactors for biological treatment and clarification; with SBR systems, both treatment and clarification take place in the same reactor, with a certain amount of time dedicated to the biological reaction (which requires aeration) and a certain amount to settlement. Furthermore, recent developments in SBR technology mean that the tank can be filled at the same time as clarification is taking place, meaning that it is possible to design plants with only one reactor. Figure 5-1 and Figure 5-2 show a typical continuously fed SBR system.

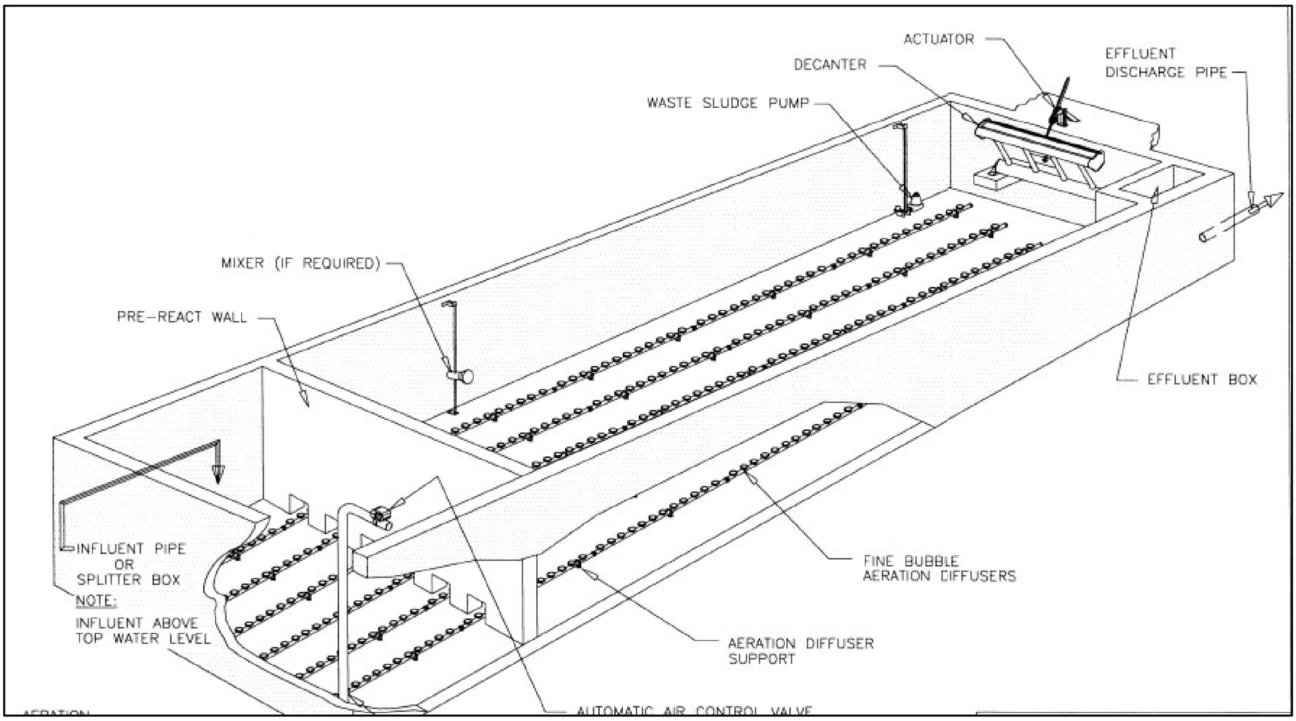


Figure 5-1: Typical Continuously Fed SBR

Figure 5-2: Inside a Continuously Fed SBR

The main advantage of SBRs is that less area is required for treatment. They can also be configured to cope with largely fluctuating flow and are capable of producing a very good quality effluent, which is very low in nutrients. The main disadvantage of SBRs is that complex control systems are required, large volumes of air are required to be blown through the wastewater, and waste sludge is produced. There is also a relatively large Mechanical and Electrical (M and E) requirement and they can require more Operator attention than other (simpler) methods of treatment. SBRs are typically considered where land area is at a premium and a very good quality of treated wastewater is required. Table 2 below summarises the advantages and disadvantages of SBR plants.

Table 2: Advantages and Disadvantages of SBR Treatment

Advantages	Disadvantages
• Can cope with fluctuating flows and loads • Small area requirement • Separate clarifier not required • Relatively low capital cost	• Complex control system required • Sludge handling required • Skilled operator needed • High electrical requirement, mainly for blowers

6 Description of Himatangi SBR System

6.1 Himatangi Flows and Loads

The Himatangi sewerage scheme can effectively be divided into two sections: reticulation and treatment. The township is similar to Riversdale in that it is a small beachside community with a population that swells over summer. An estimate of flow from the township is given in Table 3 below (taken from Good Earth Matters report, dated November 2007).

