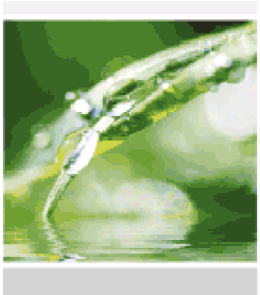
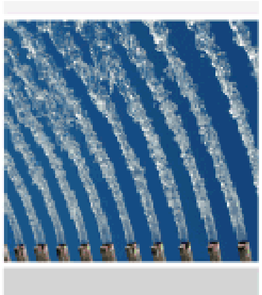
South Wairarapa Integrated Wastewater Scheme - Technical Review

South Wairarapa District Council

August 2013 – Final



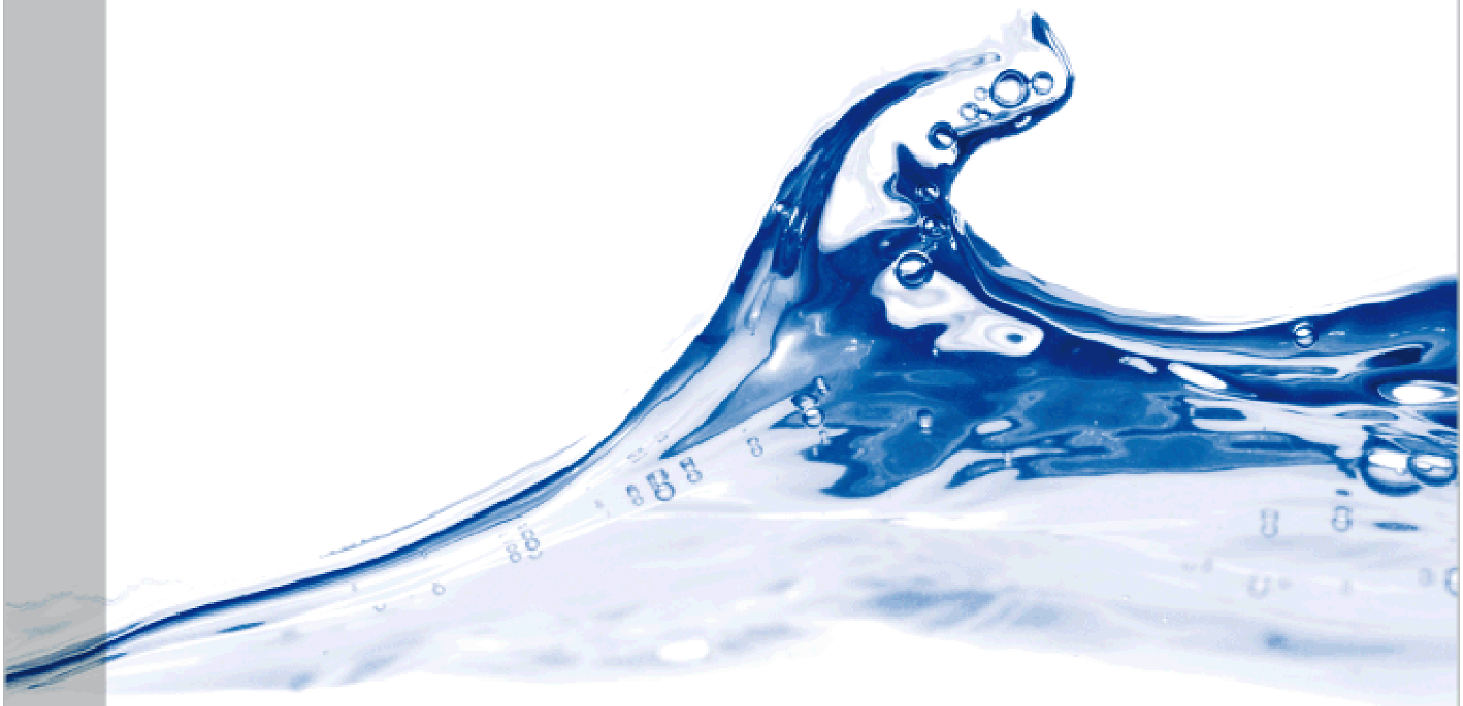


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TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

South Wairarapa District Council (SWDC) is responsible for the reticulation, treatment and disposal of wastewater in the South Wairarapa area. SWDC currently operates three pond-based wastewater treatment plants (WWTPs) at Featherston, Martinborough and Greytown. All three WWTPs discharge treated effluent to inland surface waterways.

SWDC is currently undergoing a resource consenting process to renew the effluent discharge consents for the three WWTPs. Alternative methods or locations of discharge are matters that should be considered as part of the consenting process. Therefore as part of this process and SWDC's overall long-term wastewater management strategy, SWDC has engaged AWT Water Ltd (AWT) to evaluate the following four options:

- Combined land disposal scheme with and without the inclusion of Carterton District Council's (CDC) WWTP effluent
- Separate land disposal schemes for each site
- Combined high rate treatment plant and discharge to water
- Separate high rate treatment plants for each site and discharges to water.

A high level concept design and cost estimate has been undertaken for all above options and includes a review of the budgeted costs for Council's proposed short term treatment and disposal upgrades as presented in the SWDC Work Plan.

A comparison between the reviewed short term treatment and disposal upgrade costs and the SWDC Work Plan budgeted costs is presented in Table 1 below. Pond desludging at Martinborough and Featherston has been excluded from these short term cost estimates as we understand this work is no longer required in the short to medium term. A separate analysis on inflow and infiltration remediation works for all towns has been undertaken and therefore these costs have also been excluded. We have however included professional fees and contingencies. In summary, based on our review, the overall short-term upgrade costs are significantly greater than those presented in the SWDC Work Plan. For detail on cost differences please refer to Appendix 1.

Table 1: Review of Short Term Costs

	Featherston			Martinborough			Greytown	
	AWT	Work Plan		AWT	Work Plan		AWT	Work Plan
Short Term Treatment Upgrades	$ 2,374,400	$ 795,450		$ 1,049,600	$ 1,148,595		$ 2,851,400	$ 1,700,000
Short Term Combined Land Water Discharge	$ 4,029,000	$ 2,277,580		$ 2,979,700	$ 1,800,000		$ 789,900	$ 350,000
Sub-Total	**$ 6,403,400**	**$ 3,073,030**		**$ 4,029,300**	**$ 2,948,595**		**$ 3,641,300**	**$ 2,050,000**
Professional Services	$ 930,700	$ -		$ 555,900	$ -		$ 728,300	$ -
Contingency	$ 1,163,400	$ 460,955		$ 694,800	$ 442,289		$ 910,300	$ 307,500
Total Cost	**$ 8,497,500**	**$ 3,533985**		**$ 5,280,000**	**$ 3,390,884**		**$ 5,279,900**	**$ 2,357,500**

The integrated scheme options combine the discharge from all WWTPs to a centralised location. A high level concept design of land disposal schemes has been undertaken using existing effluent flow data and assumed land application design parameters based on soil assessments undertaken by LOWE Environments Ltd. For those options where discharges to water are to continue, the replacement of existing ponds with advanced treatment technologies such as a sequencing batch reactor (SBR), or membrane bioreactor (MBR) has been assumed due to the likelihood of stringent consent condition requirements in the longer term for continued discharges to water. As part of this evaluation, consideration has also been given to the feasibility and cost of incorporating CDC WWTP effluent into the integrated land disposal scheme.

The options that have been investigated and preliminary cost estimates for each option are summarised in Figure 1 below. All options include a provision for professional services and 25% contingency.

Overall, the long-term stand-alone options are more cost-effective than the integrated options (~$15M difference) due to the ability to make use of existing land and reduced reticulation infrastructure requirements. High rate treatment options with disposal to water also appear to be more cost effective than land disposal in terms of capital costs (~$5 - $7M difference). However, following opex and net present value analysis, land treatment on individual sites appears to have a similar long-term cost to that of individual high rate treatment options This is attributed to lower on-going operational costs for land disposal and potential for revenue generation (from selling crops) when compared with high rate treatment.

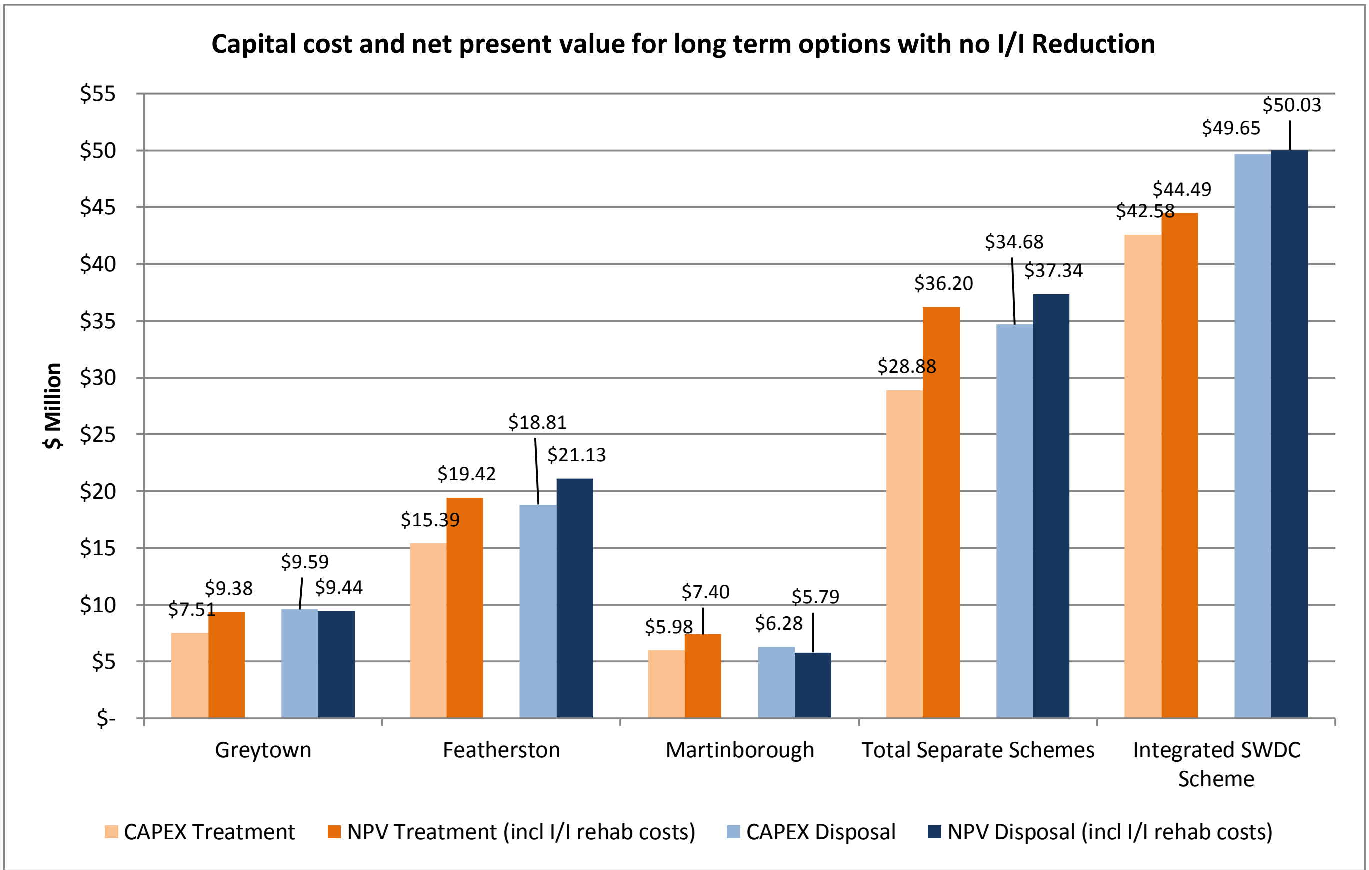


Figure 1: Comparison of capital costs vs net present value

Adding Carterton's WWTP effluent to a joint land disposal scheme increases the capital cost estimates by approximately 28%. The flow data from Carterton WWTP however was questionable, and meter calibration followed by further flow monitoring has been recommended to gain greater confidence in design flows.

Inflow and infiltration (I/I) has been identified as a significant issue in SWDC's and CDC's wastewater networks. High I/I significantly affects the cost of treating and disposing of wastewater because of the following impacts:

- Larger reticulation pipework required to convey high peak flows (or an increased risk of overflows if pipes are undersized);
- Larger pond volumes required to provide storage and flow balancing during times of high flow;

- Greater treatment capacity and operational costs to provide sufficient treatment of flows during high flow; or else a larger proportion of high flows must be bypassed and discharged without treatment (increasing risk of non-compliance with effluent quality consent limits);
- Greater storage, land and irrigation infrastructure required to fully discharge wastewater to land.

In order to assess the impact of I/I on the options analysed above, a sensitivity analysis was undertaken. The analysis shows that in Featherston, up to 43% of the average daily flow (ADF) could potentially be removed through I/I rehabilitation works. This could significantly reduce the size and cost of long term treatment and disposal options, and may achieve net savings of approximately $1.8 - $3.9M for treatment and $4.8 - $6.8M for disposal (compared with the 0% reduction scenario) depending on the extent of network rehabilitation required (30% or 5%). I/I reduction works have the largest effect on the capital cost of a land disposal scheme

The I/I effects in Martinborough and Greytown were less significant than Featherston under the scenarios modelled, because these networks are less 'leaky'. Notwithstanding, the net project cost savings achievable from remediation works will depend greatly on the extent of network rehabilitation required in all catchments.

This study has shown that the long term treatment and/or disposal of wastewater in the SWDC will require significant capital works. Of the four options considered as part of this analysis, individual high rate treatment schemes appear to be most favourable in terms of estimated capital and net present value costs. Reducing the amount of I/I into the network has the potential to reduce the scale and cost of capital works required, more so for land disposal and particularly for Featherston and the integrated scheme options based on the assumptions made.

Recommendations

Based on the findings of this work, the following recommendations have been made:

- Obtain scientifically robust evidence on the assimilative capacity of the receiving environment at each plant location for key contaminants (i.e. nutrients and pathogens). This assessment should not only focus on the worst case scenario (i.e. low flow during summer) but should also consider what assimilative capacity may be available during medium and/or high flow scenarios. This can then guide SWDC on what level of treatment may be appropriate during summer periods versus winter (and/or wet weather) periods if a full water discharge option or combined land/water discharge option were to be pursued.
- Likely effluent quality limits for both land and water discharges need to be clarified with the regulator in conjunction with a review of the suitability of both short and long term upgrades proposed to meet such limits. These quality limits will have a significant effect on the planning and design of long term options.
- Consideration of high river flow discharges, emergency discharges and/or bypass facilities within the consent(s) will also have significant effect on the planning and design of long term options. Currently our analysis has assumed full containment of all flows received by the plants.
- Land disposal scheme costs are highly sensitive to the number of irrigation days and application rates, therefore confirmation of these factors through further field testing is recommended.
- In recognition of Councils desire to address the immediate environmental concerns and show the regulator its commitment to the long-term wastewater management strategy, we suggest Council workshop with the regulator the short term upgrades in relation to its long term direction for treatment and/or disposal. There are opportunities for cost savings and efficiencies if some of the proposed short term upgrade options are deferred. Council may wish to consider taking a more collaborative approach with Greater Wellington when developing its work plan as this is intrinsically linked to the establishment of improved effluent quality standards and how these may be staged over time.

- The scale of long-term infrastructure costs identified and potential financial burden to the South Wairarapa ratepayers is an important consideration when developing consent conditions. An assessment of these costs on rates would be a beneficial exercise for future consultation purposes.
- This study only assesses high level economic and technical aspects of the different treatment and land disposal options. Social and cultural matters have not been assessed as part of this evaluation, therefore it is considered prudent that key stakeholder participation be sought when determining the preferred long-term solution and a quadruple bottom-line assessment be undertaken to support overall option selection.
- It is recommended that SWDC and CDC implement source detection strategies to provide the necessary data for a targeted I/I remediation programme, with a focus for SWDC on Featherston initially. This will clarify the scale and costs of achieving a reasonable reduction in I/I, which will affect the planning and design of long term wastewater options.
- If SWDC and CDC decide on pursuing a joint venture, further certainty of flow data from Carterton's WWTP is required for design purposes. We therefore recommend that influent and effluent flow meters are calibrated and a comprehensive flow monitoring programme is undertaken.

1 INTRODUCTION

South Wairarapa District Council (SWDC) is responsible for the reticulation, treatment and disposal of wastewater in the South Wairarapa area. SWDC currently operates three pond-based wastewater treatment plants (WWTPs) at Featherston, Martinborough and Greytown. All three WWTPs discharge treated effluent to surface water, with effluent ultimately flowing into Raumahanga River and Lake Wairarapa.

SWDC is currently undergoing a resource consenting process to renew the effluent discharge consents for these WWTPs. In recognition of the need to decrease the actual and potential effects of wastewater treatment and disposal on the environment, coupled with the increasing financial pressures on small community ratepayers, SWDC have developed a long-term strategy for wastewater management. The long-term strategy acknowledges the need for significant capital costs involved to take a long term view of solutions (20 – 50+ years). Therefore to show its commitment to the development of long-term technical options, SWDC proposes a series of short term solutions to optimise current infrastructure during which time monitoring and ongoing stakeholder consultation will be required to deliver the most appropriate long-term solution. This strategy forms the basis of SWDC's resource consent applications, and focuses currently on the short-term solutions proposed.

As part of the process for developing long-term options and to provide necessary information to the regulator on the alternatives considered, Council has engaged AWT Water Ltd (AWT) to evaluate four long-term options:

- Combined land disposal scheme with and without the inclusion of Carterton District Council's (CDC) WWTP effluent. This option combines discharges from all WWTPs to a centralised location.
- Separate land disposal schemes at each individual WWTP site.
- Combined high rate treatment plant and discharge to water. This option combines discharges from all three WWTPs and discharges to the Raumahanga River from a centralised location.
- Separate high rate treatment plants for each site and continued discharges to water.

A high level concept design and cost estimate has been undertaken for all options.

At this concept design stage, we have assumed that a land disposal scheme would involve a deferred irrigation system using centre pivot and corner arm irrigators.

Sequencing batch reactor (SBR) or membrane bioreactor (MBR) technologies incorporating nutrient removal have been assumed for the high rate treatment plant options. A detailed options evaluation for irrigation and treatment systems/technologies has not been undertaken.

As part of evaluating the land disposal and high rate treatment plant options, a review of the proposed short-term treatment and discharge upgrade budgeted costs, presented in SWDC's Work Plan, has also been undertaken and incorporated into the overall evaluation.

The economic and technical feasibility of these treatment and disposal options are discussed in this report. It is noted, however, that a complete assessment of environmental effects has not been undertaken. Furthermore, cultural and social matters have not been addressed within this report.

The capital cost of any treatment or land disposal scheme varies with the average wastewater flow, which typically dictates the size of the scheme. Inflow and infiltration (I/I) is known to be a significant issue in the South Wairarapa and Carterton districts. Infiltration is the long-term seepage of groundwater into the wastewater pipes through cracks and unsealed joints often referred to as the "slow response" portion of I/I. This contributes to a high base flow in areas where the wastewater pipework is below the groundwater table. Inflow is stormwater that enters the system via illegal connections and cracks during storm events. Inflow contributes to the sharp peaks in flow through the network during and immediately after wet weather events often referred to as the "fast response" portion of I/I. A sensitivity analysis has been undertaken to assess the potential savings in infrastructure upgrades and operational costs that could be obtained by mitigating I/I issues and reducing the average flows in the network.

2 EXISTING INFRASTRUCTURE

The following section outlines the current infrastructure at each WWTP, the compliance status against current consent conditions, and the known issues and constraints that have been identified.

2.1 Featherston

The Featherston WWTP was initially constructed in around 1975 and currently services a population equivalent (PE) of 2,340 [1]. The plant comprises a two stage oxidation pond system followed by UV disinfection. Resource Consent WAR970080 authorises the discharge of treated wastewater to Donald's Creek approximately 5.5km upstream from Lake Wairarapa.

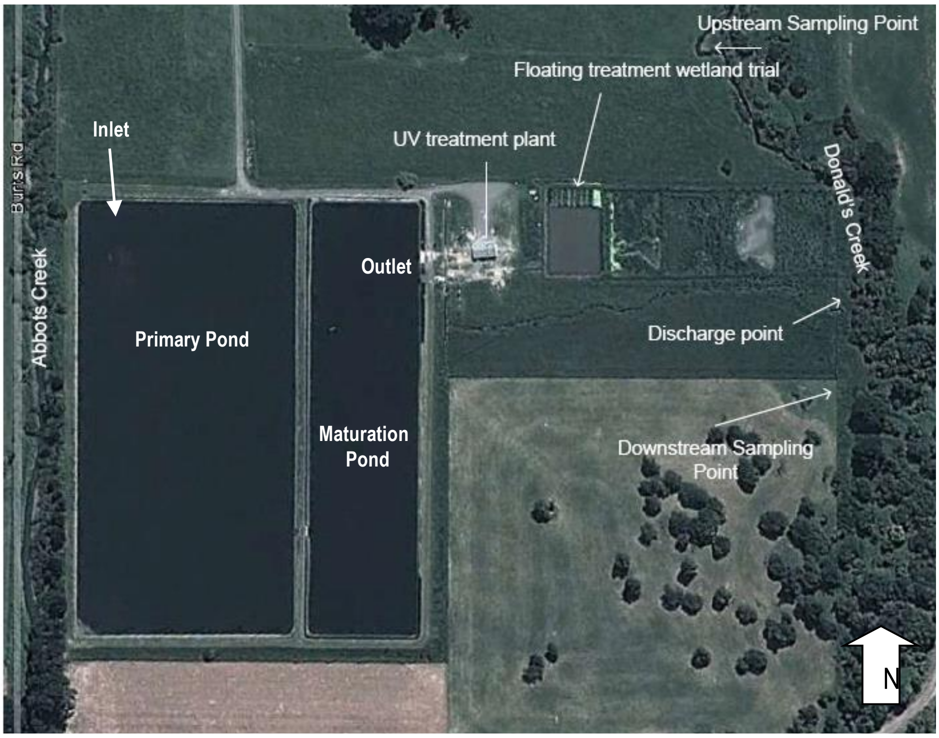


Figure 2: Featherston WWTP overview

Discharges from the Featherston WWTP have generally been compliant with effluent quality limits set out in Consent WAR970080. In particular, a significant reduction in E. Coli levels in the discharge were measured after the installation of the UV disinfection plant in December 2011.

Inflow and infiltration (I/I) is known to be a significant issue in Featherston, with peak wet weather flows sometimes up to 10 times higher than average daily flows. High I/I flows mean a large amount of stormwater needs to be stored, treated and discharged; and this adds a significant cost to the general operation of running the wastewater treatment system for treating wastewater. A high base flow from infiltration has also been identified by reviewing the wastewater per capita. For a population of 2340 and an average daily influent flow of 2,721m^3/d, this equates to an average per capita wastewater flow of approximately 1160L/per/d. This is significantly higher than the typical per capita wastewater flows in NZ, which range between 210 – 475L/per/d, including I/I [2]. There is not known to be any significant trade waste contribution to any of SWDC's WWTPs. The high per capita wastewater flow therefore indicates that infiltration from the high groundwater table, and inflow from rain events, are major sources of wastewater flows in the Featherston wastewater catchment.

The effluent flows and contaminant concentrations from the Featherston WWTP are presented in Table 2 below. For all WWTPs, effluent characteristics have been used in this study as this represents the flows/loads that would be entering the land disposal scheme.

Table 2: Featherston WWTP effluent characteristics

Flow/ Concentrations						
		Average	10th percentile	90th percentile	No. of Samples	Data Source
Influent flow	m^3/d	2721	1079	4669	2642	Mar 2005 – Aug 2012
Per person flow	L/per/d	1,160	460	1995		
Effluent flow	m^3/d	2811	830	4799	2928	Mar 2005 – Feb 2013
Total suspended solids (TSS)	mg/L	39.8	11.4	72.3	38	Aug 2007 – Aug 2011
Biochemical oxygen demand (BOD)	mg/L	17.2	9.5	27.4	37	Aug 2007 – Aug 2011
Total Nitrogen (TN)	mg/L	9.3	6.0	13.2	58	Feb 2006 – Feb 2013
Total Phosphorus (TP)	mg/L	2.3	0.9	4.2	60	Feb 2006 – Feb 2013

2.2 Martinborough

The Martinborough WWTP was initially constructed in 1975 and currently services a PE of 1,326 [1] and small number of light industrial and commercial activities. The plant comprises of the incoming sewer main that gravity flows into an oxidation pond with two surface aerators. Effluent from the oxidation pond, flows via a rock groyne into four maturation cells in series that were installed more recently in 2007. Effluent from the maturation cells flows through a UV disinfection system, also recently installed in 2011, prior to discharging to an open drain that discharges to the Raumahanga River, authorised by discharge consent WAR970079-30753.

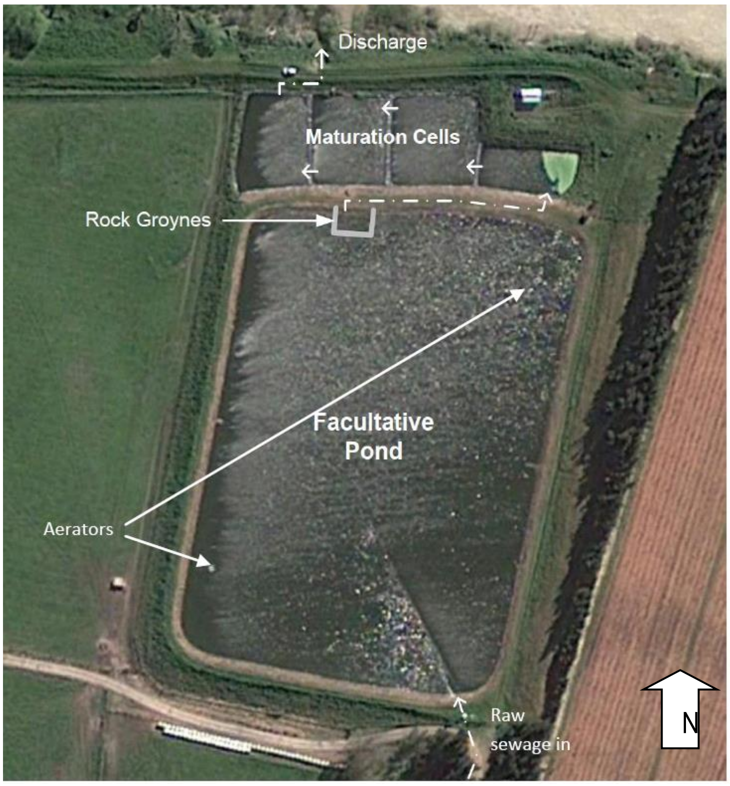


Figure 3: Martinborough WWTP overview

Non-compliance with effluent discharge limits required by the previous [2624] and current [30753] consent conditions have been documented. Most recently, non-compliance with consent [30753] has been related to *E.coli*, Total Nitrogen (TN), Ammoniacal Nitrogen (NH_4-N) and flow volume.

The effluent flows and contaminant concentrations from the Martinborough WWTP are presented in Table 3 below.

Table 3: Martinborough WWTP effluent characteristics

Flow/ Concentrations						
		Average	10th percentile	90th percentile	No. of Samples	Data Source
Influent flow	m^3/d	574	208	1106	1341	Dec 2007 – Nov 2011
Per person flow	L/per/d	433	157	834		
Effluent flow	m^3/d	654	304	1299	412	Dec 2012 – Jan 2013
TSS	mg/L	59.7	21.0	114.0	282	Aug 2002 – Apr 2013
BOD	mg/L	34.9	18.0	69.9	282	Aug 2002 – Apr 2013
TN	mg/L	27.2	14.1	38.8	108	Jan 2009 – Apr 2013
TP	mg/L	6.3	2.8	9.0	112	Jan 2009 – Apr 2013

2.3 Greytown

The Greytown WWTP was initially constructed in the 1970s and currently services a PE of 2,001 [1]. The plant comprises a primary (facultative) pond followed by a tertiary (maturation) pond. The outlet of the tertiary pond is also divided into two additional small cells separated by a rock groyne system, which helps to provide further treatment and hydraulic retention time. Flows discharge from the pond into the Papawai Stream, as authorised by discharge consent WAR-960286.

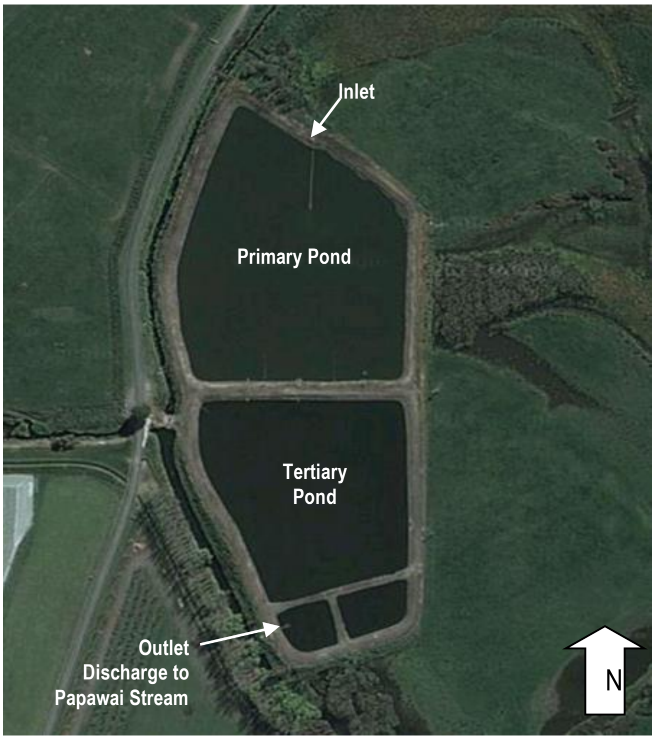


Figure 4: Greytown WWTP overview

Non-compliance with Biochemical Oxygen Demand (BOD) and Suspended Solids (SS) effluent discharge limits have been documented (Condition 20 of the discharge consent). A macroinvertabrate survey undertaken in March 2012 also indicated that water quality downstream of the discharge point had significant increases in Dissolved Reactive Phosphorus (DRP) and total ammoniacal nitrogen. The survey concluded that the Greytown oxidation pond discharge was having an adverse effect on in-stream habitat quality, and thus was non-compliant with Condition 15 of the discharge consent. However, it is noted that poor water quality has also been detected at monitoring sites along Papawai Stream and Tilsons Creek upstream of the WWTP discharge. This is likely to be due to a number of factors including rural runoff, stock access to the waterway, stormwater from Greytown, and dense macrophyte growth which at times results in low dissolved oxygen levels. The ecological degradation of this stream therefore cannot be wholly attributed to the WWTP discharge.

The effluent flows and contaminant concentrations from the Greytown WWTP are presented in Table 4 below.

Table 4: Greytown WWTP characteristics

Flow/ Concentrations						
		Average	10th percentile	90th percentile	No. of Samples	Data Source
Influent flow	m^3/d	860	421	1293	91	Sep 2012 – Nov 2012
Per person flow	L/per/d	430	211	646		
Effluent flow	m^3/d	844.6	238.4	1447.2	2723	Mar 2005 – Nov 2012
TSS	mg/L	52.2	22.0	82.8	123	Oct 2008 – Sep 2011
BOD	mg/L	67.1	28.4	104.0	120	Oct 2008 – Sep 2011
TN	mg/L	19.4	9.8	28.2	107	May 2009 – Apr 2013
TP	mg/L	5.2	3.3	6.8	107	May 2009 – Apr 2013

3 SHORT TERM OPTIONS

Due to ongoing non-compliances with discharge consents, increasing pressures to decrease the actual and potential effects of wastewater treatment and disposal on the Raumahanga River and Lake Wairarapa receiving environments, coupled with the increasing financial pressures on small community ratepayers, SWDC has developed a long-term strategy for wastewater management in the District. SWDC's strategic approach to wastewater treatment and disposal is to take a long term view of solutions (20 – 50+ year horizon) and develop long-term technical upgrade options for its wastewater infrastructure. However to illustrate Council's commitment to this strategy and address some immediate concerns, SWDC propose in the short term (0-5 years) to optimise the existing infrastructure by completing deferred maintenance and undertaking minor capital improvement projects. Council also propose to commit to a programme of operational and environmental investigations, monitoring and reporting. Empirical data collected and continued consultation with key stakeholders will be used to develop the long-term technical options.

The short term treatment and discharge upgrades proposed by SWDC are discussed further in this section.

3.1 Short Term Treatment and Discharge Upgrades

SWDC have developed a number of short term treatment upgrade and land disposal options for the WWTPs as a part of the long term strategy and resource consenting process. For the purpose of this evaluation, the short term upgrades proposed have been categorised into the following groups:

'Mandatory' Treatment Upgrades

These are upgrades that have been determined to be mandatory for long-term land disposal options considered in this review. For example, primary screening inlet works has been considered a mandatory upgrade for all plants because this would be required in all land disposal options to protect conveyance and irrigation equipment.

Additional Treatment Upgrades

These are treatment upgrades that are not considered mandatory but which have been proposed by SWDC in the Work Plan and draft resource consent applications but may not be required as part of any long-term land disposal solution. These upgrades include: floating wetland technology, coagulation for P removal, pond optimisation, and effluent discharge infrastructure relocation.

Pond optimisation and upgrades may help to reduce SWDC's risk of non-compliance with effluent quality limits. However, it has been recommended in the Greytown Resource Consent Application technical review report that further investigation of treatment technologies and processes should be undertaken to ensure that the proposed upgrades will be able to offer the treatment improvements required to meet specific effluent quality limits [3]. In addition these upgrades present a more superficial improvement that may not necessarily be required as part of any longer term solution (i.e. the capital spent on these upgrades may effectively be lost).

Combined Land/ Water Discharge

A combined land / water discharge has been proposed for all three WWTPs in the short term as a means to reduce discharges to water in times of low river flow and mitigate the potential environmental effects on the receiving water environment. SWDC has already purchased some land and has investigated the feasibility of buying more land for land disposal, either in the short term or long term.

It is noted that land purchases would also be required for long term land disposal options, particularly if an integrated treatment scheme on a site not currently owned by SWDC is adopted as the preferred long term solution.

Inflow and Infiltration Remedial Works

SWDC has proposed to undertake inflow/infiltration reduction and physical remedial works in each town. Implementing I/I remedial works will affect the flow rate, and therefore design criteria, for all upgrade options, however the extent of the potential I/I reduction is unknown. In order to size and design upgrade options using the current flow rates, we have excluded I/I reduction and physical remedial works from all cost estimates. A detailed sensitivity analysis of the cost and benefits of reducing I/I is presented in Section 11.

3.2 Short Term Cost Estimates

As the short term upgrades form a critical part of SWDC's resource consent applications and may form part of the long-term upgrade solutions, the budgeted costs presented in the SWDC Work Plan have been reviewed. Detailed costings of these proposed short term treatment upgrades, and a comparison with the Work Plan costs, are presented in Appendix 1. A summary of these reviewed costs is presented in Table 5 below.

Table 5: AWT cost estimate of short term upgrade options

Upgrade	Featherston	Martinborough	Greytown
Mandatory treatment upgrades			
Primary Screening	$200,000	$150,000	$150,000
Pond Desludging	(not required in next 5 yrs)		$239,700
UV disinfection	(already in place)		$360,000
Raise embankment height	-	$150,000	$1,638,000
Additional treatment upgrades			
Floating wetland technologies	$2,000,000[1]	$600,000	-
Coagulation (P removal)	$85,000	-	-
Pond improvements (baffles, aerators etc)	$89,400	$149,600	-
Relocate/ upgrade water discharge infrastructure	-	-	$463,700
Implement combined land/water discharge			
Land purchases	$1,750,000	$1,250,000	-
Irrigation infrastructure	$2,279,000	$1,729,700	$789,900
Professional Services (% of infrastructure costs)	20%	20%	20%
Contingency (% of infrastructure costs)	25%	25%	25%
Total Short Term Upgrade Cost	**$8,497,500**	**$5,280,000**	**$5,279,900**

*I/I remedial costs have not been included here and are evaluated in Section 11.

Some of the proposed upgrades could potentially feed into longer term treatment/disposal solutions, while the additional treatment upgrades would only be useful in the short term and may become redundant when a long term option is implemented. A schematic of how the different types of short term upgrades would impact on long term high rate treatment & water disposal or land disposal options considered in this report is presented in Table 6 below.

[1] Includes provision for floating wetland technology for SS removal

Table 6: Impact of short term upgrades on long term options

Short Term Upgrade Option	Long Term High Rate Treatment & Water Disposal	Long Term Land Disposal
Mandatory' treatment upgrades		
SS and P removal for surface water discharge		
Primary screening		
Pond desludging		
UV disinfection		
Raise embankment height		
Additional treatment upgrades		
Floating wetland technologies		
Pond improvements (baffles, aerators etc)		
Relocate/ upgrade water discharge infrastructure		
Implement combined land/water discharge		
Land purchases		
Irrigation infrastructure		

Key:

	Upgrade would feed into long term strategy
	Upgrade could be incorporated into long term strategy but has not be included for the purposes of this report.
	Upgrade may become redundant in long term strategy

SWDC ideally needs to strike a balance between upgrades that are necessary in the short term, and upgrades that would feed into a long term solution, whether it is treatment or disposal. Depending on what long term solution is selected, there may be potential to defer short term upgrades to a later date or not undertake them at all. This could potentially offer significant cost savings to SWDC. Conversely, if short term upgrades are implemented without a clear vision of the long term strategy, these upgrades may become less effective or even redundant in the future.

It is also noted that the short term treatment and disposal upgrade options alone may not be sufficient to achieve compliance with proposed effluent quality limits, as highlighted in AWT's previous review of the Greytown AEE [3]. The proposed effluent quality limits for Greytown were not seen to reflect the level and type of short term treatment upgrades that had been proposed within the AEE. In particular, the treatment limitations of pond-based systems should be recognised and taken into account. In the event the regulator imposes more stringent effluent quality limits, in particular ammonia, total nitrogen, total phosphorus and pathogen limits, more advanced treatment processes are likely to be required. Therefore SWDC are at risk of not being able to meet its effluent quality requirements by implementing the proposed short term upgrades alone. Unless short-term relaxed effluent quality limits can be agreed to with the regulator, all short term upgrades should be considered alongside long term treatment and disposal options to develop a cost-effective and efficient wastewater management strategy.

3.3 Comparison of Short Term Options with SWDC Work Plan

The short term treatment and disposal cost estimates are presented in Appendix 1 alongside the budgeted estimates set out in the SWDC Work Plan [4].

In all towns, the reviewed short term upgrade costs are higher than the budgeted Work Plan costs. Details of how each upgrade was costed are presented in Appendix 1 and the key differences are discussed below.

Professional Services and Contingency

A provisional cost for professional services has been included in our reviewed cost estimates which was not allowed for in the Work Plan. We have assumed professional services will be approximately 20% of the infrastructure costs (excluding land purchase costs) based on past experience. These services include design, consenting and project management. In addition, we have added a contingency of 25% of the infrastructure costs (excluding land purchase and professional services costs). This contingency reflects the high level nature of the cost estimates.

Land Treatment

In all three towns, the reviewed cost estimates for combined land/water infrastructure is significantly higher than that budgeted for in the SWDC Work Plan. Past project experience indicates that the capital costs for a land irrigation scheme ranges from $23,000/ha - $54,000/ha. Therefore we believe the cost of the irrigation infrastructure within the Work Plan has been underestimated.

Greytown

The cost to raise the embankment height by an average of 1.34m (as proposed in the Summary of Existing Treatment Plant and Proposed Upgrades [5]) has been determined based on estimated fill quantities multiplied by applicable rates listed in Rawlinsons New Zealand Construction Handbook and AWT's costing database (based on actual costs from similar WWTP upgrades). The cost of this upgrade was estimated to be approximately $1.67million, which is significantly higher than the $400,000 budgeted for in the Work Plan. This higher estimate is considered more appropriate given the significant volume of fill material required and the work needed to line the new embankment while the pond is still operational. It is also noted that potential consenting and remedial costs associated with extracting fill from the Ruamahanga riverbank has not been included in our cost estimate.

Featherston

The pond sludge removal proposed in the SWDC Work Plan has been excluded from the short term options because a recent sludge survey has indicated that sludge removal is not required at Featherston over the next 5 years (g2e [6]).

We have assumed that treatment upgrades to enable surface water discharge will be similar to what has been proposed at Martinborough, ie. floating treatment wetland for TSS removal and coagulation for phosphorus removal. Estimates for these technologies have been derived from past projects and proposals, and was estimated to be approximately $2,085,000. The SWDC Work Plan provided little detail on what treatment technology is proposed but budgeted just $295,450 for this work.

Martinborough

The pond sludge removal proposed in the SWDC Work Plan has been excluded from the short term options because a recent sludge survey has indicated that sludge removal is not required at Martinborough over the next 5 years (g2e [7]).

For the waveband upgrade, we have assumed that no civil works are required for raising the embankment height and no pond relining will be provided.

4 INTEGRATED LAND DISPOSAL

This section presents the concept design for an integrated land disposal scheme, including the design parameters, assessment of storage, land and reticulation infrastructure requirements and a preliminary cost estimate.

4.1 Design Approach

It has been proposed to design a deferred irrigation system for the Integrated Land Disposal Scheme. Irrigation occurs when there is a sufficient water deficit in the soils so losses from leaching through to groundwater or ponding on and running off the soil surface would be minimised. When soil moisture content is near or at field capacity (i.e. during wet conditions), irrigation is deferred and the wastewater is stored in effluent storage ponds until conditions are appropriate for irrigation again. A detailed options evaluation has not been undertaken at this stage, but the deferred irrigation approach has been adopted because it has some key advantages over other irrigation options such as rapid infiltration, overland flow or year round surface irrigation. With a deferred irrigation system, irrigation can be implemented without undertaking significant earthworks and contouring (as would be required by other irrigation methods). Furthermore, deferred irrigation systems minimise potential environmental impacts by discharging only when soil and environmental conditions are appropriate.

The general design approach for the land disposal scheme has been as follows:

- Identify appropriate design parameters such as flow rates, application rates and periods;
- Analyse land requirements based on hydraulic and nutrient (nitrogen and phosphorus) loadings;
- Calculate storage requirements and assuming all flows are contained (i.e. no overflows);
- Identify potential sites for the scheme and undertake a high level concept design of reticulation and irrigation infrastructure;
- Identify and undertake high level concept design, if necessary, of upgrades to WWTPs that are required for the implementation of the integrated land disposal scheme.
- Undertake preliminary costing's for the integrated scheme, including WWTP upgrades required for operation of the land disposal scheme.

An irrigation system using centre pivot irrigators and corner arms has been used to cost irrigation infrastructure because this system is a well-proven, efficient method for irrigation over large areas. The cost estimates are based on AWT's experience of centre pivot irrigation schemes at other sites in New Zealand. No specific design of the irrigation infrastructure has been undertaken at this stage.

It is assumed that a 'cut and carry' operation would be undertaken and perennial grasses such as ryegrass will be grown. Grasses can be harvested and made into either silage or hay. In many situations, land irrigation can be optimised by selecting a combination of different crops in different areas of the land disposal site. As this is a high level concept design, we have not undertaken crop selection to this level of detail.

It is also assumed that the existing pond systems will be retained for treatment and storage purposes. The short-term pond embankment improvement works proposed in the SWDC Work Plan have therefore been included as part of this evaluation when determining the additional storage requirements.

4.2 Design Parameters

4.2.1 Population Growth and Flow Projection

The projected population growth in the South Wairarapa district is understood to be neutral to negative over the next 20 years according to population projection data from Statistics NZ [6]. This projection, coupled with the expected reduction in flows due to I/I remedial works, indicates that the overall inflows into the integrated scheme may reduce over time. Therefore, for the purpose of land application, no changes in the design flow have been assumed and no future scenario has been analysed. It has also been assumed that no major industrial or trade waste dischargers are connected to the scheme within this 20 year design horizon.

4.2.2 Flows

The design flow for the land disposal scheme has been taken as the total average daily flow (ADF) leaving the ponds at the Featherston, Martinborough and Greytown WWTPs. The outflow data gives an indication of the actual amount of wastewater that needs to be irrigated, including input from rainfall on the ponds and losses due to evaporation. Table 7 provides a summary of the design outflows expected from each WWTP site.

Table 7: Integrated land disposal scheme design flows

		Featherston	Martinborough	Greytown	Total
Average daily flow	m^3/d	2,811	845	653	4,309
90th percentile flow	m^3/d	4,799	1,447	1,299	7,545

The irrigation system, storage ponds and reticulation have been sized using a design flow of 4,309m^3/d. Flows into the WWTPs, particularly at Featherston and Greytown, have a high degree of variability due to known inflow and infiltration (I/I) issues from ageing and possibly poorly constructed reticulation infrastructure. The oxidation and proposed storage ponds will provide some buffering capacity such that the discharge out of the combined scheme system is unlikely to experience the same peaks and variability as the inflows. However, the entire system must be designed to accommodate larger flows than would otherwise be required due to I/I, and this has significant cost implications. In particular, high I/I during wet weather events increases the size of pipes required to convey the flows through the network and the amount of storage that is required. Therefore, the cost of the combined scheme needs to be reviewed against the cost and benefits of implementing I/I identification and remedial works and this is addressed in further detail in Section 11.

4.2.3 Contaminant Loads

Table 8 provides a summary of the pond effluent contaminant loads from each WWTP site. Average annual loads have been estimated by multiplying the average daily flow at each WWTP with sampled pond effluent contaminant concentrations. The effect of various contaminants on the deferred irrigation scheme is discussed in Section 4.3.4.

Table 8: Integrated land disposal scheme design contaminant concentration or loads

		Featherston[2]	Martinborough[3]	Greytown[4]	Total
Total Suspended Solids (TSS)	kg/year	40,863	14,239	16,111	71,213
Biochemical Oxygen Demand (BOD)	kg/year	17,660	8,324	20,709	46,693
Total Nitrogen (TN)	kg/year	9,533	6,501	5,990	22,025
Total Phosphorus (TP)	kg/year	2,338	1,498	1,607	5,442
E. Coli (average)	cfu/100mL	4,853	3,806	1,305	

[2] TSS and BOD samples were taken between Aug 2008 – Aug 2011; TN, TP & E. coli samples were taken between Feb 2006 – Feb 2013.
[3] TSS and BOD samples were taken between Aug 2002 – Apr 2013; TN, TP & E. coli samples were taken between Jan 2009 – Apr 2013.
[4] TSS and BOD samples were taken between Oct 2008 – Sep 2011; TN, TP & E. coli samples were taken between May 2009 – Apr 2013.

Loadings of heavy metals, sodium and other contaminants have not been assessed in detail because there was insufficient sampling data.