Table 3: Himatangi Flows and Loads

Description	Number of residences	Non-peak		Peak	
		Occupancy	Average Daily Sewage Flow	Occupancy	Average Daily Sewage Flow
Permanent Residence	249	2.2	137	3.2	199
Holiday Homes	167	-	-	5.3	222
Total			**137**		**421**

6.2 Himatangi Reticulation

The reticulation system that will be installed at Himatangi is a pressurised reticulation system, whereby every property will have a small grinder pump (as supplied by E-one) installed below ground to pump wastewater to a pressure main. This is not dissimilar to other small bore systems which incorporate septic tanks on properties to remove solids. However, instead of removing the solids (like a septic tank) the pumps grind large solids to smaller particles so that they can be transferred to the centralised pipe main. The E-one units are essentially wet wells in which the grinder pumps sit. The pumps are small (usually around 1hp) and electricity consumption is stated by the manufacturer to be typically that of a 40 watt lightbulb. The pumps are automatically activated and run infrequently for very short periods. The main advantages of such a system are that infiltration into the network will be negligible, meaning that the network pipework will be smaller and less expensive to lay. The reduced infiltration means that there will also be less hydraulic pressure on the wastewater treatment plant. The other advantage of such a system over other small bore reticulation systems which incorporate septic tanks is that sludge does not need to be removed from the wet wells. The main disadvantage of such a system is the extra maintenance and power costs associated with the pumps. Additionally, as the solids are not removed in septic tanks, they must be dealt with at the treatment plant.

A drawing of a typical E-one grinder pump unit is given in Figure 6-1.

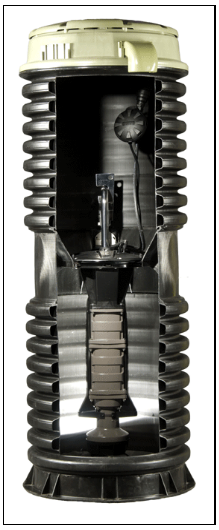


Figure 6-1: A Typical E-one grinder pump (courtesy of E-one Sewer Systems website)

6.3 Himatangi SBR

Raw sewage will be pumped to an SBR plant located approximately 1,500m from the township. The wastewater will first pass through a grit separator before entering the SBR, where biological treatment takes place. Following treatment and settlement in the reactor, the wastewater will be pumped to an irrigation balance tank, before being pumped through filters and UV disinfection and on to irrigation. The SBR has a total volume of 544m^3.

The proposed site for irrigation is farmland located to the north of the township. The soils in the area were identified as Hokio mottled soils, described in the Good Earth Matters report as "…somewhat excessively to imperfectly drained…". The rate of irrigation will be between 1.4 and 4.2mm/d.

The Good Earth Matters design report (November 2007) states that the SBR must have the capability to be configured for nutrient removal. However the reasons for this are unknown. MWH attempted to contact Good Earth Matters about this issue, but they were unwilling to discuss the project. It is therefore assumed that there is some concern about high levels of nutrients leaching into groundwater at Himatangi.

7 Description of System for Riversdale

Like the Himatangi Scheme, the design has been separated into two sections – reticulation and treatment. These are described in Sections 7.1 and 7.2. Both townships are quite flat, located near to the beach, with sandy soils. In terms of reticulation, a similar system to that proposed for Himatangi has been assumed for Riversdale. However, the locations of the treatment plants, disposal areas, and variations in population are quite different. In this regard the concept design of the Riversdale SBR contains some differences to the Himatangi example. These differences are explained in this section, Section 9, and Section 10.

7.1 Riversdale Reticulation

A reticulation system very similar to that at Himatangi has been costed for Riversdale. The E-one system is similar to the Innoflow reticulation system in that it is pressurized. However, where the Innoflow proposal incorporates septic tanks (STEG or STEP units) into the reticulation, thereby reducing solids loading on the treatment plant, the E-one system grinds any solids to a manageable size where they can be settled or degraded at the treatment plant. For purposes of consistency, and for a fair comparison between a 'Himatangi-like' treatment system and the current proposed systems, an E-one system has been costed.

Individual pump stations have been assumed for all existing lots and for Riversdale Terraces 2. As for the Ponds option, we have not include Riversdale Terraces 1 in the design. During the site visit it appeared that the camp site lots were small, and it is feasible that communal pump stations could be installed for these lots. However, for the purpose of this analysis, we have assumed pumps for the separate lots. In this respect there would be approximately 503 grinder pumps to be installed.

Like Himatangi, the reticulation would feed to a central, 'terminal' pump station where the sewage would be pumped 2.4km to the Wastewater Treatment Plant.

7.2 Riversdale SBR

The Riversdale SBR would comprise grit removal, biological treatment, sludge handling, and irrigation to land. Figure 7-1 shows a flow diagram of the process, while a description of each of the processes is given in Sections 7.2.1 to 7.2.4.