4.2.4 Land Suitability

LOWE Environmental Impact (LEI) have undertaken a desktop option assessment to identify areas in the South Wairarapa district that are theoretically suitable for land application and to determine limitations to land application in the area prior to further field investigations [7]. A weighting system of seven key land application parameters was used. The parameters used included:

(1) Landuse (a) nutrient uptake and (b) acceptability;

(2) Soil attributes (a) soil drainage and permeability, (b) depth to restrictive layer, and (c) slope and stability;

(3) Hydrological and hydrogeological attributes (a) mounding risk, and (b) flood return interval.

A GIS based approach has been used to assist in ranking the suitability of the parameter totals at individual locations, with weighted scores used to determine which of five zone groupings applies. Zone A (score of 30 – 35) is land with no significant limitations experienced and represents the preferred zone for siting of a land disposal system, whereas Zone E (score of 0-7) is considered to have severe limitations to land disposal and is likely to have prohibitive costs and management requirements to the establishment of land disposal. Figure 5 below shows the zoning classifications for land in the South Wairarapa district.

The zoning map has been used to identify land that is suitable for wastewater irrigation. As much as practicable, the integrated land disposal scheme and stand-alone irrigation schemes have been located within Zone A areas to ensure that the optimum land application can be achieved with minimal effects on the environment.

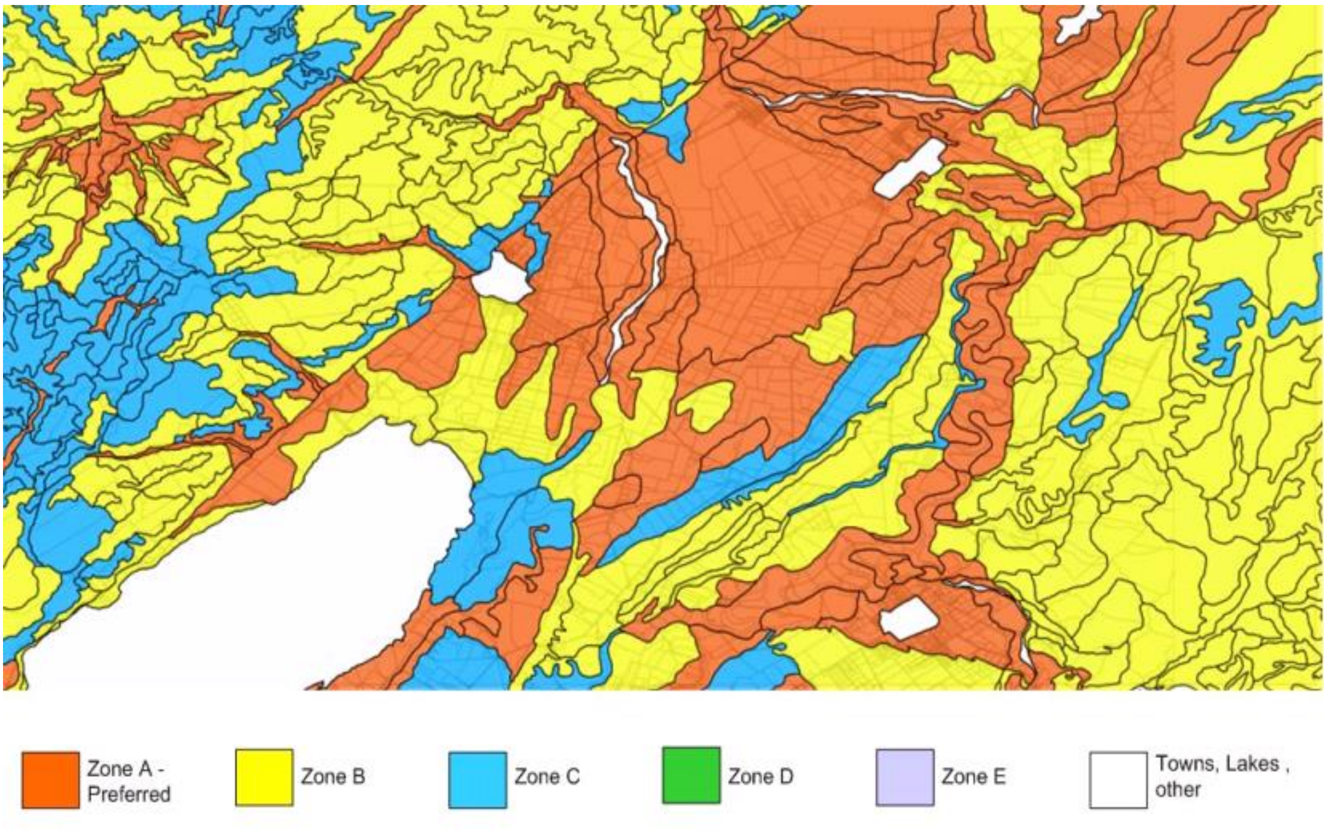


Figure 5: Land Suitability Classifications (reproduced from LEI report, May 2012)

4.2.5 Irrigation Hydraulic Application Rates

Two methods have been considered to determine the hydraulic application rate to be applied in the land disposal scheme. One method allows maximum hydraulic application to the point where soils can sustainably store and drain the wastewater. Application rates for method 1 are based on empirical evidence derived for different soil types. The second method allows hydraulic application to a point where all wastewater applied is removed via evapotranspiration and no drainage is expected to occur. Application rates for Option 2 are based on a simple water balance that takes into account typical rainfall and evapotranspiration rates for the South Wairarapa district for a certain type of plant crop grown.

Method 1 – Soil-based application approach

LRIS S-map data[5] indicates that the soils in the South Wairarapa region are predominantly silty loams which are well draining but have a relatively shallow depth to restrictive layer. This soil classification approximately correlates to a Category 4 soil under Technical Publication 58 (TP58): 'On-site Wastewater Systems: Design and Management Manual' [8].

TP58 establishes recommended typical application rates for wastewater irrigation depending on the drainage capacity of the irrigated soils. In the absence of detailed textural and soil permeability testing data, TP58 has been used to assist in determining conservative hydraulic application rates appropriate for the type of soils identified in the SWDC area. Based on TP58 guidelines for Category 3, 4, and 5 soils, three scenarios have been developed to assess the land requirements for three assumed average application rates, as shown in Table 9 below. Soil testing of Zone A soils undertaken by LEI [9] indicates an application rate up to 15mm/d is appropriate on Zone A soils, with an application regime of five days of irrigation and two days rest period. This equates to an average application rate of 10.7mm/d.

Table 9: Soil-based hydraulic application rates

Scenario	TP 58 Soil Category	Description	Typical application rates (mm/d)	Application rate used for analysis (mm/d)
1.A	3	Medium-fine and loamy sand; good drainage	15-20	15
1.B	4	Sandy loam, loam and silt-loam; moderate drainage	5	5
1.C	5	Sandy clay-loam, clay-loam and silty clay-loam; moderate to slow drainage.	3-4	3.5
1.D		Average application rate suitable for Zone A soils based on soil testing	15-24	10.7

Hydraulic application rates based on soil type are underpinned by the assumption that the soils have sufficient capacity to hold the amount of wastewater that is applied and that drainage can occur sustainably without causing leaching, ponding or mounding issues. Due to soils heterogeneous nature, the typical application rate used is averaged across the whole site. It is recommended that soil moisture probes and control systems are installed for irrigation systems of the scale proposed to enable precise monitoring of soil moisture levels and to optimise the application of wastewater to the land.

Method 2 – Evapotranspiration application approach

An alternative method for determining the hydraulic application rate (and hence land requirement) is to use a water balance method. This method assumes that there is no drainage through the soil, so all wastewater applied is taken up by plants and released through evapotranspiration. Irrigation can only occur when the potential evapotranspiration from plants exceeds the effective rainfall they will receive, hence it is the plant's ability to uptake moisture which is the limiting factor. This method is a

[5] Available on Landcare Research's LRIS web portal.

common approach taken in Australia where wastewater recycling onto 3rd party crops is undertaken [10]. It is understood that the approach in Australia is to generally distribute recycled (effluent) wastewater across as large an area as possible (due to water shortages), so only the minimum volume required by the plant is applied.

For this assessment, we have assumed perennial grasses (eg. fescue) will be grown. A basic water balance was created to compare monthly rainfall and evapotranspiration rates. Data from the Huangarua Road weather station (located approximately 3km from Martinborough WWTP) was used[6] and water balances were undertaken for median, 10th percentile and 90th percentile rainfall scenarios (refer Appendix 2). Daily land application rates determined using the water balance method are presented in Table 10 below. These represent the typical application rates that could be applied on an average, dry (10th percentile) and wet (90th percentile) year.

Table 10: Plant-based hydraulic application rates

Scenario	Description	Application rate used for analysis (mm/d)
2.A	Median rainfall and median evaporation	1.2
2.B	10th percentile rainfall and median evaporation	1.7
2.C	90th percentile rainfall and median evaporation	0.7

These average application rates are significantly lower than the application rates identified in Method 1. This indicates that a land disposal scheme would rely heavily on the soil's ability to store and then drain the wastewater (with minimal environmental effects) rather than solely on the plant's ability to uptake moisture. This is considered appropriate given the integrated scheme is sited on Zone A land which has been identified as having soils conducive to land application. Adopting the lower application rates (based solely on plant uptake and evaporation) is considered too conservative and would significantly increase the amount of land required. For example, at an application rate of 0.7mm/d over an assumed irrigation period of 108 days / year, approximately 2000ha of irrigable land would be required. This is not feasible for SWDC and is also inefficient as it does not take into account the moderate drainage capacity that is characteristic of the sandy and silty loams in the region. Therefore, Scenario 2 options were discounted and are not discussed further.

4.2.6 Irrigation Period

Irrigation to land should only occur when there is a sufficient soil moisture deficit. We therefore assumed that irrigation to land could only be undertaken over five months from November to March, or 152 days per year. This is consistent with the irrigable period determined through the water balance for 90th percentile rainfall conditions. It is therefore considered to be a conservative application period.

The total irrigation period was reduced to take into account downtime that would be required due to harvesting. Perennial grasses typically need to be harvested three to five times per year to avoid too much bulk at each cut and to prevent grass yield from reducing. Based on examples of other cut and carry operations', harvesting is expected to take on average 10 days per harvest with up to 5 harvests per year, giving a downtime of 50 days per year. We have assumed 70% of this downtime occurs within the irrigable months of November to March, so 35 days of harvesting downtime has been excluded from the irrigation period.

In addition to harvesting downtime, irrigation is not possible in times of high winds due to the potential effects of spray drift onto neighbouring environments. Previous investigations into wind effects on spray irrigation has determined that a maximum wind speed of 12m/s is a practical upper limit at which irrigation should stop [11]. Wind data from Martinborough Ews (Station #D15234) indicated that wind speeds exceed 12m/s in 2% of measurements taken from 2009 – 2013, as shown in Figure 6 below. To be

[6] Data retrieved from Cliflo National Climate Database, NIWA.

conservative, it is estimated that irrigation has to be stopped for approximately 2% of the irrigation period each year, or for 4 days over the course of five months.

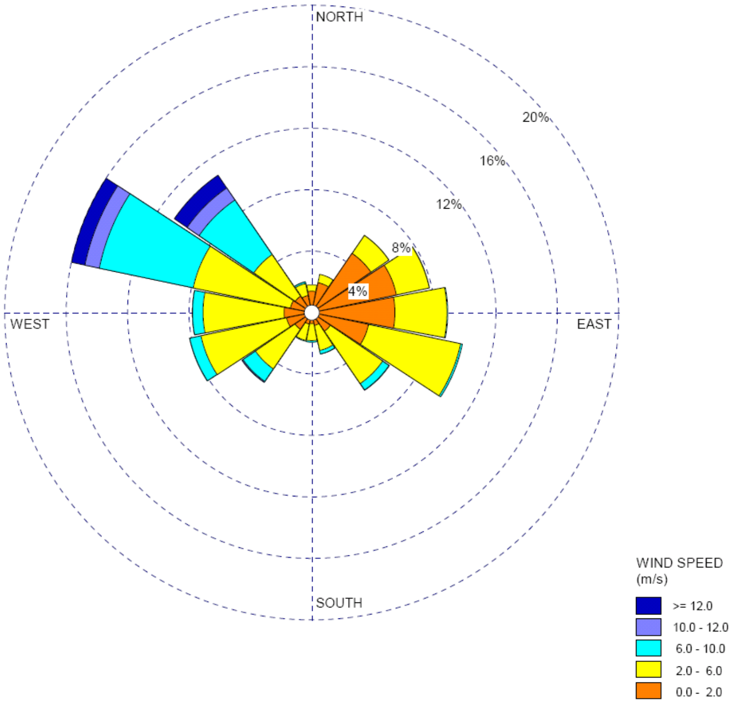


Figure 6: Martinborough Ews windrose

Overall, it has been assumed that a total of 108 days per year is available for irrigation. This was made constant across all irrigation design scenarios. The application rates and periods used in this concept design are generally consistent with the design parameters that have been adopted in previous studies, as shown in Table 11 below.

Table 11: Comparison of land application design parameters

Study	Average design flow	Application rate(s) used	Application period
	m^3/d	mm/d	d/yr
Integrated Land Disposal Scheme, AWT Water, July 2013	4,309	3.5 – 15	113
Combined Scheme Land and Cost Estimate, NZET, date unknown	3,857	2 – 10	121 – 213
Greytown WWTP Conceptual Design of Land Treatment System, LEI, September 2011	169 – 617 (for part irrigation of Greytown discharge only)	0.8 – 3.9	365 (assumed to be year round)
Featherston Wastewater Treatment Plant Land Application Option Assessment, LEI, May 2012	2,640	5	120

4.3 Land Disposal Scheme Design

4.3.1 Land Requirements

Based on the design parameters discussed in Section 4.2, the following land requirements for hydraulic and nutrient loading have been estimated.

Table 12: Integrated treatment scheme land requirements

		Scenario			
		1.A	**1.B**	**1.C**	**1.D**
Application rate	mm/d	15	5	3.5	10.7
Area required – hydraulics	ha	97	291	416	130
Area required – TN	ha	92	92	92	44
Area required – TP	ha	78	78	78	42
Irrigable land required	ha	97	291	416	130
Total area required including 25% buffer area	**ha**	**121**	**364**	**520**	**162**

Scenario 1.D is considered to be the most appropriate estimate because an application rate of 10.7mm/d is consistent with other studies and is representative of the moderately well-draining sandy loams and silty loams in the South Wairarapa region, particularly in Zone A soils where the land disposal site will be situated. This scenario has been used for the high level cost estimate explained in Section 4.5.

In all scenarios analysed, hydraulic loading (ie. high flows) is the limiting factor. This is consistent with findings from the LEI investigations, which indicated that a land application scheme would be hydraulically limited not nutrient limited [12]. Reducing the flow into the scheme through I/I remedial works, particularly in Featherston, has the potential to reduce the land area and capital cost. This is discussed further in Section 11.

An extra 25% buffer area has been added to the maximum irrigation area required to allow for areas such as:

- Setback zones (discussed in more detail below);
- Access roads, inlet works buildings and other infrastructure;
- Areas on the site that may be unsuitable for land application.

Land application schemes are required to be located at a certain setback distance from neighbouring properties. Setback distances are specified in the Wairarapa Combined District Plan Rule 4.5.2 [13]. It is noted that this rule is operative but the online version of the District Plan has not yet been updated to reflect the new rules. The setback distances pertinent to the combined scheme include:

Rule 4.5.2 (d) Minimum dwelling setbacks:

(x) 150m from the perimeter of a spray disposal area with e-coli concentrations of less than a median of 2,000cfu/100mL.

(xi) 25m from the perimeter of a spray disposal area with e-coli concentrations of less than a median of 100cfu/100mL using low pressure, low boom sprinkler systems without end guns, at a wind speed of 4m/s including sustained gusts.

Rule 4.5.2 (m) Disposal of wastewater from a municipal WWTP shall comply with the following setback distances:

(i) Wastewater with e-coli concentrations of less than a median of 2,000cfu/100mL: 125m from the property boundary for spray irrigation.

(ii) Wastewater with e-coli concentrations of less than a median of 100cfu/100mL: 25m from the property boundary for spray irrigation using low pressure, low boom sprinkler systems without end guns, at a wind speed of 4m/s including sustained gusts.

Where the treated effluent exceeds a median of 2,000cfu/100mL, resource consent for a restricted discretionary activity will be required unless the wastewater disposal is authorised by an existing consent or designation.

Rule 4.5.2(k)(i):

(4) No effluent holding pond shall be located within 300m of an existing dwelling that is under separate ownership.

Rule 4.5.2(d) requires that future residential developments are constructed a minimum distance away from the irrigation area. This is advantageous to Council as the duty to meet these setback distances are on developers rather than Council, so future reverse sensitivity issues should not pose a major consideration in the design or assessment of environmental effects. Current reverse sensitivity issues may still arise, however, these have not been assessed as part of this work.

Rule 4.5.2(m) specifies the setback distances that Council must comply with. We have assumed a separation distance of 125m is required for the spray irrigation, as the current median effluent e-coli concentrations from WWTPs are known to be greater than 100cfu/100mL. There is scope to reduce this setback distance if the introduction of inlet screening works and UV plants at Martinborough and Greytown WWTPs are successful in reducing the e-coli concentrations in the effluent.

It has also been assumed that the area required for effluent flow balancing ponds can fit within the ‘buffer’ area between the irrigation scheme and property boundary. This will provide a small reduction in the total land area required, however is contingent on the scheme layout and space availability. We have assumed the storage ponds will not be located near any existing dwellings so Rule 4.5.2(k)(i) would not be applicable.

4.3.2 Storage Infrastructure

A deferred irrigation system requires sufficient storage to be available to store flows during periods where application to land is not appropriate. Storage requirements have been estimated on the basis that an average of 4,309m^3/d must be stored for 252 days per year (the time when irrigation is not possible and assuming now allowance for wet weather overflows to water). This gives a variable storage requirement of approximately 1,086,000m^3.

Table 13 below summarises the pond area and volumes at the existing treatment plants. The SWDC Work Plan includes upgrades to the existing Greytown and Martinborough WWTP ponds that are expected to raise the top water level at these plants to provide additional storage. At Greytown WWTP, the embankment will be raised by an average 1.34m to allow for a higher average operating level and more storage in a 1 in 100 year flood event. It is understood approximately 0.4m of this increased height will be available for additional pond storage [12]. At Martinborough WWTP, a waveband upgrade has been proposed to increase the maximum operating level in the pond by approximately 0.5m [14]. Based on the available surface area and depth information, we have estimated that pond upgrades could potentially increase storage volume by 15,000m^3 at Greytown and 8,500m^3 at Martinborough.

Table 13: Pond storage at existing treatment plants

		Greytown [15]	Featherston [16]	Martinborough [17]	Total
Approx. Surface Area	m^2	33,500	38,900	16,300	-
Average Operating Depth	m	1.4	1.2	1.4	-
Approx. Existing Treatment & Buffering Storage[7]	m^3	46,900	47,400	23,000	-
Additional Storage proposed in Work Plan	m^3	15,000[8]	-	8,500	23,500
Additional Storage Required	m^3				1,062,500

Overall, the additional storage that would be required at the combined scheme site is approximately 1,062,500m^3. Additional land purchases for storage ponds at the existing WWTP sites have not been included in this concept design as it is assumed the additional storage could be provided on land already owned by SWDC. In order to reduce conveyance capex and opex cost, it would be preferable to locate the storage infrastructure at each existing WWTP site. Further investigation of land availability and suitability in terms of geotechnical condition of each site for such infrastructure is therefore recommended. Where sufficient space is not available at the WWTP sites, there is potential to locate storage volume at the site of the integrated land disposal scheme if required.

A flow balancing pond would be built at the site of the integrated land disposal scheme. The irrigation pumps will draw from the flow balancing pond, so it must be large enough to provide sufficient buffering to maintain a constant flow to the irrigation scheme when in operation. All ponds and pump stations would be telemetered to ensure the level in the flow balancing pond is maintained by triggering pumps at the WWTPs to switch on and pump flow through.

To reduce the amount of land that SWDC needs to acquire, it was assumed that the flow balancing pond would be reasonably small and situated at the irrigation site. As noted earlier, 25% extra land has been included in our land requirement estimates to provide for buffer and reserve land around the irrigation site. It is assumed that this buffer land can be utilised for the balancing of wastewater flows. This assumption is, however, limited by the availability of land, geotechnical conditions and the proximity of the land to other users (refer to setback distances discussed in section 4.3.1). Cost of additional land for flow balancing has therefore not been considered in our cost evaluation.

4.3.3 Reticulation Infrastructure

An indicative footprint of the Integrated Land Disposal scheme and associated reticulation network is presented in Figure 7 below. The location has been selected due to the availability of suitable (Zone A) land in that area. Locating the scheme within relative proximity to Featherston is optimal as Featherston has the largest wastewater discharge and therefore requires the largest and most costly conveyance infrastructure.

Where practicable, the proposed pipe alignments follow existing roads. This minimises the number of easements and construction works through private property. It is assumed that all pipelines will be pumped, with pumping stations located at each of the WWTP sites and at key junctions of the Greytown and Martinborough sewer lines, and influent line to the land application site. There is potential to reduce the number of booster stations depending on pump selection and location.

[7] There was insufficient information to estimate the proportion of the existing ponds that could be used for buffering storage so this existing storage capacity has been excluded from design. Our estimates for additional storage requirements are therefore considered conservative.

[8] LEI reports an additional storage capacity of approximately 13,000m^3.

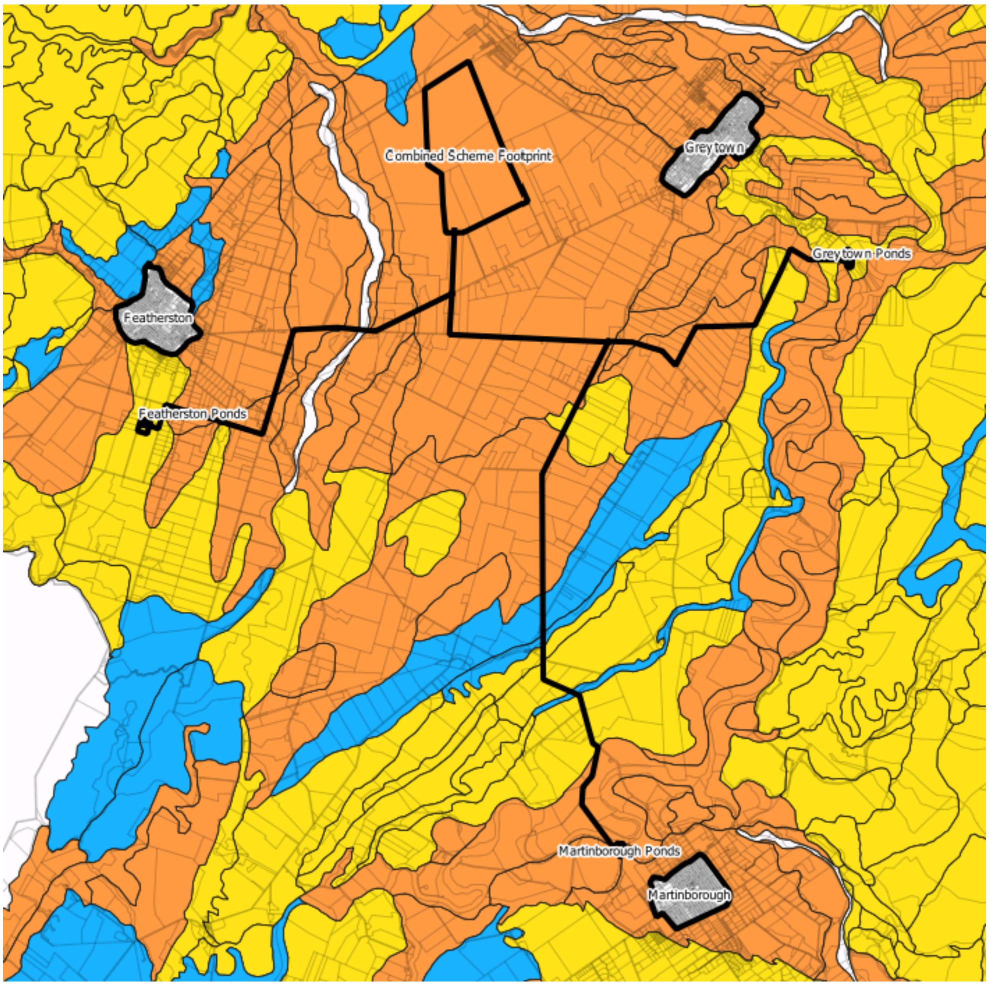


Figure 7: SWDC integrated land disposal scheme footprint

When the level in the flow balancing pond is low, pumps at the separate WWTP sites will switch on and continuously pump flows from the storage ponds. We have assumed that the pumps will operate 6 months of the year. The reticulation network has therefore been sized based on pumps being able to pump the annual flow volume continuously over the course of 6 months. A nominal velocity of 1m/s was used for pipe sizing to ensure self-cleaning velocities can be achieved. Table 14 below shows the pipe schedule for the integrated land disposal scheme and calculated average pipe velocities.

Table 14: Pipe schedule for integrated land disposal scheme

Pipe ID	From	To	Distance (km)	Nominal pump flow rate (L/s)	Nominal diameter (mm)
F01	Featherston	CS01 PS	8.4	65	300
M01	Martinborough	G-M PS	11.5	15	160
G01	Greytown	G-M PS	6.5	20	160
G-M01	G-M PS	LD01 PS	4	35	200
LD01	LD01 PS	LD Inlet	1.3	100	350

4.3.4 Contaminant Load Assessment

While flow is the limiting factor in sizing the irrigation scheme, consideration must also be given to the contaminant loads to be applied to the land, and their potential environmental impacts. This section provides a brief assessment of contaminant loads of particular concern.

Nitrogen

The main mechanism for nitrogen removal in a cut and carry operation is by plant uptake and denitrification/immobilisation in the soils. Plants uptake nutrients for growth and these nutrients are sequestered in the silage or hay that is removed from the site. Given the right soil and environmental conditions, microbes in the soil can mineralise, nitrify and denitrify nitrogen compounds and release gaseous nitrogen to the atmosphere. To a lesser extent, immobilisation and volitalisation of nitrogen compounds can also remove nitrogen from the irrigation site.

Nitrogen not removed by any of the above removal mechanisms is at risk of being leached into the receiving environment. In order to assess this risk, a basic nutrient balance has been undertaken to determine how much nitrogen can be up-taken by plants (assuming this is the predominant removal mechanism).

The maximum nutrient uptake rate varies between plants and depends on a number of factors including soil properties, climate conditions, and the rate of effluent application. For example, crops can uptake a higher concentration of N as the rate of application of effluent increases. However, higher application rates increase the risk of nitrate N leaching to groundwater. Leaching is also more likely to occur on coarser textured soils and as rainfall increases. The operation of a deferred irrigation scheme, where application generally occurs in dry weather conditions, and the location of the site on appropriate soils, will help to minimise the risk of nitrogen leaching.

Nitrogen uptake rates for perennial grasses has been estimated to be 500kg N/ha/yr [18]. The results of the nutrient balance for nitrogen is presented in Table 15 below.

Table 15: Nitrogen balance

		Scenario			
		1.A	1.B	1.C	1.D
Irrigation area	ha	97	291	416	130
Plant Uptake	t N/yr	48.5	145.5	207.8	65.0
Nutrient Loading	t N/yr	22.0	22.0	22.0	22.0
Excess Capacity	t N/yr	26.5	123.5	185.8	43.0

In all scenarios, the nitrogen loading rate is significantly less than the plant uptake rate. This indicates that minimal leaching of nitrogen should occur. However, leaching losses are not totally preventable due to the natural uncertainties of the system and variability in the soils. Overall, it is considered that the risk of adverse effects on the environment due to nitrogen loading is low.

Phosphorus

Phosphorus is removed predominantly through plant uptake and adsorption/fixation to the soils. Phosphorus uptake rates for perennial grasses has been estimated to be 130kg P/ha/yr [18].

P sorption isotherms measured by LEI for the Greytown proposed land application site indicated the soils had a P storage capacity in the range of 300-500mg/kg soil [12]. It is noted that phosphorus storage capacity may be less than the values measured at Greytown in the less clayey soils in Zone A, and the values from the Greytown study have been used here in lieu of any site-specific data. Following the method set out in LEI's assessment, the phosphorus retention capacity in the soil has been estimated based on the following parameters:

- Storage capacity of 300mg/kg
- Storage depth of 0.4m
- Soil density of 1.1 tonnes/m^3
- Site lifespan of 50 years (assumed)

Based on the above soil properties, it is estimated that the average P retention in the soil would be approximately 26.4kg P/ha/yr, which equates to a maximum soil retention of 1.32 tonnes P/ha over the assumed life of the combined scheme site. The site lifespan based on P saturation however is indefinite, as plant uptake rates always exceed rates of application. Table 16 below shows the phosphorus nutrient balance for all irrigation scenarios.

Table 16: Phosphorus balance

		Scenario			
		1.A	1.B	1.C	1.D
Irrigation area	ha	97	291	416	130
Plant uptake	t P/yr	12.6	37.8	54.0	16.9
Soil retention	t P/yr	2.6	7.7	11.0	3.4
Effluent Loading	t P/yr	5.4	5.4	5.4	5.4
Excess Capacity	t P/yr	9.8	45.2	66.9	14.9

Phosphorus loading will be less than the potential phosphorus removal rates across all four irrigation scenarios. Therefore, leaching is likely to be low and the associated impacts on the environment are unlikely to be significant.

Suspended Solids

A high concentration of suspended solids in the wastewater effluent can increase the risk of spray nozzles clogging, which can reduce the efficiency and uniformity of the application of wastewater to the site. The installation of inlet screening works at all three WWTPs will reduce the concentration of TSS effluent from the ponds. In addition, a filtration system is proposed at the inlet to the irrigation pump station. This is likely to consist of a mechanical screen with a gap size <500microns to remove debris that may have accumulated in the storage ponds, such as leaves, grass stems and bird feathers.

Elevated TSS concentrations from pond systems are also generally associated with algae. Algae blinding of soils can occur when land application of pond effluent to areas with hollows may prevail in ponding of effluent. Algae blinding can result in further impedance of irrigated effluent through clogging of the soil. This can be suitably managed through appropriate application rates, resting periods, periodic ploughing & re-cropping and filtration prior to the irrigation system.

Pathogens

Pathogenic microbes are typically adsorbed onto soil surfaces and become immobilised / inactivated. However, pathogens not retained or inactivated in the soil are susceptible to leaching, which could lead to pathogens contaminating groundwater or surface waters. It is recommended that treatment be installed to reduce the amount of pathogens (E. Coli, faecal coliforms etc). Improving the quality of the wastewater can also potentially enhance the value and saleability of the crops that are grown on the site[9]. Furthermore, as discussed in Section 3.3.1, the E. Coli concentrations in effluent wastewater can determine the amount of buffer area required, which could have a significant impact on land requirements.

[9] Fonterra have adopted a stringent treatment standard, equivalent to the Title 22 standard of the Californian Health Law, which applies to treated wastewater irrigated to crops for human consumption. Under this standard, only very high quality treated wastewater (eg. treated with microfiltration and UV disinfection) can be spread onto pasture which is grazed by, or harvested for feeding to dairy cows [25].

Sodium

Salt and sodium loadings on land application sites can cause effects on the health of the plants and soil structure. High salt concentrations in the soil can reduce crop yield, which in turn reduces the nutrient loads being sequestered. Sodium accumulation in soils can degrade the soil structure and reduce permeability; thus reducing drainage and water availability for plant growth. While the risks of salt and sodium accumulation in NZ soils are low [19], it may be prudent to periodically monitor these parameters given the potential effects on crop growth and soil structure can be significant.

4.4 WWTP Upgrades Required for Integrated Scheme

In order to facilitate the conveyance and disposal of wastewater through a combined land disposal scheme, certain upgrades would be required at the WWTPs. These upgrades have been included in the long term, integrated land disposal option and the costs associated with each of the proposed upgrades is explained in further detail in (Appendix 2).

It is noted that some of these WWTP upgrades have also been presented as short term options in Section 3. If the upgrade is implemented in the short term, then that cost would not be incurred again and can be removed from the long term cost estimate.

Pond Sludge Removal

The Greytown WWTP requires desludging to optimise the performance of the pond and increase storage volume. Sludge surveys have been conducted at the Martinborough and Featherston ponds also and it is understood that these ponds do not require desludging in the short to medium term.

Primary Screening

A basic primary screening system including screens, grit trap and building has been proposed at all three WWTPs. This will be beneficial in reducing the amount of gross solids and inert TSS that enters the ponds. Grit would otherwise accumulate in the ponds reducing the effective storage and treatment volume. Removal of screenings at the ponds will reduce the risk of conveyance pumps, filters and irrigation nozzles being clogged and result in a cleaner sludge removed from the ponds when they are eventually desludged.

UV Disinfection

The proposed installation of a UV disinfection plant at Greytown WWTP has been included in the combined scheme cost estimate. This is considered necessary as it will reduce the E. coli count in the final effluent that is to be discharged to land.

Raise Embankment Height

Embankment and wave band upgrades have been proposed for Greytown and Martinborough to increase the storage volume available in the existing oxidation ponds and increase the buffering capacity to reduce the risk of pond inundation during high floodwater levels.

Additional Treatment

Additional treatment such as nutrient or TSS removal has not been included in the long-term land disposal options for the reasons presented earlier in Section 4.3.4. Notwithstanding, due to the nature of pond treatment, algae may be a risk to the land disposal scheme, therefore it is recommended that the management of algae is investigated further at a more detailed design stage.

4.5 Integrated Disposal Scheme Capital Cost Estimate

The preliminary cost estimate for the Integrated Land Disposal Scheme is summarised below. A detailed explanation of how these costs were determined, including assumptions, inclusions and exclusions, is provided in Appendix 2. Inflow and infiltration remedial works have not been included in these cost estimates and are addressed in detail in Section 11.

Table 17: Integrated Disposal Scheme Capital Cost Estimate

	Item		Cost
1)	Combined Deferred Irrigation Scheme and Storage	$	19,649,000
2)	Reticulation	$	12,866,000
3)	Martinborough Pond Upgrades	$	275,000
4)	Greytown Pond Upgrades	$	2,363,000
5)	Featherston Pond Upgrades	$	125,000
	Sub-Total	**$**	**35,278,000**
6)	Professional Services	$	6,245,000
7)	Contingency (25%)	$	7,807,000
	Total Cost (Excluding GST)	**$**	**49,330,000**

5 SEPARATE LAND DISPOSAL SCHEMES

In order to make an 'apples for apples' comparison with the integrated land disposal scheme, AWT has also evaluated the costs of implementing stand-alone land disposal systems for Featherston, Martinborough and Greytown. These stand-alone schemes have been costed based on a combination of proposed upgrades set out in the Work Plan [4] and an assessment of land, storage and reticulation infrastructure required for full land disposal at each site. The design approach and design parameters detailed in Section 4 were used. The following provides an outline of the proposed design and detailed cost estimates including assumptions, inclusions and exclusions, are provided in Appendix 3.

5.1 Featherston

5.1.1 Featherston Stand-alone Land Disposal Scheme Design

SWDC has budgeted for the purchase of 60-70ha of land around Featherston for a combined land/water discharge regime to be implemented in the short term. The scheme designed in this section is for the complete discharge to land of flows all year round (with storage in the winter). The Featherston stand-alone land disposal scheme has been designed based on the following design parameters:

- Average daily flow of 2,811m^3/d
- Peak flow of 4,799m^3/d
- Zone A soils, therefore an average application rate of 10.7mm/d over 113d/year has been used.

Based on the above, an irrigation area of 85ha and approximately 709,000m^3 of storage is required. A proposed stand-alone land application scheme has been sited in Zone A land to the west of the Featherston Ponds, as shown in Figure 8. Reticulation to the irrigation site would be via a 1km long, 300NB rising main. Installation of primary screening works, including inlet screens and grit removal, has also been incorporated into a stand alone land disposal scheme for Featherston.

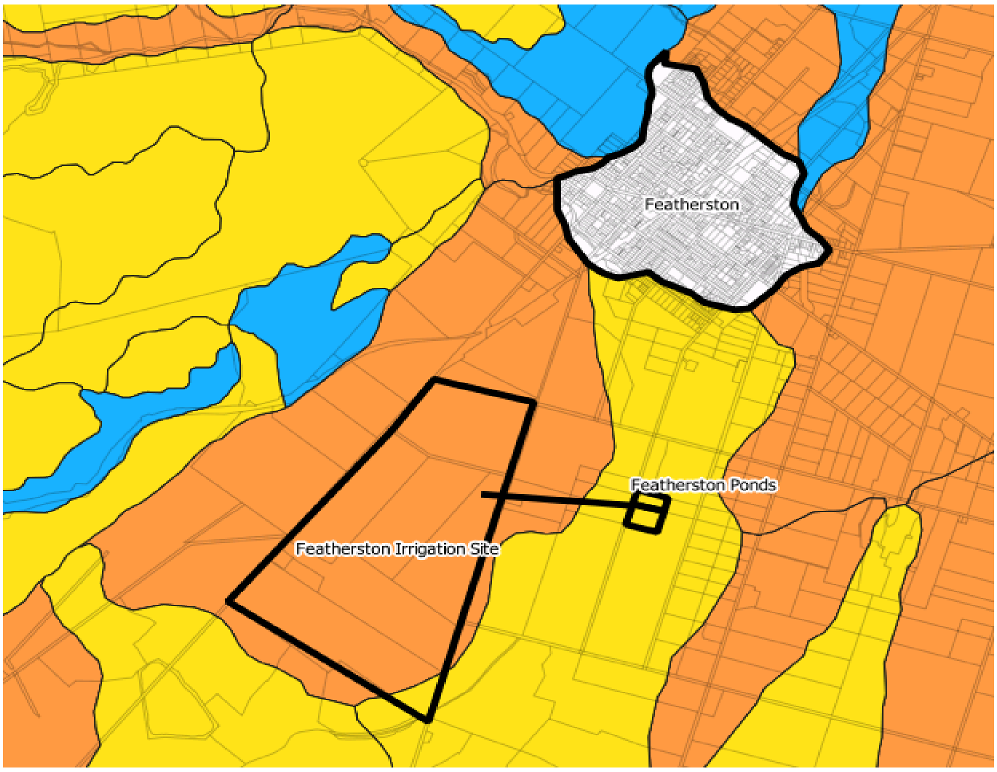


Figure 8: Featherston stand-alone scheme

5.1.2 Featherston Stand-alone Upgrade Cost Estimate

A cost estimate for a stand-alone land application and upgrade scheme at Featherston WWTP is summarised below and detailed in Appendix 3.

Table 18: Featherston Stand-alone Land Disposal Scheme Upgrade Cost Estimate

	Item		Cost
1)	Pond Optimisation	$	200,000
2)	Land Disposal	$	13,598,000
	Sub-Total	**$**	**13,798,000**
3)	Professional Services	$	2,230,000
4)	Contingency (25%)	$	2,787,000
	Total Cost (Excluding GST)	**$**	**18,815,000**

Inflow and infiltration remedial works have not been included in these cost estimates and are addressed in detail in Section 11.

5.2 Martinborough

5.2.1 Martinborough Stand-alone Land Disposal Scheme Design

The following pond upgrade works are considered necessary for a Martinborough land disposal scheme:

- Installation of primary screening, including inlet screens and grit removal.
- Wave band upgrade. It is proposed to heighten the existing wave band by an additional 0.5m; this will enable the maximum operating level in the pond to be increased, providing an estimated 8,500m^3 extra storage.

The Martinborough resource consent application and AEE sought to discharge to land under a combined land and water discharge (CLAWD) regime, whereby land disposal only occurs during low flow conditions [17]. The Work Plan has budgeted purchasing up to 50ha of land in the short term for the CLAWD regime. However, for the purpose of this comparison, we have analysed the cost and land requirements for a full land discharge system.

The Martinborough stand-alone land disposal scheme has been designed based on the following design parameters:

- Average daily flow of 653m^3/d.
- Peak flow of 1,299m^3/d.
- Average application rate of 3.5mm/d over 113d/year. This lower application rate was used as the soils on the proposed site are classed as Zone B and are less suited for wastewater irrigation, therefore a more conservative average application rate has been considered. The application rate may be adjusted following more site-specific soil analyses.
- Following the waveband upgrade, it is assumed that there would be an additional 8,500m^3 of storage available in the existing Martinborough ponds.

Based on the above, an irrigation area of 60ha and approximately 156,000m^3 of storage is required. It is understood that SWDC already owns approximately 84ha of land on Lake Ferry Road (identified as Pain Farm), approximately 2.1km southwest of Martinborough WWTP [17], as shown in Figure 9. The proposed stand-alone land application scheme has been sited on this land and no land purchase costs have been included in the cost estimate. Reticulation to the irrigation site would consist of a 160NB rising main from the WWTP outlet.

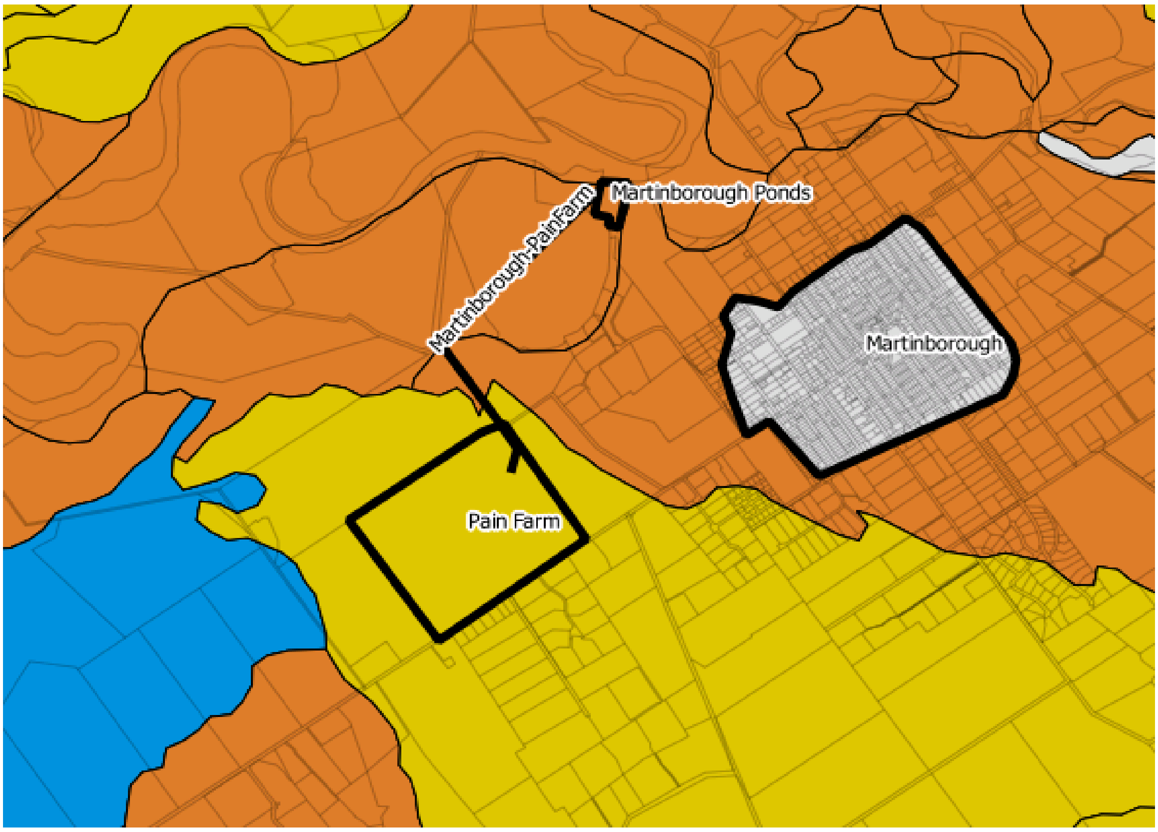


Figure 9: Martinborough stand-alone scheme

5.2.2 Martinborough Stand-alone Upgrade Cost Estimate

A cost estimate for a stand-alone land application and upgrade scheme at Martinborough WWTP is summarised below and detailed explanation provided in Appendix 3.

Table 19: Martinborough Stand-alone Land Disposal Scheme Upgrade Cost Estimate

	Item	Cost	
1)	Pond Optimisation	$	275,000
2)	Land Disposal	$	4,046,000
	Sub-Total	**$**	**4,321,000**
3)	Professional Services	$	864,000
4)	Contingency (25%)	$	1,080,000
	Total Cost (Excluding GST)	**$**	**6,265,000**

Inflow and infiltration remedial works have not been included in these cost estimates and are addressed in detail in Section 11.

5.3 Greytown

5.3.1 Greytown Stand-alone Land Disposal Scheme Design

The proposed pond upgrades considered necessary for Greytown is outlined below. A comprehensive review of the Greytown long term work plan has also been recently undertaken by AWT [3].

- Sludge survey and desludging of approximately 22.8 tonnes of sludge.
- Increase bund height by average of 1.34m to provide increased storage and flood protection from a 1 in 100 year storm event.
- Installation of new primary screening, inlet pump, inlet works building.
- Installation of a UV disinfection plant. This is considered necessary to reduce the pathogen count of the wastewater. Plans to extend the trial UV plant into a full-scale system would be implemented.

In the SWDC Long Term Plan and Greytown upgrade AEE [20], it has been proposed to relocate the surface water discharge to Ruamahanga River and discharge only up to 33% of the plant flows to land when river levels are low. For the purpose of this review, however, we have assumed full discharge to land and therefore have excluded the cost of relocating the surface water discharge from our cost estimates.

SWDC has already purchased around 20ha of land, of which 16ha can be used for irrigation. It is understood SWDC are in the process of buying an additional 30ha (approximately 18ha of which is irrigable) [21]. For this review, we have assumed that 16ha of irrigable land does not need to be purchased. It is also assumed that the land is readily available for use as a land disposal site and is awaiting the installation of the irrigation infrastructure (ie. no major earthworks, relocating existing buildings etc are required).

The Greytown stand-alone land application scheme has been designed based on the following design parameters:

- Average daily flow of 845m^3/d
- Peak flow of 1,447m^3/d (instantaneous peak flow of 56L/s)
- A weighted application rate of 7.4mm/d over 113d/year. This has been derived by calculating the weighted average of Zone A and Zone B soils on the proposed site. Based on GIS analysis, approximately 46ha of the site is on Zone A land and 38ha is on Zone B soils. Average application rates have been assumed to be 10.7mm/d and 3.5mm/d for Zone A and B soils, respectively.
- Proposed works to raise the embankments around the Greytown ponds is assumed to provide an additional 15,000 m^3 of storage.