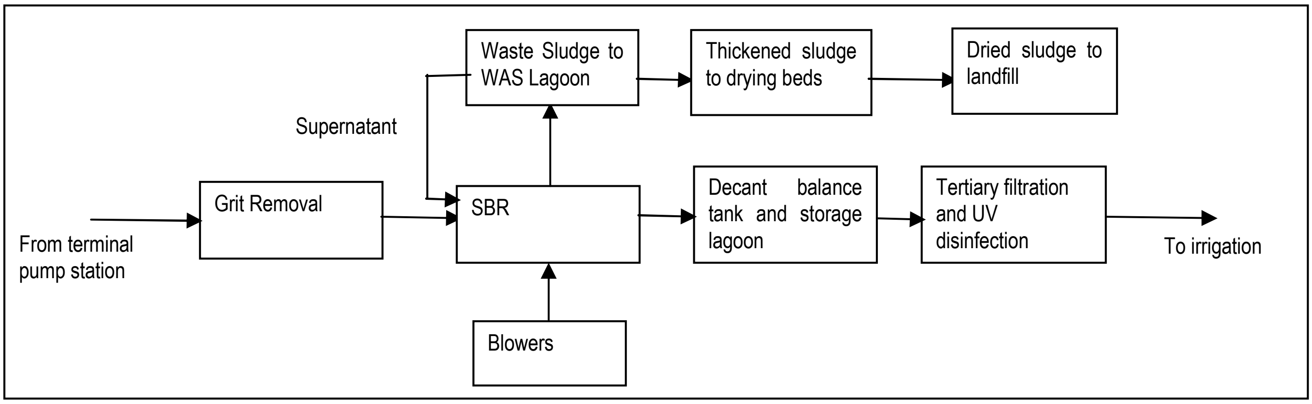


Figure 7-1: Process Flow Schematic of SBR Option

7.2.1 Grit Removal

As Riversdale is located near a sandy beach, grit removal is considered necessary. It will improve the life of any pumps and will reduce the risk of fine sand and grit interference with the aeration system.

7.2.2 SBR (including blowers and carbon dosing)

The proposed SBR system is a continuous flow reactor, also known as an IDAL (Intermittent Decant Aerated Lagoon) system. In an IDAL plant, the reactor will continue to fill, even while decanting. The total volume required is a function of the amount of BOD and nutrients to be removed, as well as the settleability of the wastewater. In other words, there must be sufficient volume for the biological process to complete, and there must be sufficient depth and surface area for sufficient settlement to take place. Due to the large variability in flow, it is proposed to construct the reactor with three (3no.) chambers, one with a surface area of 82m^2, the other two with a surface area of 41m^2 each. The total depth of the reactor would therefore be 4.7m.

The advantage of a multi-chamber system is it allows only one of the smaller compartments to be used throughout the winter and autumn months, thereby reducing air and blower requirements. It also allows a level of operational flexibility, particularly leading up to the Christmas period. During peak population and flow over Christmas and New Year all three compartments would be in use. The reactors would be fitted with a fine bubble diffused air (FBDA) system fed by three (3no.) variable speed drive (VSD) blowers. Floating decanters would be installed to drain settled wastewater.

During the winter months the reactor would operate on a fill and empty basis, i.e., one of the smaller basins would continue to fill until top water level is attained, when decant would take place. Leading up to the summer period, the reactor would be automated to run on fixed cycles of between four and twelve hours. As sufficient biomass would need to be established to cope with higher summer flows, a chemical dosing plant would need to be provided to dose an external carbon source, such as ethanol or acetic acid. It is estimated that this would take between four and six weeks, and it is a very difficult, expensive, and operator intensive process.

7.2.3 Reactor Decant and Irrigation

Supernatant decanted from the reactor would be collected in an irrigation balance tank around 100m^3 volume, before being pumped to a UV disinfection unit. A pond providing around five days storage would also be provided for extreme wet weather occasions.

7.2.4 Disinfection

A UV disinfection unit would be provided to address any health concerns with irrigation of human waste to land. The Himatangi proposal describes the need for a filter to ensure the integrity of the disposal system. In our experience, a well operated activated sludge system will not result in excessive solids in the final effluent; more likely, the requirement for a filter at Riversdale would be to ensure to ensure the integrity of the UV system. It is unlikely that solids carryover would be a problem. We have therefore not included tertiary filtration in our design.

7.2.5 Sludge Handling

Waste sludge from the SBR would be pumped to a sludge lagoon approximately 1200 m^3 in volume, where sludge thickening takes place. It is envisaged that the lagoon would thicken the WAS from around 0.30 – 0.45% dried solids (DS) concentration to approximately 3% DS concentration. As the lagoon would be lightly loaded for most of the year, odour is unlikely to be a problem. Every few months the operator would be required to pump settled sludge to two (2no.) drying beds. Drying beds are capable (in dry climates) of attaining a solids content of 30 - 40%. The dried sludge would be removed and taken by truck annually to the Bonny Glenn landfill in the Rangitikei district, which would require a DS content of at least 20%. This method of sludge handling is not Operator or energy intensive.

An alternative option is to provide aerobic digestion and thickening in an aerated tank, with tankering of the thickened sludge to the Masterton pond system at Homebush. However, this was found to be the more expensive of the two options, both in terms of capital and operating expenditure.

8 Description of Other Proposed Systems

The other systems currently under investigation are a pond system and a recirculating media filter, as provided by Innoflow. These are described in broad detail in previous reports by Opus so only a brief description of these options is given here. The recent report "Riversdale Beach Sewerage Scheme Cost Update – July 2007" provides updated costs for each of the options. The report considers three locations for a pond system, and also considers that the pond may or may not take the Riversdale Terraces 2 flow. The Innoflow option assumes that flow from Riversdale, Riversdale Terraces 1, and Riversdale Terraces 2 would be treated. For the purpose of this report, we will compare an SBR system with a Pond system at Tatham land, treating effluent from Riversdale and Riversdale Terraces 2 (given as Option B in the "Riversdale Beach Sewerage Scheme Cost Update – July 2007" report). These will be compared against an Innoflow system at East Leigh, treating effluent from Riversdale and both Riversdale Terraces 1 and Riversdale Terraces 2 (given as Option A in the aforementioned report).

8.1 Pond System at Tatham Land

The pond option comprises a series of ponds covering covering 2.3ha at Mr Tatham's land. The proposed system incorporates a conventional sewer main pumping raw sewage to a series of ponds, where the wastewater is treated, BOD and pathogens being largely reduced in the process. Irrigation would also take place on Mr Tatham's land; at an irrigation rate of 2mm/d, the area required for irrigation would be 7.2ha. The main advantage of a pond system is the large buffering capacity afforded, as well as being a reliable method of coliform reduction. They are also very simple to operate and are a very robust solution where land is available and a basic level of treatment is required. The disadvantages are a high capital cost and the fact that algae levels can be high, which largely precludes dripline irrigation as a method of disposal. Ponds will generally not significantly reduce nutrient levels.

8.2 Innoflow System

The Innoflow system comprises a series of 'pods' located at the East Leigh land, each containing a media on which a biofilm grows and degrades the wastewater. Raw wastewater would be settled in onsite STEP or STEG tanks, similar to septic tanks, which would allow small bore reticulation to be laid through the town, in a similar fashion to the E-one system. Like the pond option, irrigation would take place on Mr Tatham's land. It should be noted that the Innoflow option allows for collection of wastewater from Riversdale Terraces 1 as well as Riversdale Terraces 2 and Riversdale township. The settled wastewater is then pumped through the textile media, where treatment occurs. Following UV disinfection, the wastewater would be pumped to Mr Tatham's land for spray irrigation.

9 Costs

9.1 Comparison Between the Options

Costs for each of the options are summarised in Table 4 below, with all of the options allowing for spray irrigation on Mr Tatham's land. The costs for the Innoflow and Pond system are taken from the Opus report "Riversdale Beach sewerage Scheme Cost Update – July 2007" The estimated costs for the proposed SBR system have been derived from a combination of costs for the other options, budget prices from suppliers, and MWH experience in similar projects. Detailed estimates for the SBR option are given in Appendix B.

Table 4: Summary of Costs

Option		Pond System at Tatham Land	Innoflow System at East Leigh Land	SBR System at Tatham Land
Capital Costs ($million)	expected	9.8	9.5	9.7
	upper limit	10.2	9.9	-
Operating Costs / yr ($k)		120 - 130	139	262
Net Present Value (NPV, $million)		11.5	11.4	12.4

Note: NPV has been derived on the basis of a discount period of 19 years, discount rate of 7%, and a 20 year depreciation period

It should be recognised that, while the Innoflow proposal deals with Riversdale Terraces 1 as well as Riversdale Terraces 2 and Riversdale, this was the only Innoflow option presented in the aforementioned report, and it is therefore considered fair to compare it with the other options. Although not given in the Opus report, the operating costs are estimated at around $120k - $130k per year for the Ponds option.

The SBR system (including reticulation) is similar in capital cost to the other options, but would be considerably more expensive to operate. Sludge handling and standard Operator time would comprise around $54k/yr of the cost of operating the treatment plant. As per the Opus report, we have allowed 1% of civil and 3% of mechanical and electrical costs for repairs and maintenance. This totals $128k per year. This seems to be a large sum, but is necessarily included so that a fair comparison across the options can be made. The remainder of the operating cost is comprised mainly of consumables, electrical and chemical costs, and an allowance for contingency. This is considered necessary as we consider operating the SBR at certain times of the year to be a difficult and risky process.