Approximately 37ha of irrigable land and 198,000m^3 of storage is required for a deferred irrigation scheme at Greytown WWTP. The proposed land irrigation site is shown in Figure 10 below. Site selection has been based on assumptions about land SWDC currently owns or is looking to acquire. The land directly east and south of the Greytown Ponds is already owned by SWDC and includes 16ha of irrigable land. Council has investigated purchasing Lot 6 and Lot 8 of Part Papawai 13 and Papawai 16, located off Tilsons Rd, Greytown (referred to as the Bicknell land). The total land area here is approximately 18.1ha, of which approximately 12.7ha of land is irrigable. The additional land required (approximately 37.3ha) has been sited adjacent to the Bicknell land in order to reduce the reticulation requirements. In order to transfer flows from the Greytown WWTP outlet to the Bicknell land, a 700m long, 160NB PE pipe has been costed.

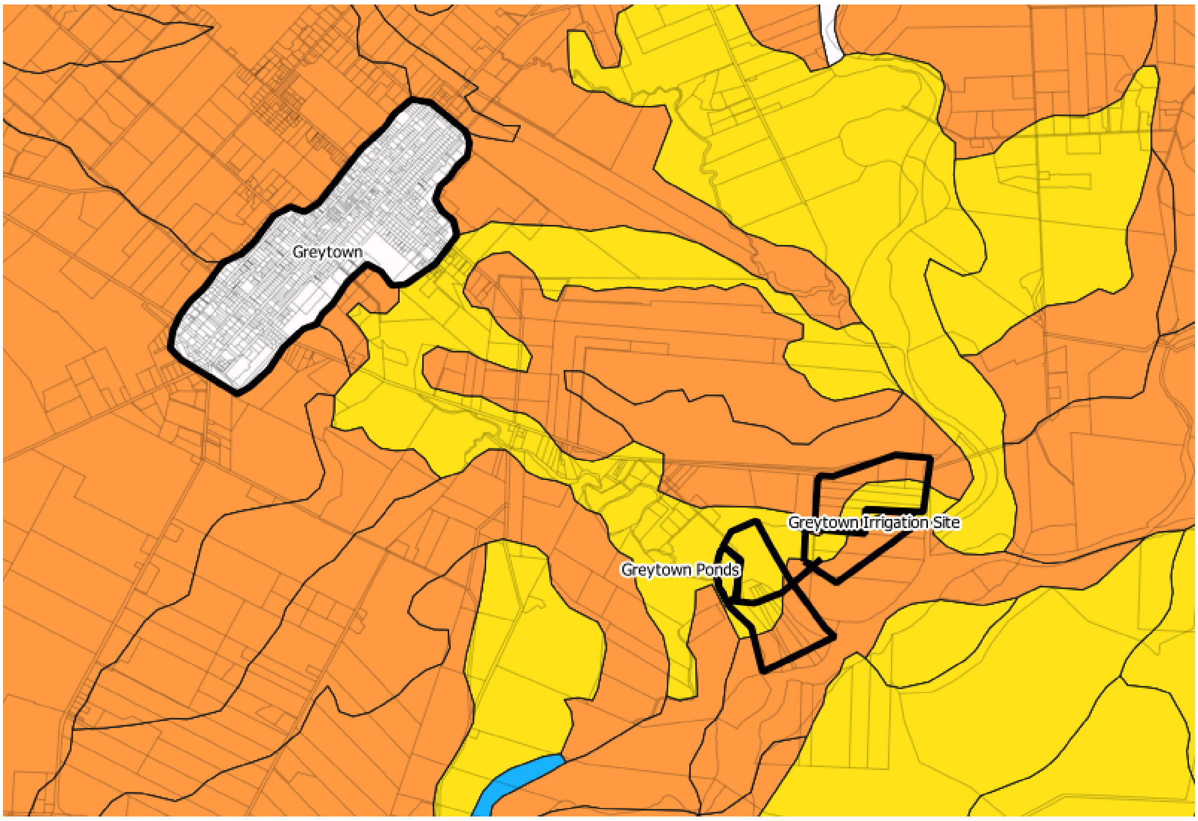


Figure 10: Greytown stand-alone scheme

5.3.2 Greytown Stand-alone Upgrade Cost Estimate

A cost estimate for a stand-alone land application and upgrade scheme at Greytown WWTP is summarised below and detailed in Appendix 3.

Table 20: Greytown Stand-alone Land Disposal Scheme Upgrade Cost Estimate

	Item	Cost	
1)	Pond Desludging	$	240,000
2)	Pond Optimisation (incl primary screening & pond embankment modifications)	$	1,788,000
3)	UV Disinfection	$	360,000
4)	Land Disposal	$	4,508,000
	Sub-Total	**$**	**6,896,000**
5)	Professional Services	$	1,197,000
6)	Contingency (25%)	$	1,496,000
	Total Cost (Excluding GST)	**$**	**9,589,000**

5.4 Separate Land Disposal Scheme Cost Estimate

The overall capital costs for three separate land disposal schemes is summarised below in Table 21.

Table 21 Total scheme costs for separate land disposal schemes

	Featherston	Martinborough	Greytown	Total
Capital Works Costs	$ 13,798,000	$ 4,321,000	$ 6,896,000	$ 25,015,000
Professional Services	$ 2,230,000	$ 864,000	$ 1,197,000	$ 4,291,000
Contingency (25%)	$ 2,787,000	$ 1,080,000	$ 1,496,000	$ 5,363,000
Total Cost (Excluding GST)	**$ 18,815,000**	**$ 6,265,000**	**$ 9,589,000**	**$ 34,669,000**

6 CARTERTON DISTRICT COUNCIL JOINT SCHEME

6.1 Carterton WWTP

Carterton District Council (CDC) own and operate a wastewater treatment plant located approximately 2km south of Carterton town. The WWTP services Carterton township, which has a population of approximately 4,200 PE. The plant consists of primary screening, three oxidation ponds, a clarifier and constructed wetlands, as shown in Figure 11 below.

Figure 11: Carterton WWTP overview

From January to March, CDC are not authorised to discharge treated effluent to the Mangatarere Stream, and therefore discharge to land. Council are currently discharging to approximately 2ha of land via a system of surface and sub-surface dripline irrigation. Infiltration bores have also been used in the past but these became clogged after a few seasons and are no longer used. CDC have purchased an additional 60ha of land with the intention of discharging a greater portion of flow to land. Approximately 20ha of this land is suitable for irrigation and it is understood that CDC will discharge up to 6 mm/day over this area (for a total discharge of approximately 1000 – 1500m^3/d) [22]. Irrigation would be via centre pivot irrigators which will be operated in an adaptive management approach in accordance with soil moisture levels.

Given the relative proximity of the Carterton WWTP to the proposed South Wairarapa integrated land disposal scheme site, there may be some efficiencies to be gained from operating a joint disposal scheme. This has been considered in the following section.

6.2 Design Parameters

Flow data initially provided by NZET was highly variable with much of the monitoring period showing malfunctioning influent and/or effluent flow monitors. Upon further consultation with NZET, a design annual average pond effluent flow of 3,000m^3/d and a peak monthly flow of 5,000m^3/d was used [23]. We understand CDC has undertaken substantial I/I remediation works in the last year. The effect on flow reduction of these I/I works is not known and has therefore not been allowed for in this study.

It is understood that CDC intend to discharge between 1000-1500 m^3/d onto 20ha of land adjacent to the existing WWTP. A deferred irrigation scheme will be implemented, applying approximately 6 mm/d when soil conditions allow. It is therefore proposed the joint SWDC + CDC scheme will dispose of the balance of daily flows, which is estimated to be on average 2,000m^3/d and a 90%ile flow of 4,000m^3/d. Table 22 presents the additional flows and loads from Carterton WWTP that has been added to the base scenario developed in Section 4.

Table 22: Design parameters for SWDC + CDC joint land disposal scheme

		SWDC Integrated Scheme	Carterton WWTP	SWDC + CDC Joint Scheme
Average daily flow	m^3/d	4,309	2,000	6,309
90th percentile flow	m^3/d	7,545	4,000	11,545
Total Suspended Solids (TSS)	kg/year	71,213	10,227	81,440
Biochemical Oxygen Demand (BOD)	kg/year	46,693	1,461	48,154
Total Nitrogen (TN)	kg/year	22,025	1,403	23,427
Total Phosphorus (TP)	kg/year	5,442	212	5,654
E. Coli	cfu/100mL	6,873	318	7,191

It is noted that the Carterton WWTP has significantly lower contaminant loads despite the higher flow volume. This is attributed to the higher level of treatment that is provided by the clarifier, wetlands and UV disinfection. Inflow and infiltration will also account for the lower contaminant concentrations due to rainwater dilution.

6.3 Carterton & SWDC Integrated Land Disposal Scheme Design

6.3.1 Land Requirements

Land area requirements were estimated based on a hydraulic application rate of 10.7mm/d for 113 days/year, as described in Section 3. Based on these design parameters, up to 190 ha of irrigable land would be required for this joint land disposal scheme. A 25% land buffer increases the land requirement to 238 ha.

We have arbitrarily sited the integrated land disposal scheme in a rural area halfway between Featherston and Greytown (Figure 12). There is a significant amount of Zone A soils available in this area and large land parcels. Hence, there is potential to acquire large, continuous land parcels in this area which provides some cost efficiencies over purchasing smaller land blocks. Centralising the land disposal sites allows for the ability to amalgamate some of the reticulation and irrigation pumping infrastructure and can provide further economies of scale.

6.3.2 Storage Requirements

The Carterton Sewage Treatment Plant AEE [24] indicated that there is a total buffer storage capacity of 38,000 m^3 available within the three oxidation ponds. Based on an average flow volume of 6,309m^3/d and an existing storage capacity of approximately 61,500 m^3 in total (including available storage at Greytown and Martinborough), it is estimated that an additional 1,530,000 m^3 of storage is required. This storage is assumed to be provided primarily at the existing WWTP sites, as well as in a new flow balancing storage pond at the Integrated Land Disposal scheme site.

6.3.3 Reticulation Infrastructure

Reticulating flows from Carterton WWTP to the integrated land disposal scheme site identified in Section 4.3 would require a 9.7km long, 250NB rising main and pump station, as shown in Figure 12. It is noted that separate inlet works for the Carterton pipeline entering the integrated land disposal site would be required at a different location. This additional cost has been included in the cost estimate for this option presented in Appendix 4.

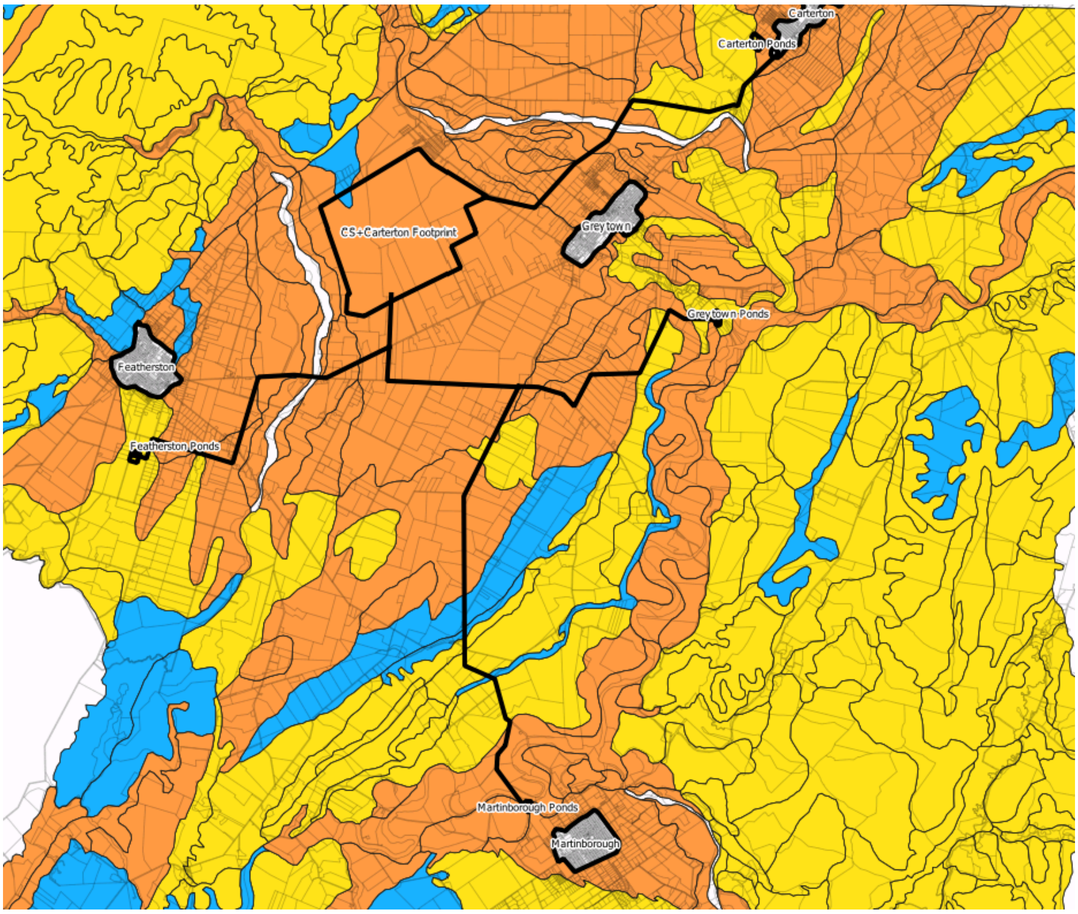


Figure 12: SWDC + CDC Joint Land Disposal Scheme

Table 23 below presents a pipe schedule for this option. The reticulation network has been designed and costed in the same way as the Integrated Land Disposal Scheme, described in Section 4.3.3.

Table 23: Pipe schedule for SWDC + CDC joint land disposal scheme

Pipe ID	From	To	Distance (km)	Nominal pump flow rate (L/s)	Nominal diameter (mm)	Calculated average velocity (m/s)
F01	Featherston	CS01 PS	8.4	65	300	0.92
M01	Martinborough	G-M PS	11.5	15	160	0.75
G01	Greytown	G-M PS	6.5	20	160	0.97
G-M01	G-M PS	LD01 PS	4	35	200	1.10
LD01	LD01 PS	LD Inlet	1.3	100	350	1.04
C01	Carterton	LD Inlet 2	9.7	46	250	0.94

6.3.4 Contaminant Load Assessment

The contaminant load contribution from the Carterton WWTP is very small compared with the load from SWDC plants. This is primarily due to the enhanced treatment provided at the Carterton WWTP combined with dilution from inflow and infiltration in the Carterton wastewater network. Due to the significantly greater volume of wastewater to be disposed, the actual areal loading of nitrogen and phosphorus across the entire site will be reduced, as shown in Table 24 below. The actual loading of nutrient would be significantly less than the nutrient load limit. There is a risk that this will create a nutrient deficit in the soils, which could potentially inhibit plant growth. Further analysis should be undertaken to confirm the validity of the effluent quality data used in this assessment and to investigate the potential effects of the low nutrient loading on the land disposal site.

Table 24: Joint scheme nutrient loading

		SWDC Integrated Scheme	SWDC + CDC Joint Scheme	Nutrient Load Limit
TN load	kg/year	22,025	23,427	
Areal TN load	kg/ha/year	169	123	500
TP load	kg/year	5,442	5,654	
Areal TP load	kg/ha/year	42	30	130

6.4 Carterton & SWDC Integrated Disposal Scheme Cost Estimate

The preliminary cost estimate for the Joint Integrated Land Disposal Scheme is summarised below, and a detailed explanation of how these were derived is provided in Appendix 4.

Table 25: Joint Integrated Land Disposal Scheme Cost Estimate

	Item	Cost	
1)	Integrated Deferred Irrigation Scheme and Storage inc. Carterton	$	28,480,000
2)	Reticulation	$	17,437,000
3)	Martinborough Pond Upgrades	$	275,000
4)	Greytown Pond Upgrades	$	2,363,000
5)	Featherston Pond Upgrades	$	125,000
	Sub-Total	**$**	**48,680,000**
6)	Professional Services	$	8,546,000
7)	Contingency (25%)	$	10,682,000
	Total Cost (Excluding GST)	**$**	**67,907,000**

7 INTEGRATED HIGH RATE TREATMENT PLANT

To assess the economic and technical feasibility of a land disposal scheme, it is necessary to compare the land disposal option with alternative effluent discharge routes. SWDC and GWRC have established that the status quo (do nothing and continue discharge to water) is not acceptable for the long term given a history of non-compliance with volume and quality consent limits and uncertainties over the effects of the effluent discharges on the receiving environment. A feasible alternative to investigate is the installation of a high rate treatment plant (or plants), either at the individual WWTP sites or an integrated treatment plant at a centralised location. With enhanced treatment, the effluent could achieve a quality level suitable for continued discharge to water, or could become available for other reuse opportunities. A concept design and cost estimate of these high rate treatment options has been undertaken.

7.1 High Rate Treatment Design Approach

The design flows used for the high rate treatment plant are based on influent flow as it has been assumed that the existing ponds will be replaced with an inlet screening/ grit trap building and pump station, which would directly pump screened and degritted wastewater to a centralised treatment plant. The design flows are presented in Table 26 below. Design influent contaminant concentrations have not been assessed as no influent quality data is available.

Table 26: High rate treatment plant design flows

		Greytown	Featherston	Martinborough	Total
Average daily flow	m^3/d	860	2721	574	4155
90th percentile flow	m^3/d	1293	4669	1106	7068

Provision could be made for a flow balancing pond / tank to provide buffering during wet weather events but at this stage, it has been assumed that there will be sufficient storage in the pump station and reticulation to allow for buffering of high wet weather flows. Furthermore, constructed overflow points and/or treatment bypass facilities have not been considered as part of this analysis.

The treatment plant would utilise high rate treatment processes which use bacteria (biomass) to break down soluble and small particulate organics. These soluble components are then settled out and removed as sludge, with a portion of sludge being recycled back into the process tank to maintain the microbiological population. This process is called activated sludge and there are several variations on this process. The Conventional Activated Sludge (CAS) system utilises the activated sludge process in separate storage, aeration and clarifier tanks. CAS typically has a larger footprint than package plant variations and require more operating input. Given CAS, sequencing batch reactor (SBR) and membrane bioreactor (MBR) plants are very similar process technologies, it has been decided to discount the CAS system and investigate the more compact high rate treatment plants in this evaluation.

The influent design parameters for a high rate treatment plant would be the influent flow and contaminant concentrations currently entering the WWTPs. Since no significant trade waste or industrial processes have been identified in the SWDC wastewater networks, the influent contaminant concentrations are likely to be typical of New Zealand domestic wastewater.

7.1.1 Option 1 – SBR

An SBR is an activated sludge process where all biological treatment process stages occur as a repeated cycle in a single tank which is equipped with aeration, mixing and decanting equipment. Figure 13 depicts a process flow diagram for this option. More than one reactor tank can be placed in parallel to meet the required capacity of the plant. Sequential Batch Reactors treat wastewater in a batch process with the reactor operating in a sequence of timed phases of filling, aeration, anoxic reaction, anaerobic reaction, settling, and decanting. An SBR separates the treatment steps in time (sequential time phases in the same tank) in contrast to a conventional activated sludge process which separates the treatment steps in space (simultaneous reaction in separate tanks).

Due to the staged nature of the process, sufficient storage would be required to balance influent flows between treatment 'batches'. The sizing of the storage tanks should ensure that hydraulic retention time in the tanks is not too long as anaerobic conditions might then develop; which could lead to odour, dangerous gas emissions and consumption of wastewater carbon. Bypass functions should also be provided to allow overflows of primary treated effluent around the SBR process during peak wet weather events.

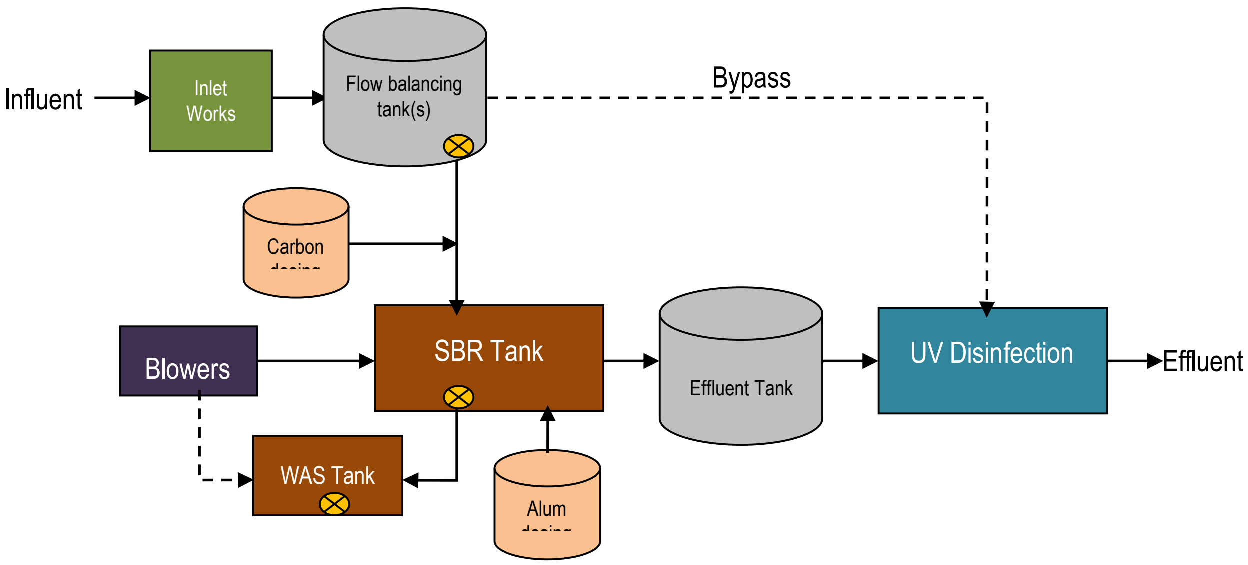


Figure 13: Process flow diagram for Sequencing Batch Reactor process

7.1.2 Option 2 – MBR

A membrane bioreactor (MBR) is a continuous flow activated sludge process similar to a conventional activated sludge process except that the solids / liquid separation is achieved using microfiltration membranes rather than secondary clarifiers. As a result of the membrane filters the mixed liquor suspended solids concentration can be much higher resulting in smaller reactor tanks. The pore size of the membranes is sufficiently fine to provide disinfection as well as resulting in an effluent with very low suspended solids and BOD concentrations.

The suitability of MBRs is often limited by their hydraulic throughput due to the very specific flux rate of the membranes. However, this constraint can be mitigated by using storage tanks for flow balancing to maintain a constant flowrate through the membranes. Figure 14 depicts a process flow diagram for this option.

The MBR has the advantage of providing disinfection within the MBR tank and very high levels of SS and BOD removal. To protect the membranes from damage by sharp objects, the influent screening required for membrane systems is more stringent than for most other high rate systems. Membranes also require regular chemical cleaning using hypochlorite and/or citric acid clean-in-place systems.

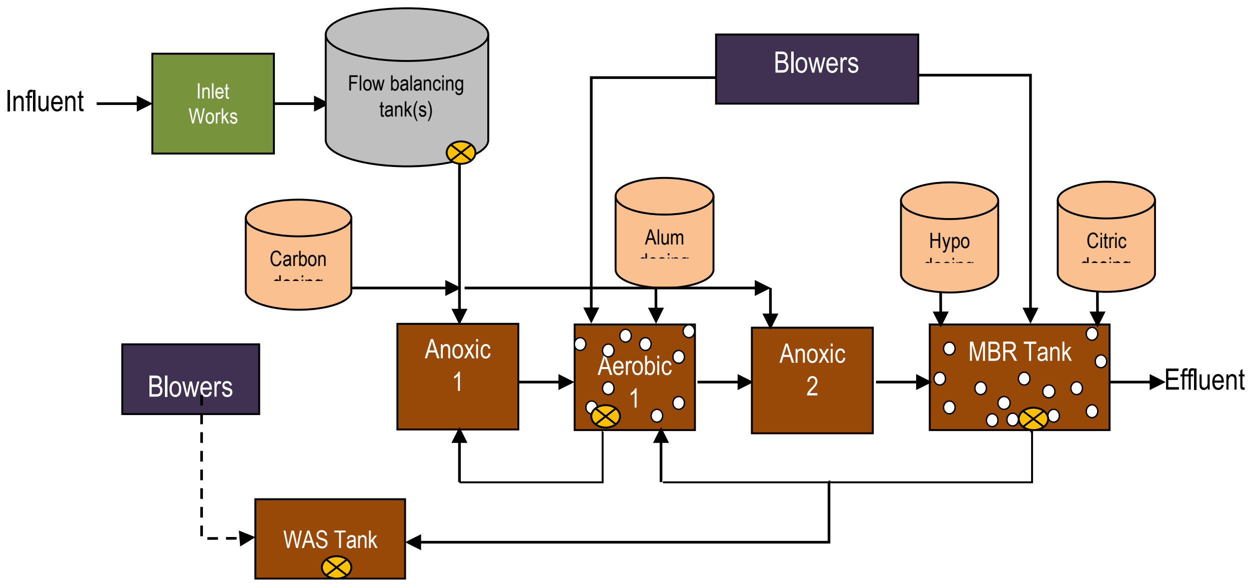


Figure 14: Process flow diagram for membrane bioreactor process

7.1.3 Treatment Plant Footprint

An integrated high rate treatment plant footprint has been estimated to be 3.5ha, based on AWT's past project experience with SBR and MBR plants. At this high level concept stage, it is safe to assume that an SBR or MBR plant will have very similar footprints and land requirements. This assumption can be investigated at a later stage if SWDC decide to take the option of an integrated treatment plant scheme further. Figure 15 presents the concept design footprint and reticulation network.

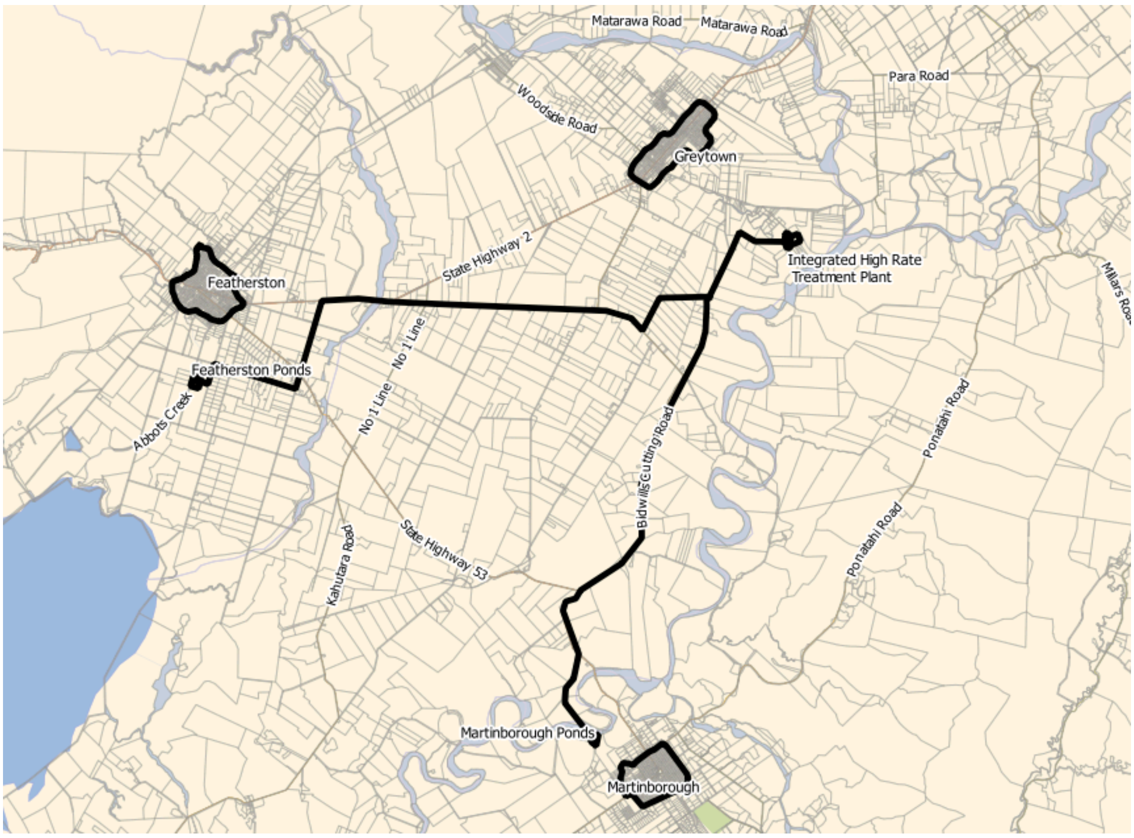


Figure 15: Integrated high rate treatment plant footprint

The treatment plant has been sited at the existing Greytown WWTP site because of the following factors:

- Building on land already owned and used by Council for wastewater treatment reduces capital land costs and planning/consenting considerations such as reverse sensitivity issues, zoning and designations.
- Although a high rate treatment plant would significantly reduce pollutant loads, there would still be some nutrient load entering the receiving environment. Discharging to the Ruamahanga River would offer better mixing and dispersion than discharging into the Tauherenikau River and Lake Wairarapa.
- The proximity to the Ruamahanga River minimises piping required for discharging the treated effluent to water. There is also sufficient space on the existing site to construct additional post-UV treatment systems such as wetlands etc to allow effluent to pass over land prior to discharging into the waterway. The construction of a new discharge structure into the Ruamahanga River is included in the plant cost estimates.
- The location is reasonably close to Featherston and thus minimises the length of larger pipes required from the Featherston network to the treatment plant.
- A pipebridge at Martinborough is necessary and would be significantly larger, have more complexities in design and consenting if receiving effluent from Featherston and Greytown as opposed to only conveying Martinboroughs flows.

This is an indicative location only and further investigation/options evaluation should be undertaken if an integrated high rate treatment plant option is to be considered further.

7.1.4 Reticulation Infrastructure

The proposed reticulation alignment for the integrated high rate treatment plant is indicated in Figure 15.

Currently, the existing ponds offer some buffering of wet weather peaks and are affected to some extent by rainfall and evaporation. The high rate treatment option requires full strength wastewater in order to retain the degradable carbon in the wastewater for biological nutrient removal. This would require the ponds for the individual towns to be decommissioned for the combined high rate treatment scheme, hence some of this buffering capacity will no longer be available and would need to be compensated for in the reticulation and plant sizing. Therefore the conveyance system would need to be sized to manage peak influent flows from the connected wastewater networks. Furthermore, the screened sewerage would have higher TSS and contaminant loads which have the potential to cause greater silt build-up and odour / septicity issues within the network than with pond effluent. More regular flushing and cleaning may be required as a result.

The terminal pump stations that would pump flows from the catchments to the new treatment plant would function differently to the pump stations for the combined land disposal scheme. For this option, sewerage will accumulate in the wetwell to a certain level before the pump switches on and pumps flow out of the wetwell. Nominal pumps have been selected based on the peak (wet weather) influent flow, and the pump flow rates have been used to size the reticulation. Pumps were sized based on an estimated peak flow and expected head. Some key assumptions used to size the pumps and reticulation network include:

- Pump stations operate with two pumps in duty / standby mode, with a maximum of 10 pump starts per hour and a minimum of 4 minute pump runs.
- Pump selection was based on 90th percentile wet weather pond influent flows as the reticulation should have sufficient capacity to convey wet weather flows to reduce the risk of overflows in the upstream network. Pond influent flows have been used as this is the actual incoming flow rate from the upstream catchments.
- Wet wells will provide sufficient storage to balance flows between pump starts and no additional storage at the pump station is provided.
- A design velocity of 1.0 m/s was selected to ensure that all pipes would be able to maintain self cleansing velocities (typically greater than 0.7m/s) and prevent silt build-up within the pipes.

- Static head was estimated from Google Earth elevations and friction head was calculated based on the Darcy-Weisbach equation.
- Analysis of design head indicates that the Martinborough rising main would require two pumping stations because the nominal pump flow and design head cannot be achieved by a single pump station.

The pipe schedule is presented in Table 27 below. All pipes have been costed as polyethylene (PE) pipes.

Table 27: Integrated treatment scheme pipe schedule

Pipe ID	From	To	Distance (km)	Nominal pump flow rate (L/s)	Nominal diameter (mm)	Calculated velocity at 90th%ile flows (m/s)
F02	Featherston	F-M PS	15	108.1	350	1.1
M02	Martinborough	F-M PS	12.3	25.6	180	1.02
F-M02	F-M 9S	Inlet	2.9	133.7	400	1.03

These pipe sizes and distances are indicative only and were used for the high level cost estimates. No detailed design of the reticulation network or pump stations have been undertaken.

7.2 Integrated High Rate Treatment Capital Cost Estimate

The cost and footprint of a MBR and SBR plant are unlikely to be significantly different at this high level assessment stage, so they have been treated as a nominal high rate treatment plant for cost estimating purposes. A lump sum cost estimate for the high rate treatment plant has been estimated based on the average daily flow (4,155m^3/d) and cost curve derived from AWT's project database of over 30 MBR and SBR plants in New Zealand, presented in Figure 16. Reticulation costs have been estimated based on the pipe schedule detailed in Section 7.1.4.

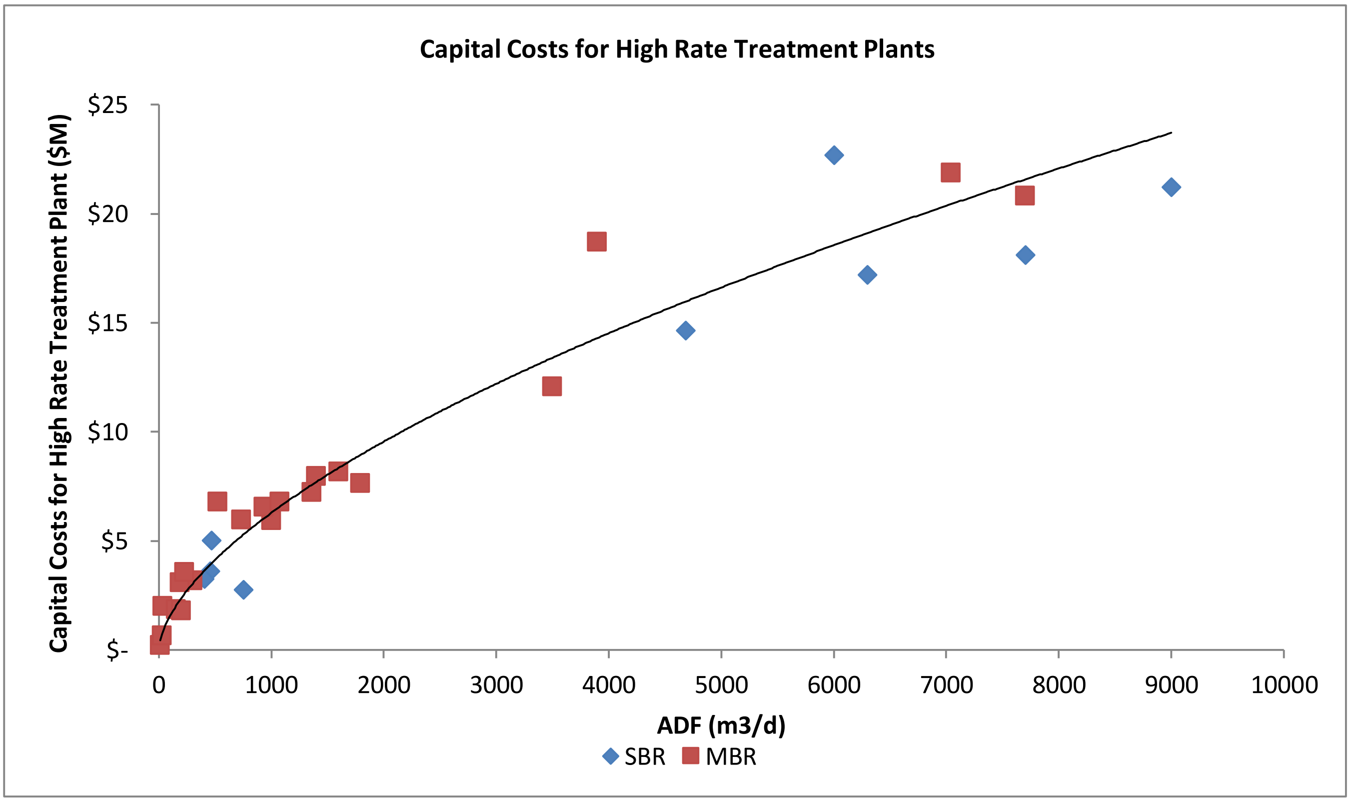


Figure 16: Cost curve for high rate treatment plant capex cost

Plant costs include the total capital works for a new plant, including inlet works, the process plant, discharge structure and ancillary works. We have not allowed for the costs associated with decommissioning of the existing ponds.

A cost estimate for the Integrated High Rate Treatment Scheme is summarised below. A detailed explanation of how these costs were estimated, including assumptions, inclusions and exclusions, is provided in Appendix 5.

Table 28: Integrated High Rate Treatment Scheme Cost Estimate

	Item		Cost
1)	High Rate Treatment Plant	$	12,750,000
2)	Reticulation	$	16,015,000
3)	Installation of Primary Works and Terminal Pump Stations	$	600,000
	Sub-Total	**$**	**29,365,000**
4)	Professional Services	$	5,873,000
5)	Contingency (25%)	$	7,341,000
	Total Cost (Excluding GST)	**$**	**42,580,000**

8 SEPARATE HIGH RATE TREATMENT PLANTS

Separate high rate treatment plants have been evaluated to offer a comparison against the integrated high rate treatment plant option discussed in Section 7. The high rate plants would provide effective nutrient removal over the longer term so continued discharge to water and compliance with more stringent discharge quality limits could be achieved.

8.1 Separate High Rate Treatment Design Approach

At each WWTP site, we have assumed that a high rate treatment plant such as a SBR or MBR will be installed to provide an 'apples with apples' comparison against the integrated high rate treatment plant. These separate high rate treatment plants will replace the existing pond systems, although some existing plant features such as the UV disinfection plant at Featherston could potentially be retained.

Assuming the existing ponds would be decommissioned, average daily flows have been based on the pond influent data as set out in Table 26 rather than pond effluent data.

8.2 Separate High Rate Treatment Cost Estimates

As discussed in Section 7.1, the cost and footprint of a MBR and SBR plant are unlikely to be very different at this high level assessment stage, so they have been treated as nominal high rate treatment plants. The capital cost of a high rate treatment plant is dependent on two main factors: the average daily flow and distance between the plant from the terminal reticulation point (currently the inlet to the existing WWTPs). A higher average daily flow requires greater capacity and larger space, while a greater reticulation distance requires more pipes and pump station infrastructure.

Table 29 presents the high level cost estimates for each of the three WWTP sites, based on the cost curve shown in Figure 16 and assuming a nominal distance from the terminal pump station of 0.5km. There is potential for some cost savings to be achieved if some of the existing infrastructure such as UV plant and discharge structures are retained. A detailed explanation of how these costs were estimated, including assumptions, inclusions and exclusions, is provided in Appendix 5.

Table 29: Stand-alone high rate treatment plant cost estimates

	Featherston	Martinborough	Greytown	Total
Capital Works Costs	$ 10,613,000	$ 4,127,000	$ 5,177,000	$ 19,917,000
Professional Services	$ 2,123,000	$ 825,000	$ 1,035,000	$ 3,983,000
Contingency (25%)	$ 2,653,000	$ 1,032,000	$ 1,294,000	$ 4,979,000
Total Cost (Excluding GST)	**$ 15,389,000**	**$ 5,984,000**	**$ 7,506,000**	**$ 28,879,000**

9 OPERATIONAL COST ESTIMATES

9.1 Land Disposal Scheme Operational Costs

Operational costs for a land disposal scheme have been based on past project experience. Operational costs will be proportional to the amount of average daily flow discharged because the higher the flow; the larger the pumping and irrigation requirements. The types of operational costs involved in a land disposal scheme include:

- Infrastructure maintenance: on-going maintenance and repair of the ponds, inlet works, irrigation pumps, pipework, irrigation equipment, and other infrastructure. This also includes contract labour required for maintenance, calibration etc.
- Power: Electricity for the pumps, irrigation systems and control systems will be an operational cost. The power demand at the existing WWTPs is expected to increase if a land disposal scheme is implemented because of the additional pumping requirements.
- Grass and landscape maintenance: re-grassing, weed control, and landscape maintenance to optimise crop growth and nutrient uptake.
- Harvesting: cropped grass will be harvested around four - five times per year and bailed into hay or haylage or made into silage for on-selling as dry stock fodder. This will result in some revenue recovery (this is discussed further in section 10 below). Harvesting costs include the contract labour and plant cost for a harvesting contractor to undertake this work.
- Irrigation scheme operation: this allows for an operator who will oversee the operation of the land disposal scheme(s) and general maintenance and harvesting works.

A high level review of two pivot centre irrigation schemes in NZ indicates the average operational cost for the irrigation infrastructure including harvesting, power grassing infrastructure maintenance is approximately $0.09/m^3/d. In addition to this, opex costs associated with current pond maintenance based on 2013 SWDC costing data[10] and return from cropping has been included. However, opex costs associated with pumping effluent to the individual or integrated land disposal areas has not been included. Estimated annual operational costs for integrated and separate treatment plants are presented in Table 30 below.

Table 30: Comparison of estimated annual operational costs for land disposal options

	Featherson	Martinborough	Greytown	Total Separate Schemes	Integrated Scheme
ADF (m3/d)	2811	653	845	4309	4309
Unit opex cost ($/m3/d)	0.38	0.38	0.38	0.38	0.39
Estimated annual opex cost ($/yr)	$391,000	$91,000	$118,000	$600,000	$620,000
Annual Revenue from Crop ($/yr)	$100,000	$71,000	$43,000	$153,000	$153,000
Total estimated annual opex cost ($/yr)	**$291,000**	**$20,000**	**$75,000**	**$447,000**	**$467,000**

[10] Included in this opex cost was Salaries, Light/Heat/Power, resource consents, routine maintenance, monitoring, pond desludging survey minus$75k as recommended by Bill Sloan (pers comm 7/8/13). A breakdown of opex per plant was not available.

9.2 High Rate Treatment Operational Cost Estimates

Operational costs for high rate treatment plants tend to be proportionate to the volume of flow treated. Figure 17 shows the daily operational cost ($/m^3/d) for a range of flow volumes. This is based on our experience of operational costs at 15 SBR and MBR plants throughout NZ. The unit operational cost for treatment decreases as the total flow volume increases due to economies of scale that can be achieved with higher flow volumes. This indicates that the long term operational cost for separate smaller treatment plants will be less cost effective than one centralised, larger plant.

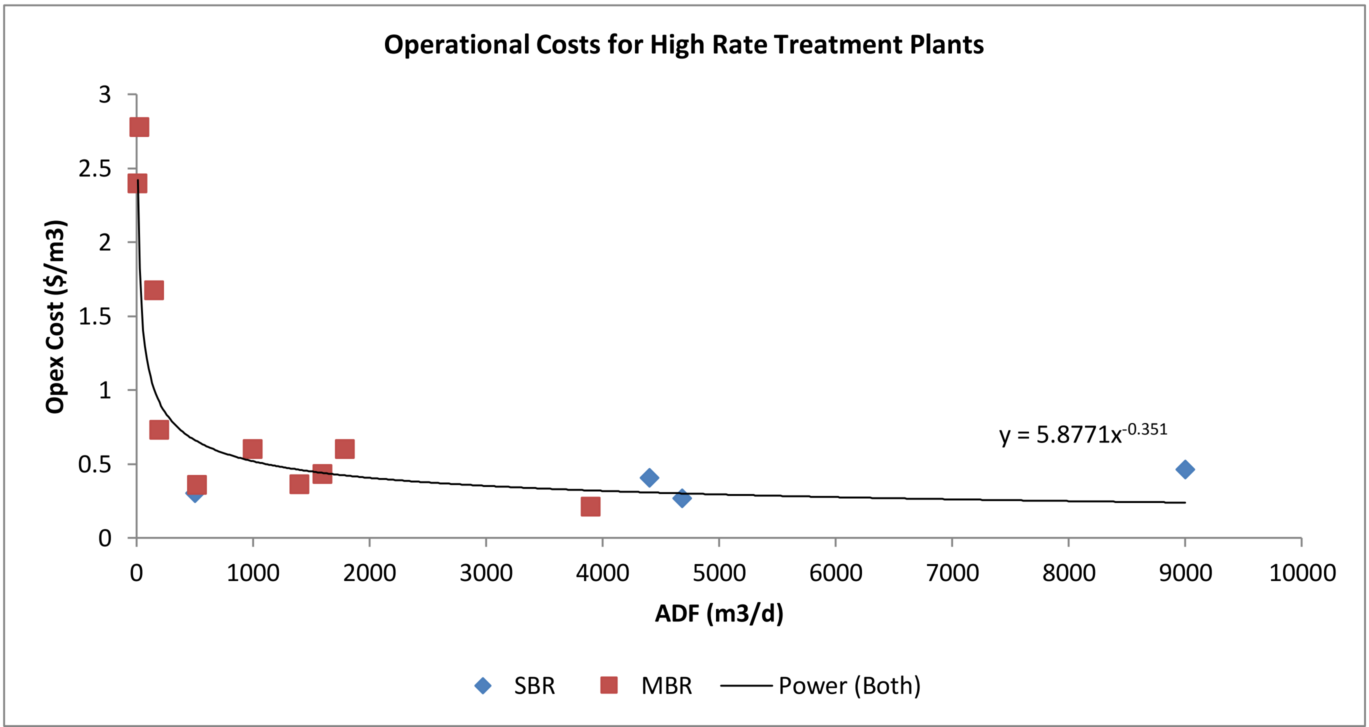


Figure 17: Cost curve for high rate treatment plant opex cost

Estimated annual operational costs for integrated and separate treatment plants are presented in Table 31 below. Plant opex costs have been taken direct from the above cost curve and do not include pumping costs associated with the integrated scheme.

Table 31: Comparison of estimated annual operational costs for high rate treatment plant options

	Featherston	Martinborough	Greytown	Total Separate Schemes	Integrated Scheme
ADF (m3/d)	2721	574	860	4155	4155
Unit opex cost ($/m3/d)	0.37	0.63	0.55	1.55	0.34[1]
Estimated annual opex cost ($/yr)	**$364,000**	**$133,000**	**$172,000**	**$669,000**	**$511,000**

Note: (1) includes an estimated pumping unit opex cost to the centralised scheme not otherwise required for the stand-alone plants.

An integrated high rate treatment scheme could potentially provide up to $150,000 per annum in savings through operational efficiencies compared with three separate high rate treatment schemes. These potential long-term cost savings should be weighed against the additional initial capital expenditure required for a centralised scheme (particularly given the additional reticulation requirements). This is an area recommended for further investigation if SWDC decide to pursue high rate treatment and discharge to water as a long term option.