9.2 Comparison between Riversdale and Himatangi SBR options

The contract cost for construction of the Himatangi system is $5.645m, well below our estimate for Riversdale of $9.7m. However, there are a number of differences between the two sites. The first is the difference in the design flows and population. Riversdale has a design flow rate of 552m^3/d, while Himatangi has a design peak flow rate of 421m^3/d. This is a 31% difference, and the differences in peak populations are even greater (1,682 at Himatangi, compared with 3,681 at Riversdale). This alone has a large effect on the cost. Other significant items that we have priced and that are unlikely to have been included (or comprise a relatively small cost compared to Riversdale) in the Himatangi costs are:

- land purchase
- irrigation
- chemical dosing plant
- Access and easements
- Electrical lines into the works
- Engineering fees.

The above items total nearly $1.5m (it should, however, be noted that the Himatangi costs include a total of around $200k for land and electrical and control items). We have also allowed around $740k for contingency, an item that is not highlighted in the Himatangi costs. This is approximately 8% of the total capital cost, which can be considered low. However, we have allowed 5% contingency in the reticulation capital aspect as we consider this a low risk item; 20% has been allowed for capital contingency items at the treatment plant.

The operating costs for Himatangi have been estimated at $121k/yr, approximately half of the Riversdale estimate. As flow to the Riversdale works will be relatively low most of the year, the electrical costs will also be relatively low compared to Himatangi. However, as stated in Section 9.1, we have allowed a cost for repairs and maintenance that are significantly higher than the Himatangi option, so that a fair comparison can be made to the pond and Innoflow options. As stated in Section 9.1, contingency items of 20% for operation of the reticulation and 30% for operation of the treatment plant have been allowed.

MWH have several concerns about the operability and suitability of an SBR for Riversdale, discussed further in Section 10, which is reflected in this figure. This also affects Operator time, and we have estimated this to be nearly two and a half times more than the Himatangi estimate. This is mainly because of the need for carbon dosing, which does not occur at Himatangi, but also because the works would be distant from Masterton, meaning that travel time would be high.

10 Discussion

The isolation of Riversdale, its large seasonal population swings, and the absence of suitable land and receiving water nearby presents some challenging obstacles. The preferred system for Riversdale should therefore be able to cope with the seasonal fluctuations, will not be overly costly to construct, and should be robust and easy to operate. Perhaps most importantly, the treatment plant should be capable of *meeting the environmental requirements in the most appropriate manner*.

In this respect, the receiving environment plays a very important role in determining the quality requirements of the treated water. For example, the quality requirements for a very small discharge to a large river will be quite different to the quality requirements for a large discharge to a very small river. In the former example, a very basic form of treatment, such as a ponds system, may suffice. This would unlikely be sufficient in the latter case, where a much more advanced system would be required. It is the effects of a discharge on the environment which largely determines the treatment requirements. This is a key issue as, generally speaking, the better quality effluent required, the greater the complexity of treatment and the greater the ongoing cost. This is borne out in the NPV figures.

10.1 Economic Issues

The NPV analysis across the options showed that the whole life cost is highest for the SBR option. The ongoing operational cost will be significant, largely due to the ongoing cost of maintaining the mechanical and electrical equipment, regular operator visits, and the cost of sludge handling. Additionally, the SBR will require a very skilled Operator, and some allowance must be made for the risk of plant failure, which we consider very high, especially in the period leading up to Christmas.

It should be noted here that the majority of the operating costs for the pond system are derived from an annual allowance of 1% of total civil cost and 3% of M and E cost to cover repair and maintenance. Given the high capital cost of the ponds system, we consider that this yields a very conservative estimate of the operating cost for the ponds (around $120k – $130k per year). This seems especially high when one considers that ongoing operating costs have been separately estimated at 0.5 days per week, a not unreasonable estimate. By comparison, the bottom up estimate of cost for the SBR is $262k. Based on UNEP[2] figures, one would expect the operating costs to be 3-10 times cheaper than mechanical, biological treatment such as SBR.

10.2 Environmental Issues

The design of the SBR assumes that only limited nitrogen removal is required but, like Himatangi, capacity for nitrogen removal in the future has been provided. The extra cost of this is around $50k. However, as described in Section 6.3, the Himatangi report does not outline why nitrogen removal would be required. This is a key difference between the Riversdale and Himatangi schemes – previous ground and soil studies indicate that nitrogen loadings will not exceed guideline values for irrigation to Mr Tatham's land at an irrigation rate of 2mm/d. The requirement (or otherwise) for TN reduction is discussed in more detail below.