10 OPTIONS SUMMARY

Capital Costs Analysis

A summary of the estimated capital costs for the long term options discussed in this report is presented in Figure 18 below. All cost estimates include a professional services fee component of 20% of infrastructure costs and a 25% contingency allowance.

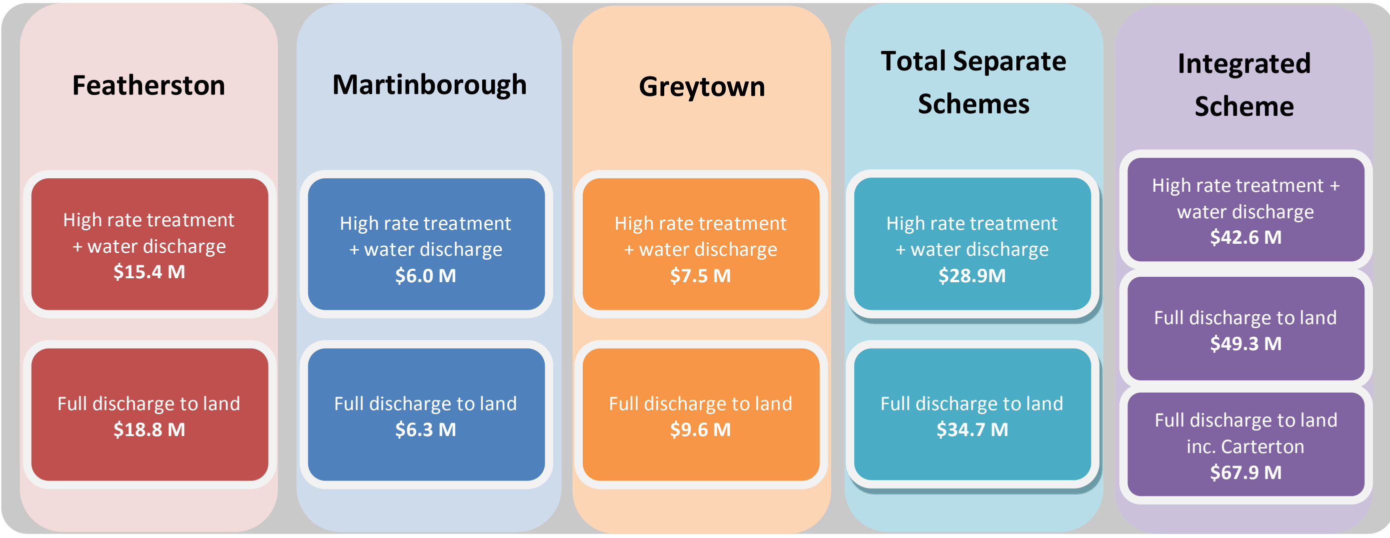


Figure 18: Capital cost estimates of all treatment and disposal options

An assessment of the proposed short term options set out in SWDC's Work Plan highlighted that some of the upgrade options could become redundant depending on the long term option pursued. It is understood that these 'additional' upgrades have been proposed in an effort to provide short term improvements in the treatment capabilities of the existing WWTPs while a long term strategy is considered and implemented. There is however potential for SWDC to achieve some cost savings by discounting these short term upgrades now and focussing on upgrades that will integrate into a long term strategy as presented in Figure 19 below.

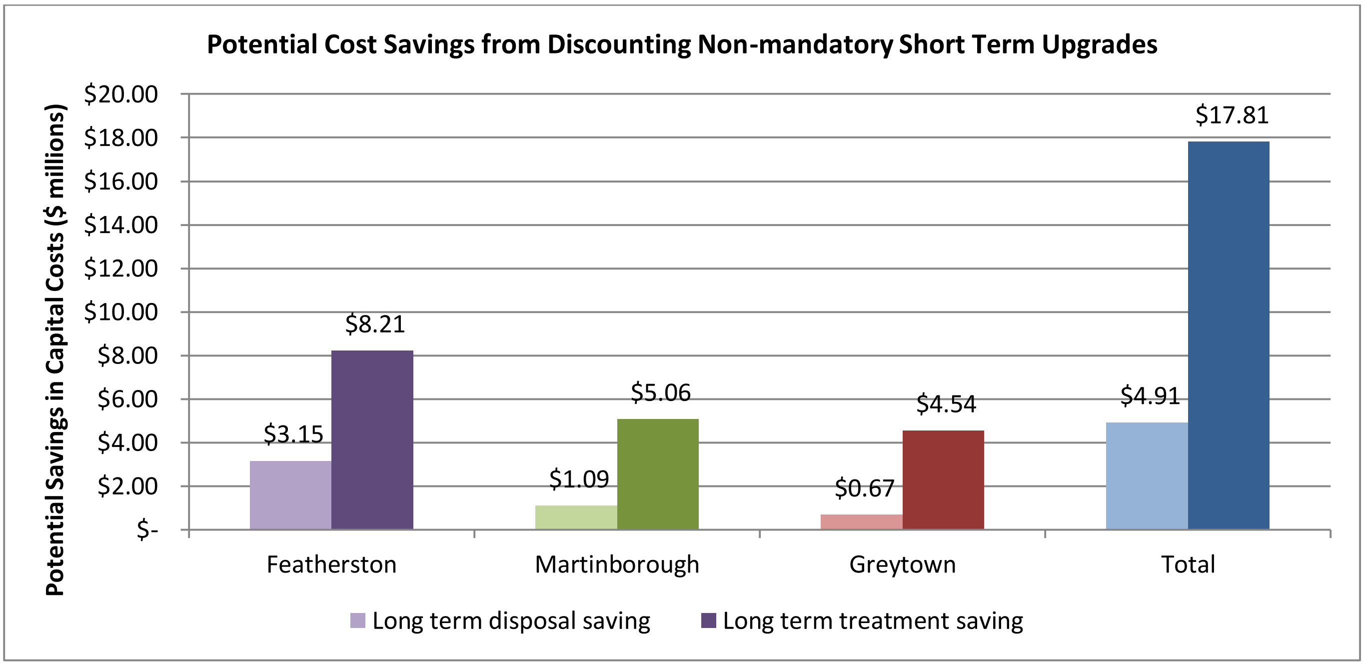


Figure 19: Potential savings from discounting non-mandatory short term upgrades

For example, avoiding the cost of floating wetland treatment if full land disposal were pursued, or in the event high rate treatment and full water discharge were pursued, cost savings from modifications to the ponds as these would likely be decommissioned (land purchases could potentially be recovered).

The total capital cost of each long term high rate treatment and land disposal option is presented in Figure 20.

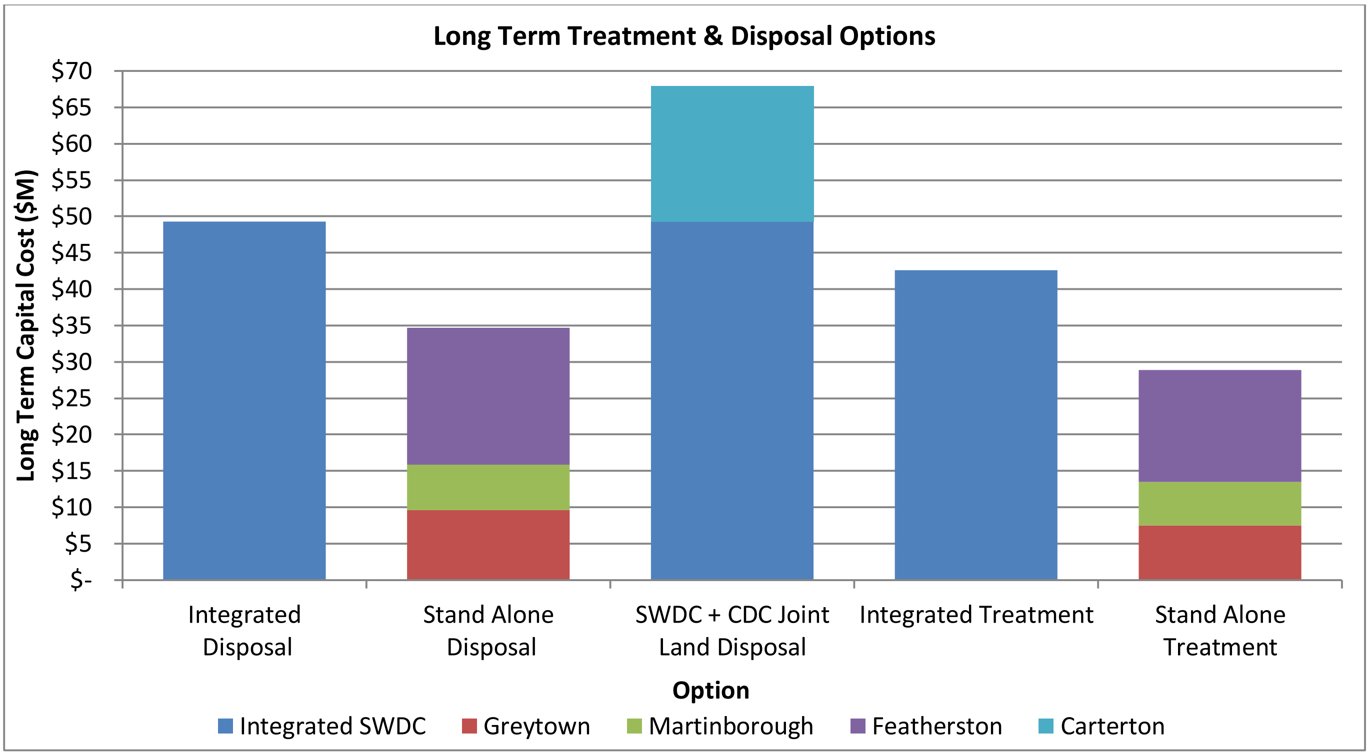


Figure 20: Summary of long term treatment and disposal options by town

Combining the schemes into one centralised location appears to be more expensive than separate schemes for both treatment and disposal options. This is attributed to the costs associated with additional reticulation infrastructure that would be required to convey wastewater to a centralised location. The breakdown of the costs into key components, is illustrated in Figure 21.

Reticulation costs represent a significant portion of the capital costs of the centralised options, particularly for the high rate treatment option due to the removal of the existing ponds and hence reduced buffering capacities resulting in increased conveyance sizing. Conversely, reticulation costs for the separate schemes is minimal as it is assumed that the future treatment or disposal site would be located at or nearby to the existing WWTPs. It is noted that these reticulation costs have been based on conveying flows to a nominal site identified by AWT and are indicative only; there is potential to optimise the reticulation design and costing through further site selection investigations, pipe material selection, construction methodology and other factors.

Figure 21 also shows that, high rate treatment options are more capital cost-effective than land disposal. This is attributed to the treatment plants smaller footprint and little to no new land purchase requirements (and land already purchased can be sold in future). Treatment options are also less sensitive to climatic conditions and can operate year round, whereas land disposal is limited by soil and weather conditions. Replacing the existing pond systems with a treatment plant (or plants) will also reduce the flows that needs to be treated by eliminating the portion of flow that enters the pond via rainfall, although some additional upstream storage would still be needed to buffer instantaneous peak flows. Any proposals to continue to discharge treated effluent to water in the longer term however, are likely to arouse significant cultural, social and environmental interest. These matters have not been discussed in this study but should form part of a holistic options assessment going forward.

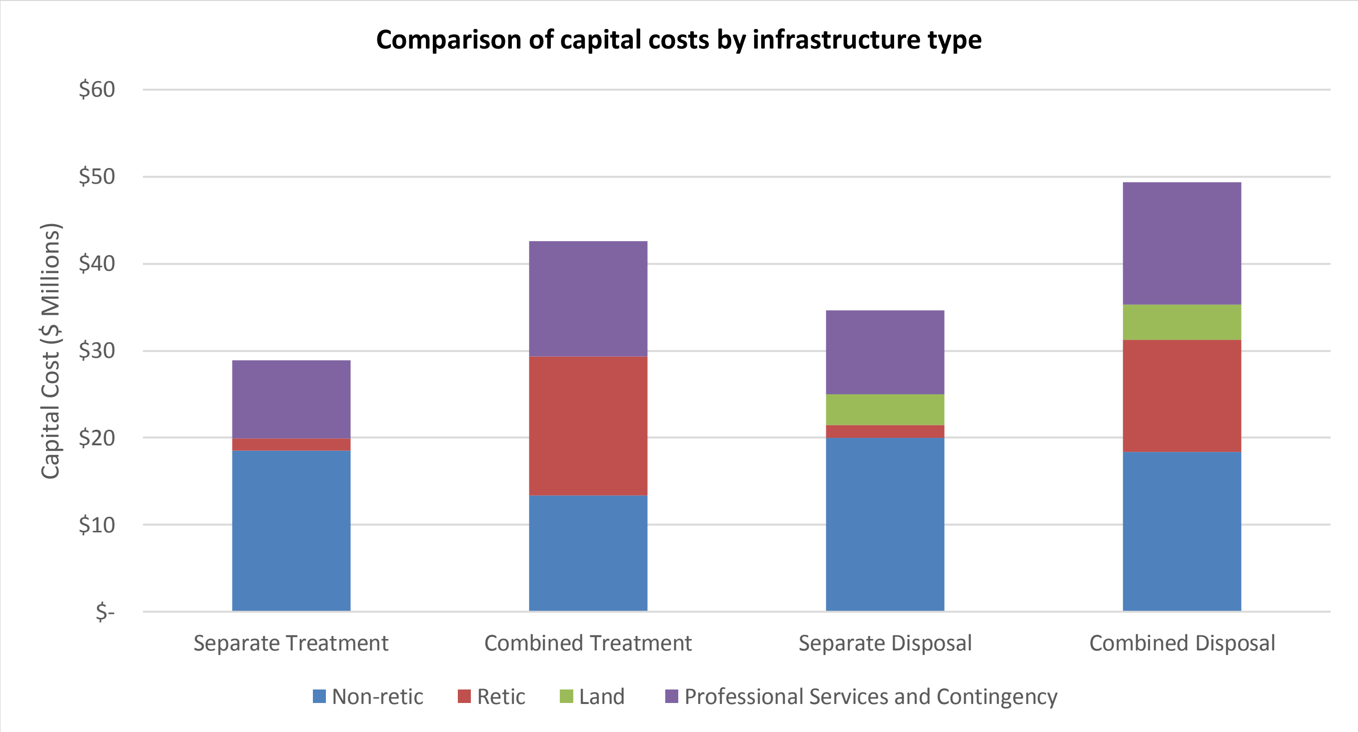


Figure 21: Comparison of capital cost estimates by infrastructure type

It has also been identified that the capital cost of land disposal options are significantly affected by land and irrigation infrastructure requirements, which cost an estimated total of approximately $55,000/ha ($25,000/ha for land purchase and $30,000/ha for infrastructure). Reducing the amount of land required will therefore significantly reduce the total capital cost of the scheme. As the scheme is hydraulically limited, the irrigation scheme size may be reduced in two ways; by reducing flows or by adjusting the number of days of irrigation and/or irrigation rate. As this is a high level study, we have taken a conservative approach in selecting design parameters for sizing of the land disposal schemes. A more refined size and cost estimate could be derived if further investigations and detailed options assessments were to be undertaken.

Finally, the addition of Carterton increases the joint land disposal scheme capital costs by approximately 28%, which is consistent given Carterton would contribute approximately 30% of the flow into the scheme. We have highlighted, however, that the flow data from Carterton WWTP is questionable and requires further validation.

Net Present Value Analysis

A basic net present value analysis, presented in Figure 22, has been undertaken using a design horizon of 30 years, with capital expenditure assumed to be paid over a ten year period and a nominal discount rate of 7%. The discount rate has been inflation adjusted to an actual discount rate of 3.9%[11]. This analysis includes provision for desludging Featherston and Martinborough ponds in the disposal options as it is assumed this will be required at least once in the next 30 years. Desludging of the Greytown ponds has been allowed for in the disposal options as an upfront capital cost.

We have also included potential revenue from the selling of hay or silage from the land disposal schemes, which has been estimated to generate approximately $3,800/ha in annual revenue (based on the Taupo LDS). It is noted, however, that pumping costs for the integrated treatment plant and all land disposal options, and depreciation costs have been excluded from this analysis.

[11] Based on an inflation rate of 3% and recommended NPV calculations as presented in 'Cost Benefit Analysis Primer', New Zealand Treasury, December 2005.

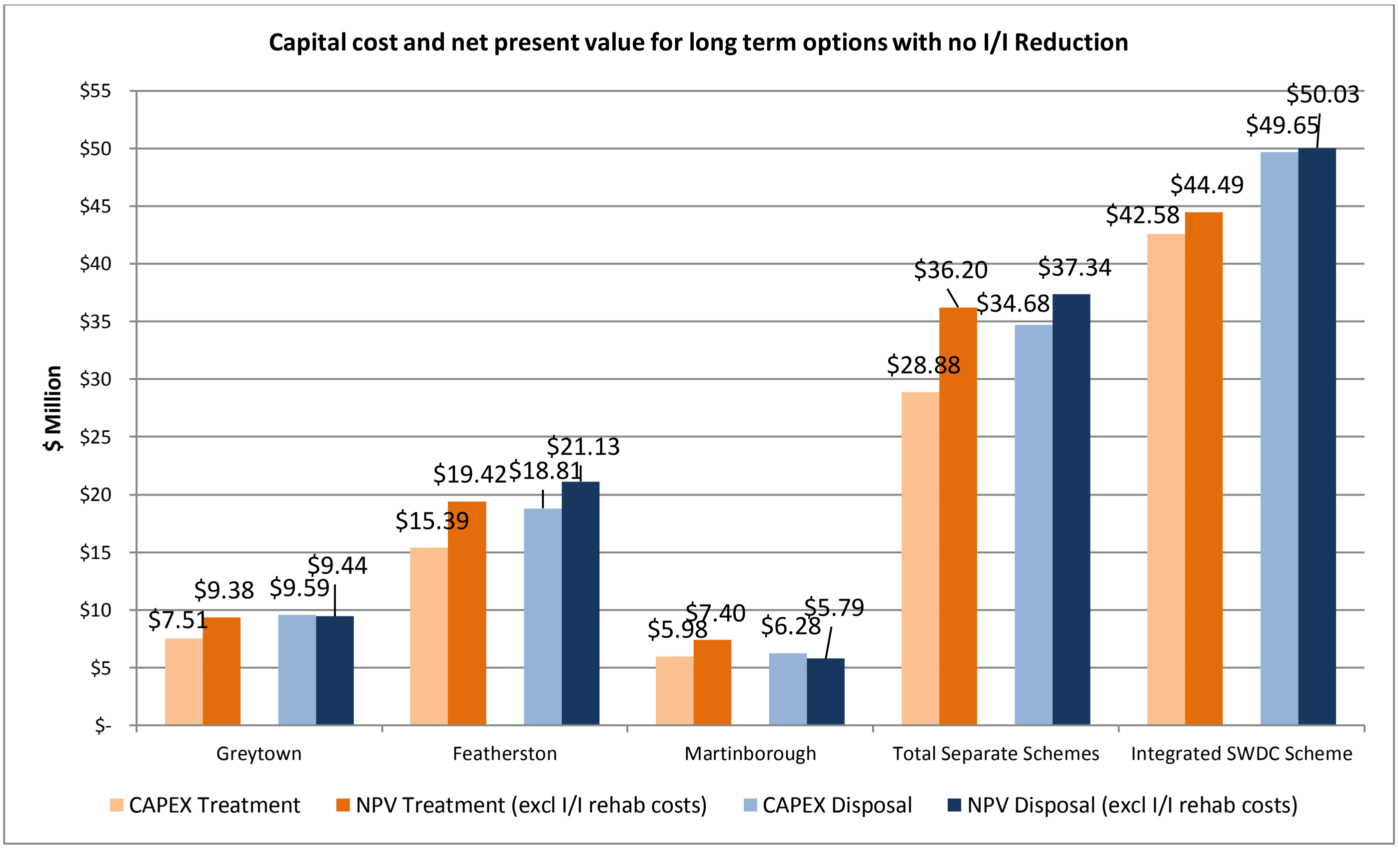


Figure 22: Comparison of capital costs vs net present value

The NPV shows that despite the treatment options having a lower capital cost to the land disposal options, the net present values are similar due to the higher on-going operational costs associated with energy requirements by high rate treatment plants

Overall, there are certain costs and benefits associated with each long term option. The economic and technical feasibility of all options have been discussed in this study, and these indicate that separate scheme options are more cost effective in terms of capital costs and both individual treatment and land disposal schemes are similar in terms of their long-term net present value costs. The potential capital cost savings need to be balanced against the long term operational costs, and the benefit of an integrated scheme needs to be balanced against the cost of reticulation infrastructure. We have not addressed social and cultural matters or undertaken a complete assessment of environmental effects as part of this analysis.

11 INFLOW AND INFILTRATION SENSITIVITY ANALYSIS

Inflow and infiltration (I/I) has been identified as a significant issue in the SWDC and CDC networks that could potentially have a large effect on the size and cost of long term treatment and/or disposal options. Infiltration is the long-term seepage of groundwater into the wastewater pipes through cracks and unsealed joints. This contributes to a high base flow in areas where the pipework is below the groundwater table. Inflow is stormwater that enters the system via illegal connections and cracks during storm events. This contributes to the sharp peaks in flow through the network during and after wet weather events.

Typical domestic per capita wastewater flows in NZ range between 210 – 475L/per/d [2], and many councils use an average per capita flow of 250L/per/d for design purposes. Table 32 illustrates that the average per capita flows in Greytown and Martinborough are at the higher end of the range, and Featherston's average per capita flows are significantly higher than would normally be expected. While no major trade waste dischargers have been identified in any of the towns, it is possible that some trade waste is skewing these per capita domestic flows upwards, however we do not have sufficient data to verify this. Based on an average per capita flow of 250L/per/d, we have estimated the 'base flow' at each town; this represents the assumed average domestic base flow that is not influenced by I/I. The remainder of the flow is expected to be I/I-related and is the portion of daily flow that can be targeted for reduction through network rehabilitation works.

Table 32: Estimated I/I flows

		Greytown	Featherston	Martinborough	Carterton
Average daily flow[12]	m^3/d	860	2721	574	3000[13]
Wet weather flow[14]	m^3/d	1293	4669	1106	5000
Population	PE	2001	2340	1326	4122
Average per capita flow at ADF	L/per/d	430	1163	433	728
Estimated base flow	m^3/d	500	585	332	1031
Estimated I/I portion of ADF	m^3/d	360	2136	243	970
	% of ADF	42%	74%	42%	
Estimated I/I portion of WWF	m^3/d	793	4084	775	2970
	% of WWF	61%	85%	70%	

In order to understand how reducing I/I would affect the long term treatment and disposal option costs, a comprehensive I/I analysis spreadsheet has been developed. This spreadsheet can be used for the following analyses, and is discussed in more detail in Appendix 6.

Assess impact of reduced I/I flow on long-term capital costs

The user can input a nominal reduction in I/I flows either as a reduction in per capita flow, percentage reduction in flow or a nominal daily flow volume reduction. These values can be input for all four towns (including Carterton) and when a value is entered, the spreadsheet re-calculates the estimated capital costs. The capital cost sensitivity analysis graphs the expected reduction in capital cost based on nominal reduction I/I flow values. Professional services fees and contingencies have been included in the capital cost estimates.

[12] At pond influent ie. excluding effects from rainfall, leakage or evaporation in the ponds.

[13] It is assumed that 1,000m^3/d is treated and disposed of at Carterton WWTP year round, so only 2,000m^3/d ADF and 4,000m^3/d WWF was used in the I/I sensitivity analysis.

[14] Assumed to be 90th%ile flows into the WWTPs.