While this report does not constitute a peer review, the work conducted by Opus appears to show that the land available on Mr Tatham's property is suitable for receiving effluent from a pond system. Typically, the land area required for irrigation will be defined by either Total Nitrogen (TN) loading, or hydraulic loading, i.e., the depth of water that can be applied. Studies conducted by Opus indicate that, at a discharge rate of 2mm/d (as given in the Opus report "Riversdale Beach Sewerage Scheme Cost Update – July 2007") irrigation will be limited by the depth of water that can be applied, and not the amount of TN. As described in Section 8, a pond system, while removing a large amount of carbonaceous matter, will not necessarily remove significant amounts of nitrogen (it should be noted that, in reality, the large volume of the ponds in relation to the small flows will mean that there will be an element of nitrogen removal).

The MWH report "Suitability of Innoflow Treatment Systems for the Riversdale Beach Community", dated August 2006, stated that the method of treatment would not only depend on the receiving environment, but also on the method of irrigation. The report went on to state that if dripline or subsurface irrigation was employed, pond treatment would not be suitable because of the risk of the irrigation network blocking, and the Innoflow system would be preferred. However, if spray irrigation was employed, then blocking of the irrigation network was a very small risk and the pond system would be preferred. Latest information (refer to the report "Riversdale Beach Sewerage Scheme Cost Update – July 2007") indicates that spraying would be employed on Mr Tatham's land. On the basis that the land is suitable for irrigation of pond effluent, that spray irrigation will be

[2] UNEP. (1999). Planning and Management of Lakes and Reservoirs: An Integrated Approach to Eutrophication. IETC technical Publication Series No 11. International Environmental Technology Centre, United Nations Environment Programme, Japan.

employed, and that appropriate runoff and spray drift measures mitigation are employed (if needed), the ponds system appears to be the most appropriate option.

10.3 Engineering Issues

There will be considerable, near insurmountable difficulties with operating an SBR at Riversdale. During the winter months, operation of the works should be relatively straightforward as the population swings aren't as great as during summer. It would still be expected that an Operator would visit the works around three times per week – activated sludge systems must be carefully monitored and operated. However, biomass would need to be grown in the reactors prior to the arrival of the summer holiday population. It would be necessary to incorporate a carbon source, such as ethanol or acetic acid, in order to grow the biomass, which is a process that can take several weeks. We have allowed for a period of six weeks of carbon dosing and biomass preparation. In our experience this is a very tricky process, which presents a high risk of plant failure.

The advantage of a small bore reticulation system incorporating grinder pumps on individual properties (such as the E-one system) is that there would be very little infiltration into the sewer network. This has the benefit that the size of the SBR can be reduced (compared with conventional reticulation). There is ongoing discussion in the wastewater community about the benefits of small bore, pumped reticulation compared with larger bore, conventional gravity reticulation. Certainly, improved pipe manufacture and pipe laying methods mean that infiltration in gravity systems is much lower than it used to be.

A continuously fed SBR has recently been commissioned at Pauanui on the Coromandel Peninsula. While the flows and loads were higher than for Riversdale, the Commissioning Engineer has stated in a personal communication that preparing the works for summer flows was a fulltime job which took several weeks. It would be expected that the Riversdale plant would be no less Operator intensive.

10.4 Discussion Summary

Given that there is sufficient land for the pond system, that they are very simple to operate, that they provide a larger buffer capacity, and that they appear to meet the environmental requirements, the question arises - Why construct a complex, very difficult to operate plant where there is no driver to do so? The Innoflow system can be configured to remove nitrogen but, again, if discharge were to occur on Mr Tatham's land, there would appear to be no reason to reduce levels of nitrogen.

While SBRs are renowned for being able to cope with large variations in flow, Riversdale presents an extreme example where sustained peak flows are envisaged to be around eighteen times higher than sustained low (winter) flow. Not only will much of the works be redundant for most of the year, there are substantial operating risks and difficulties associated with such a system to provide adequate and effective treatment during the peak summer period. The need for such a high level of treatment is also highly questionable, given the low irrigation rate. Even when the higher whole life costs for the SBR are not considered, the SBR system is not an appropriate option for Riversdale.

11 Conclusions and Recommendations

An NPV analysis based on concept design of an IDAL SBR for Riversdale estimated the capital cost to be $9.7m with a whole life cost of $12.4m. This is slightly higher than the equivalent ponds option where the whole life cost is estimated at $11.5m, and the Innoflow option, where the whole life cost is estimated at $11.4m.

Notwithstanding the results of the NPV analysis, we have significant concerns about an SBR type plant for Riversdale, namely:

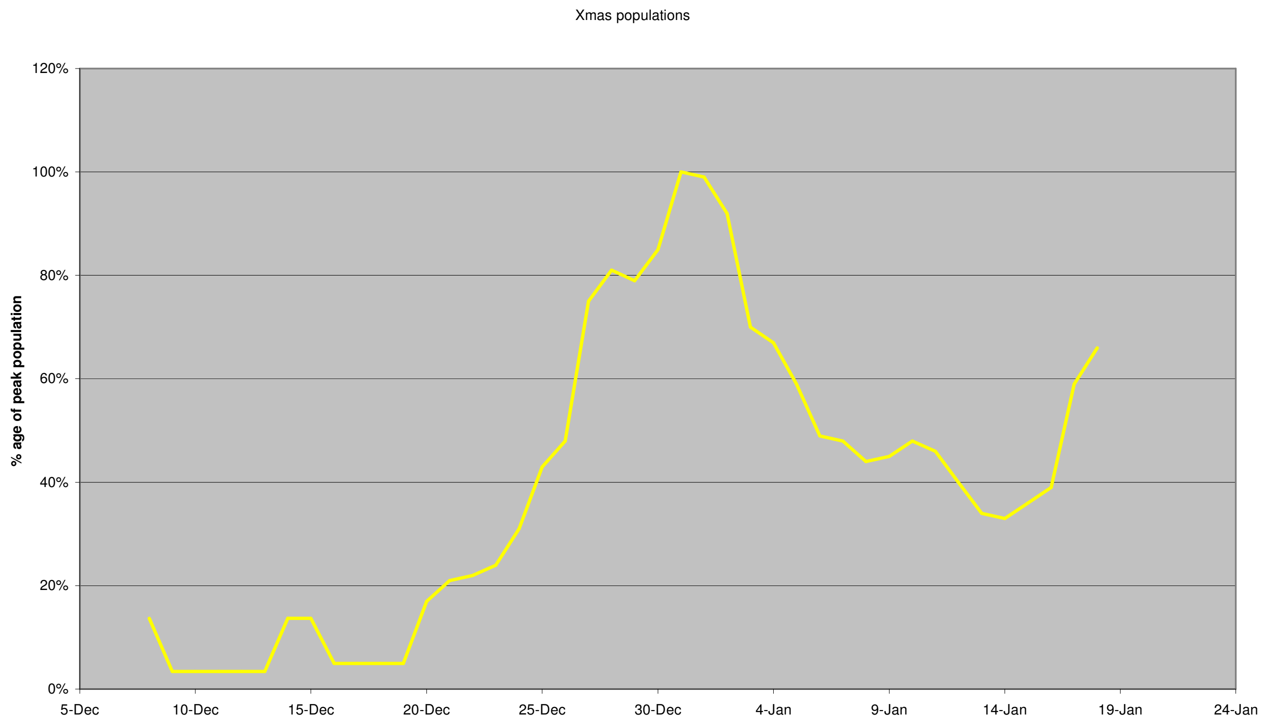
- The works will be extremely difficult and expensive to operate, especially leading up to the summer peak period. The risk of plant failure during this period is high
- Previous work indicates that the receiving environment at Mr Tatham's property is suitable for spray irrigation of pond effluent. There does not appear to be a need for a complex, treatment process, such as an SBR, with a much larger inherent operational risk of failure.

Based on this assessment, the pond system is considered the most treatment appropriate option for Riversdale for the following reasons:

- Sufficient land is available for the ponds
- It is a very simple, robust, and easy to operate treatment system
- A high level of natural disinfection is provided
- There is little mechanical equipment, and the risk of failure is small
- There is substantial buffering capacity for sustained wet periods
- Operating costs are comparatively low

Appendix A Plot Showing Flow to Works

Note: This plot has been taken from Opus Design worksheet “Estimate V9.0.xls”.



Appendix B Breakdown of SBR Costs

	Treatment Costs					
Main Capital Items (treatment)						
Civil Items	**Item**	**Unit**	**Qty**	**Rate**	**Amount**	**Comments**
	IDAL system, concrete	m3	166.99	$2,600.00	$434,169.44	taken from tank costing database. Allow for an anoxic section
	WAS Lagoon and drying beds	LS	1	$66,561.13	$66,561.13	see "Sludge handling compare" costs
	Control Room	m2	20	$2,000.00	$40,000.00	Scaled From Pines, use 0.6 factor rule
	Blower housing	m2	10	$2,000.00	$20,000.00	Scaled From Pines, use 0.6 factor rule
	Access road, easement, and driveway to works	LS	1	$100,000.00	$100,000.00	Engineers estimate, partially based on Pines
	Site drainage	LS	1	$10,000.00	$10,000.00	Engineers Estimate
	Treated water / irrigation tank and pump	LS	1	$80,000.00	$80,000.00	Based on WAS tank at Pines
	Treated storage lagoon	LS	1	$40,000.00	$40,000.00	Engineers Estimate
	Valves, Interconnecting pipework	LS	1	$100,000.00	$100,000.00	Engineers Estimate
	Fencing	LS	1	$50,000.00	$50,000.00	Engineers Estimate
	Other civil work	LS	%	20.00%	$188,146.11	Engineer Estimate
	Subtotal				**$1,128,876.68**	
M and E items						
	Grit Separator	LS	1	$140,000.00	$140,000.00	From Himatangi
	Decanters	LS	1	$116,000.00	$116,000.00	From Siemens quote. $69500US, allow exchange rate of 0.6
	Blowers	LS	1	$31,000.00	$31,000.00	Scaled From Pines, use 0.6 factor rule
	Diffusers	LS	1	$81,000.00	$81,000.00	Scaled From Pines, use 0.6 factor rule
	Aerator for WAS lagoon	LS	1	$7,500.00	$7,500.00	From Pines, use 0.6 factor rule
	Chemical Dosing Plant and storage area	LS	1	$50,000.00	$50,000.00	Engineers Estimate
	Standby Generator	LS	1	$59,325.00	$59,325.00	Himatangi + 5%
	Electrical line in	50m	14	$20,000.00	$280,000.00	engineer estimate $20k / 50m
	Irrigation	LS	1	$303,000.00	$303,000.00	Based on Opus Ponds option
	UV Plant	LS	1	$100,000.00	$100,000.00	Includes stainless steel channel
	Electrical, Instrumentation, Automation, and telemetry	LS	%	15.00%	$175,173.75	Engineers Estimate
	Subtotal				**$1,342,998.75**	
Other Items						
	Land purchase	ha	9	$44,118.00	$397,062.00	including land disposal
	Consenting	LS	1	$200,000.00	$200,000.00	Based on Innoflow option
	Preliminaries and General	LS	%	0.05	$123,593.77	
	Engineering fees	LS	%	0.13	$308,984.43	
	Construction Monitoring	LS	%	0.05	$123,593.77	
	Commissioning	LS	%	0.10	$247,187.54	
	Contingency	LS	%	0.20	$494,375.09	
	Subtotal				**$1,894,796.60**	
	TOTAL				**$4,366,672.03**	
Operating Costs						
Treatment						
	Blowers	kWh	30000	$0.16	$4,800.00	
	Other electrical (WAS pumps, irrigation pumps etc)	LS	1	$3,000.00	$3,000.00	
	Operator site visits (regular)	h	1104	$25.00	$27,600.00	3 visits per week,8 hours total per visit. Inc visits to reticulation
	Operator (leading up to Christmas and easter)	h	320	$25.00	$8,000.00	six weeks full time per year, 5 days per week. See Pauanui
	Carbon dosing	t	2	$3,000.00	$6,000.00	Engineer Estimate, difficulties inestimating how much we wouold need to dose
	Sludge handling and disposal	LS	1	$17,196.87	$17,196.87	From "Sludge handling compare" spreadsheet
	General maintenance - civil	LS	%	1.00%	$11,288.77	Engineers estimate, based on opus ponds option
	General maintenance - M and E	LS	%	3.00%	$40,289.96	Engineers estimate, based on Opus ponds option. Inc irrigation
	Irrigation cost	LS	1	$6,500.00	$6,500.00	1 hr per day, as per Opus report July 2007
	Sample testing	no	12	$100.00	$1,200.00	samples collected once per month
	Consumables (lamps, cleaning chemicals etc)	LS	1	$2,000.00	$2,000.00	
	Contingency	LS	%	30.00%	$38,362.68	Allowance for risk. Higher than Opus as SBR will be difficult to operate
					$166,238.28	
	Reticulation Costs					
Main Capital Items (reticulation)						
	Item	**Unit**	**Qty**	**Rate**	**Amount**	**Comments**
	E-one units	no.	503	$6,700.00	$3,370,100.00	Based on Himatangi per unit cost. 503no. inc. campgrounds (1 unit per lot), minus 5% to allow for campgrounds having shared STEP type units
	Pipework and reticulation	m	12650	$85.00	$1,075,250.00	Based on Himatangi per unit cost
	Terminal Pump Station	LS	1	$113,500.00	$113,500.00	Taken from Himatangi
	Main pipeline to treatment plant	m	2700	$110.00	$297,000.00	Himitangi cost + 30% - laying across steep, difficult terrain
	P and G, including consenting, as builts, traffic management	%	0.02		$97,117.00	comparable to Himatangi
	Design and Drawings	LS	1	$66,000.00	$66,000.00	Himatangi + 10%
	Commissioning	LS	1	$22,000.00	$22,000.00	Himatangi + 10%
	Contingency	%	0.05		$252,048.35	more than Himatangi, slightly trickier work
	Subtotal				**$5,293,015.35**	
Main Operating Items						
	Reticulation electrical costs	LS	1	$3,000.00	$3,000.00	Engineer estimate
	Civil maintenance	LS	%	1.00%	$25,539.49	1 per month, based on talk with Manawatu District Council
	Mechanical maintenance	$	%	3.00%	$52,254.00	A little high, but is in keeping with Opus option
	Contingency	LS	%	20.00%	$16,158.70	20% contingency as per Opus costs
	TOTAL				**$96,952.19**	