Assess cost of I/I flow rehabilitation

Three levels of I/I rehabilitation are typically undertaken with varying levels of effectiveness, as presented in Table 33 below. It is noted that these reductions are a high level estimate based on past research and projects. Typically, the I/I reduction in a 'leakier' system will be much greater than in a less leaky system. Also, it is common to identify different areas of a catchment for different rehabilitation works as it is more effective to target a small but very leaky section of the network with Level 3 rehabilitation works than to fix the entire catchment with Level 1 rehabilitation works. For the I/I analysis, we have estimated the cost of I/I rehabilitation works based on the assumption that 5% and 30% of the network will be rehabilitated.

Table 33: Percentage reductions in I/I flow typically achieved through I/I rehabilitation works

Rehabilitation Level	Description	% Reduction in I/I typically achieved	
		Dry Weather Flow	Wet Weather Flow
1	Fix all manhole defects and direct inflow source inspections	5% -10%	15% - 20%
2	Level 1 + reline all public sewers	30% - 40%	40% - 50%
3	Level 2 + reline all private laterals	50% - 60%	60% - 75%

The cost of rehabilitation works increases with the increasing rehabilitation levels. In particular, Level 3 rehabilitation works can be up to 2 to 3 times more expensive than Level 2 rehabilitation works. This is due to the increased difficulty in accessing and relining private laterals, particularly in outlying areas where laterals from private properties can be several tens or hundreds of metres long. The estimated and indicative capital cost (todays cost) of reducing average daily and wet weather flows through the three levels of rehabilitation works is presented in Figure 23[15]. These costs have been derived based on multiplying unit rates for fixing manholes, inspecting properties and relining pipes by the number of manholes, properties and lineal metres of pipe in each catchment[16]. An important and arbitrary assumption is that 5% and 30% of the infrastructure in each level of rehabilitation is rehabilitated in order to achieve the targeted I/I reduction. In reality this figure could vary anywhere from 5% to 80% and there is currently no information available to refine this figure.

[15] It is assumed that the rehabilitation works effectively reduce I/I flows on an average day by 5%, 35% and 55% for Levels 1, 2, and 3, respectively. On a wet weather day, the reduction in I/I flows is assumed to be 17.5%, 45% and 68% for Levels 1, 2 and 3, respectively.

[16] Based on GIS and rating data provided by SWDC. We have assumed that all properties are inspected but only 5% or 30% of the network is rehabilitated (i.e. only 2 scenarios modelled).

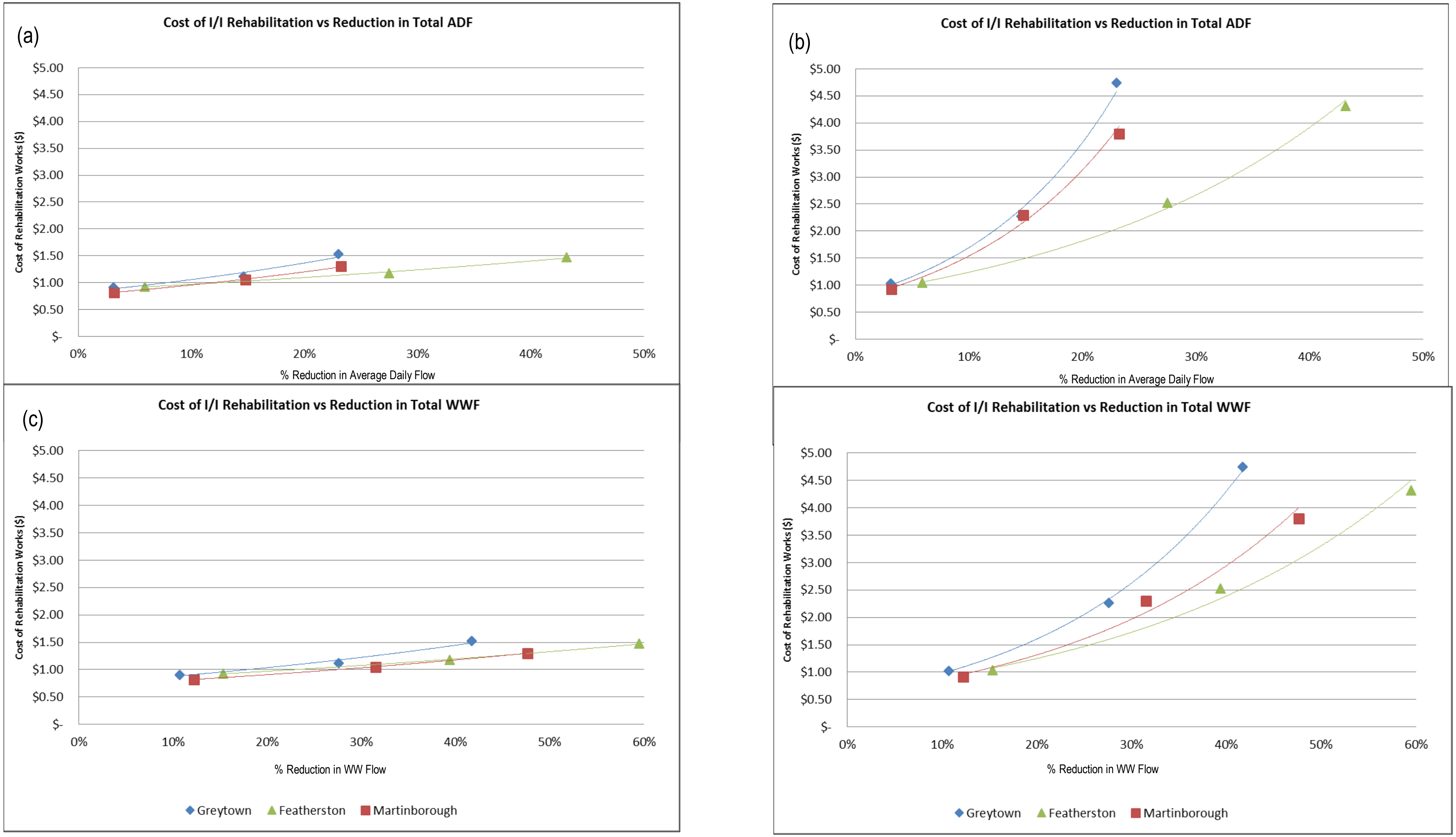


Figure 23: Indicative Cost ($millions)of I/I rehabilitation vs reduction in ADF and WWF for (a & c) 5% and (b & d) 30% of network requiring rehabilitation

Figure 23 illustrates that for close to the same cost of rehabilitation works, fixing a 'leakier' system (i.e. Featherston) will have greater overall improvement in reducing I/I. For example, for a similar cost in rehabilitation costs, reducing I/I flows by 55% through Level 3 rehabilitation works leads to a 20-25% reduction in the average daily flow at Greytown and Martinborough whereas a 55% reduction in I/I flows at Featherston can give a 43% reduction in average daily flow. This suggests that it may be less economical to undertake Level 2 and 3 I/I rehabilitation works in Greytown and Martinborough compared with Featherston, however this is based on the assumption that the same portion of network infrastructure requires rehabilitation in each township.

Figure 23 also illustrates the cost impacts from the assumptions made regarding the proportion of network infrastructure requiring rehabilitation. The rehabilitation works costs are significantly less when assuming only 5% of the network requires rehabilitation compared with 30%. For example, for the same level of ADF flow reduction achieved through level 3 rehabilitation in Featherston (~43% ADF reduction), costs may range from $1.5million to around $4.5million for the two scenarios modelled (i.e. 5% and 30% of network rehabilitation). Thus it can be estimated that for every 1km removed from the rehabilitation programme for Featherston through better isolation, ultimately saves SWDC around $500,000/km in rehabilitation costs.

By way of an example, Levin's wastewater network has similar groundwater infiltration issues to the SWDC albeit, Levin is a much less leakier system. Monitoring work undertaken to quantify and locate I/I within the Levin network, isolated 89% of the I/I flow, (which corresponded to 10% of the total annual flow) to within 2% of the network.

Featherston I/I Sensitivity

The I/I effects on the Featherston catchment are discussed in further detail as this town has been found to be particularly affected by I/I.

SWDC had budgeted $2 million for I/I reduction works in Featherston in its Work Plan. Based on the cost curves above, this equates to approximately 22% or 43% reduction in ADF and 35% or 60% reduction in WWF (480m^3/d – 1490m^3/d) subject to the arbitrary assumptions made regarding the amount of infrastructure required to be rehabilitated (i.e. 30% versus 5%).

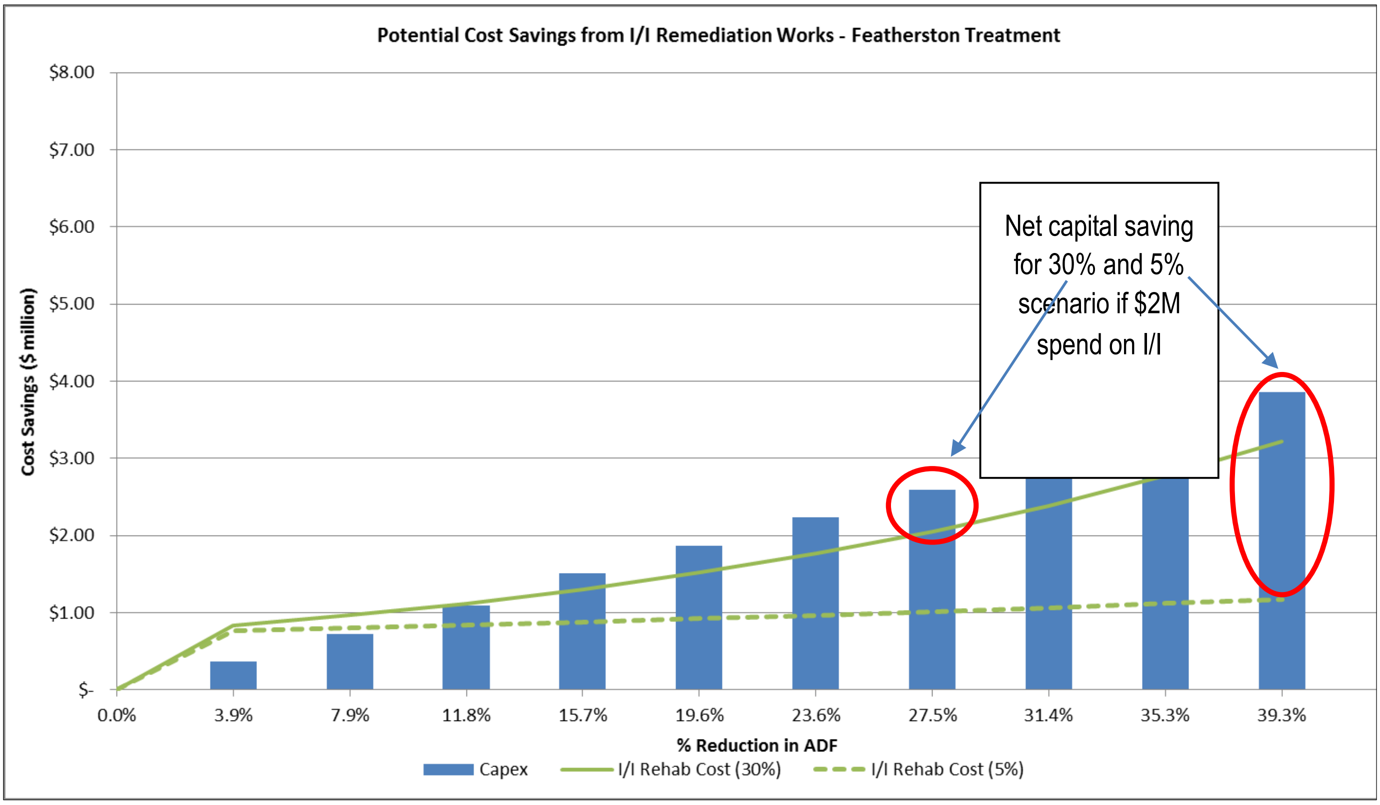
As shown in Figure 24, this reduction in flow could give potential capital cost savings in the order of $0.5 – $2.5million for a long-term treatment option or $3M - $6M for a long-term disposal option. This suggests that I/I rehabilitation works has the potential to provide some cost savings in the capital costs, and more so for land disposal options[17]. However, there is also a risk that the cost of I/I works may outweigh the cost savings unless carefully targeted I/I work is undertaken.

We reiterate that undertaking I/I rehab work is not only beneficial in potentially reducing overall long-term scheme costs, it will also replace ageing infrastructure and improve the overall condition of the network.

A NPV analysis has been performed to determine the effect of I/I reduction works (in terms of % reduction in ADF) against the costs of I/I rehab and capital and operational costs at Featherston (subject to the arbitrary assumptions made regarding the amount of infrastructure required to be rehabilitated – 5% and 30% at levels 1, 2 and 3). A 30 year design horizon was used, with rehabilitation and capital costs expected to be incurred over the first 10 years. These NPVs are presented in Figure 25

For both treatment and disposal, the NPV decreases with increasing I/I reduction. This indicates that the long term cost for a treatment and disposal scheme in Featherston could be reduced if I/I rehabilitation works are undertaken. Savings of between $1.8 - $3.9M NPV costs for treatment (compared with the 0% reduction scenario) and $4.8 - $6.8M NPV costs for disposal are achievable depending on the extent of network rehabilitation required (30% or 5%).

[17] The values presented are todays capex costs and I/I rehab costs spent over 10 years.



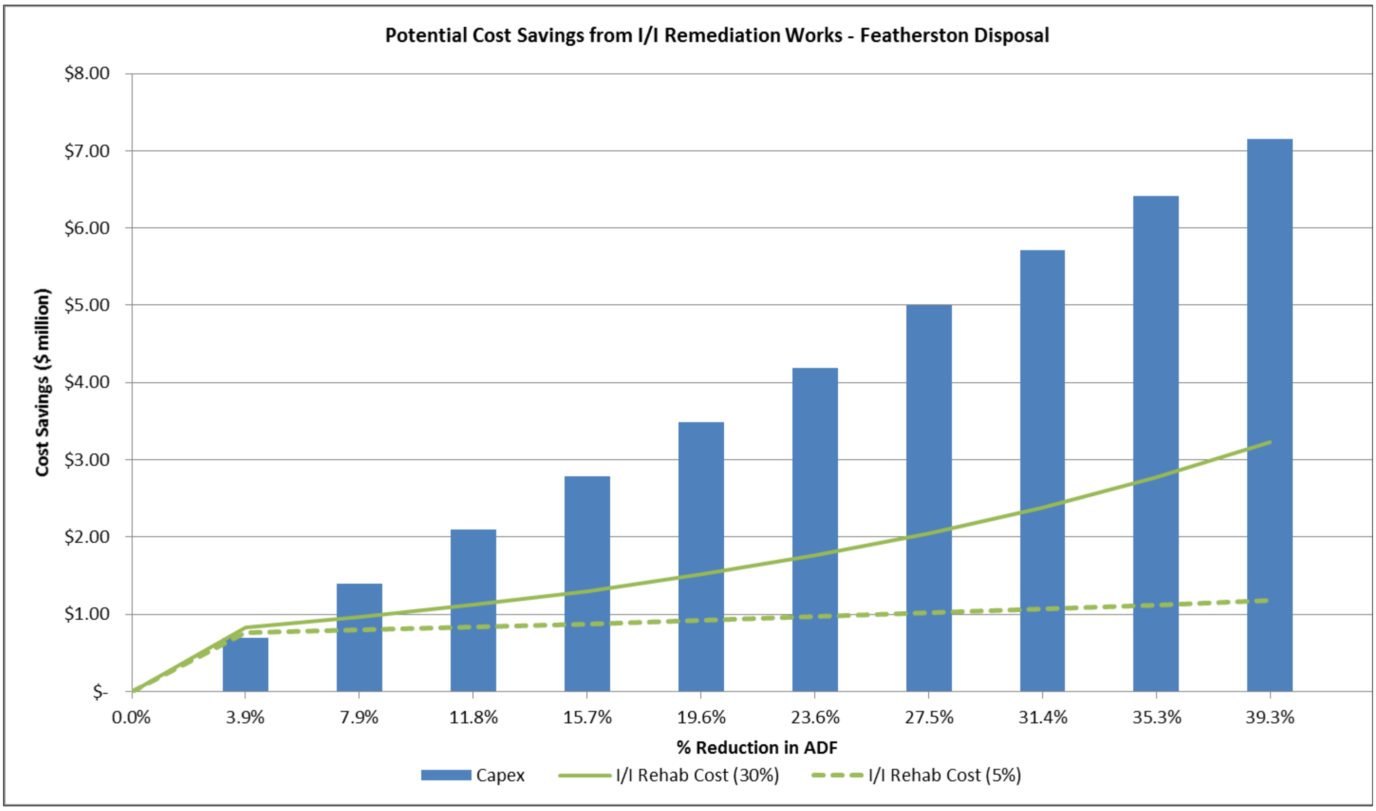


Figure 24: Potential capex savings from Featherston I/I Works – (a) Treatment and (b) Disposal

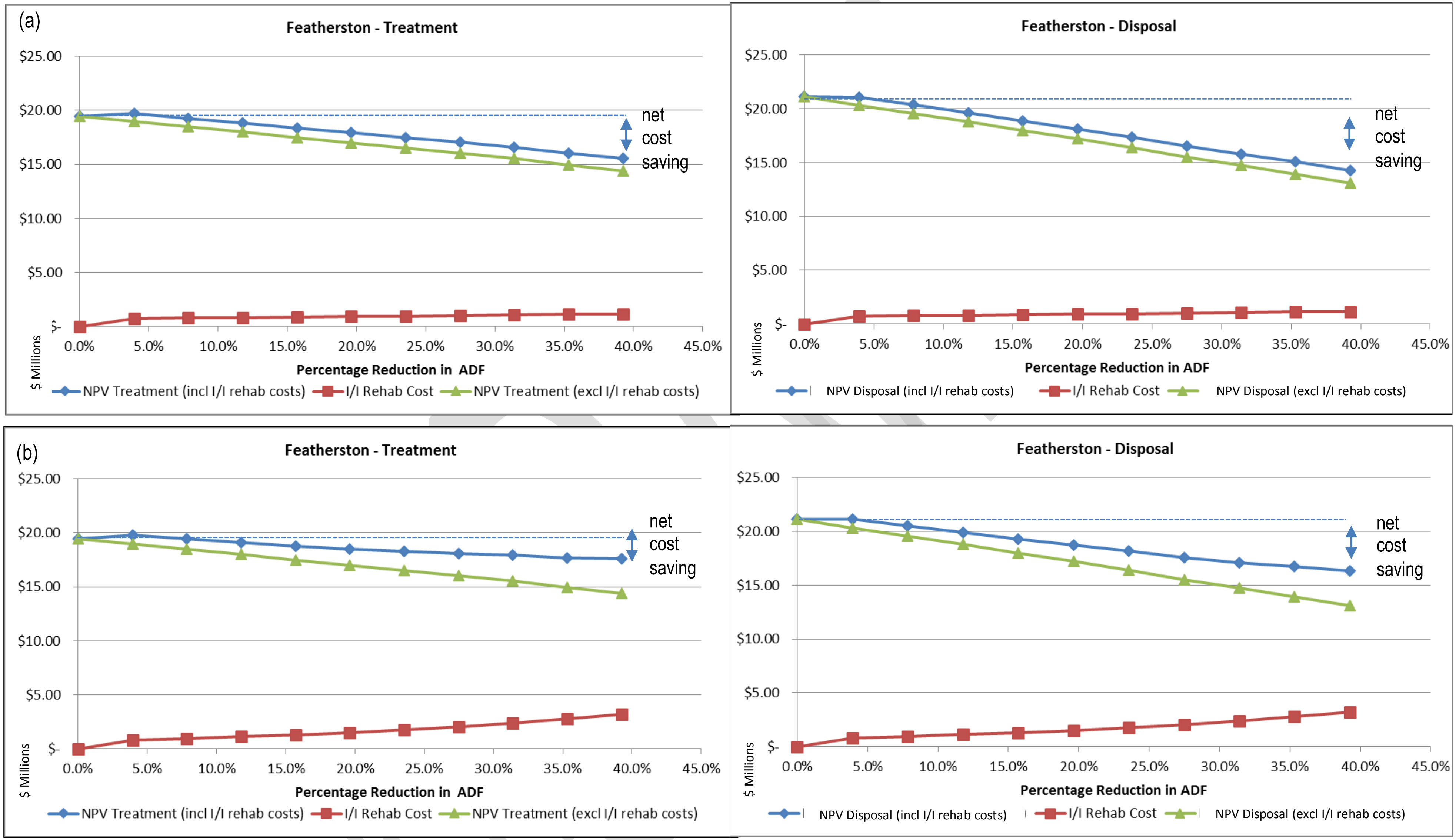


Figure 25: Effect of I/I reduction on NPV for Featherston High Rate Treatment & Land Disposal options (a) 5% and (b) 30% of network requiring rehabilitation

As noted, this analysis is very sensitive to the percentage of the network that is rehabilitated, which we have assumed to be 5% and 30%. For example, if the entire network required rehabilitation, this would become too costly and would not provide significant cost savings. More focussed network I/I investigations are highly recommended to assess and confirm the validity of these analyses. It is recommended to undertake investigations in Featherston in order to quantify the amount of I/I rehabilitation work required in the network as a next step. Examples of previous work undertaken elsewhere in New Zealand can be provided to SWDC to assess the probable reality of achieving these potential savings.

12 CONCLUSIONS AND RECOMMENDATIONS

Concept design and cost estimates have been carried out for a range of wastewater treatment and disposal options for the South Wairarapa District Council's three WWTPs at Greytown, Featherston and Martinborough. The drivers for this study were to assess the financial and technical requirements of each option and identify risks and opportunities.

Short Term Options

Based on our review of the proposed short term options we have concluded that the budgeted costs in the SWDC Work Plan have been underestimated. This is largely due to higher rates for land irrigation than previously expected and our inclusion of provisional costs for professional services and contingency.

In our opinion there is uncertainty around whether the proposed short term upgrades would be sufficient to meet the stringent effluent discharge quality limits currently being negotiated with GWRC. Furthermore, there is uncertainty of the 'usefulness' of some of the upgrades proposed in the long-term. It is therefore considered that these short term options pose risk to SWDC, in that undertaking the upgrades may not fully allow SWDC to meet its objectives and result in cost-efficient spending. Recommendations pertaining to the short term options include:

- Obtain scientifically robust evidence on the assimilative capacity of the receiving environment at each plant location. This assessment should not only focus on the worst case scenario (i.e. low flow during summer) but should also consider what assimilative capacity may be available during medium and/or high flow scenarios. This can then guide SWDC on what level of treatment may be appropriate during summer periods versus winter (wet weather) if a water discharge or combined land/water discharge option were to be pursued.
- Clarify and confirm with the regulator likely effluent quality limits for both land and water discharges and review the suitability of proposed short term upgrades to meet such limits. As part of this exercise SWDC can use AWT's report to provide information on the economics of the discussed options. Overflow and/or treatment bypass facilities should also be considered in conjunction with wet and dry weather discharge conditions as part of any consent. This will have a flow on effect on the planning and design of long term options.
- Workshop and confirm appropriateness of short term upgrades in relation to the long-term direction for treatment and/or disposal.
- There may be merit in work-shopping the above with the regulator to raise awareness of the likely long-term costs SWDC need to plan for and the efficacy of the proposed short term options at improving long term environmental outcomes.
- In the event SWDC pursue with the proposed short-term options, a review of the Work Plan is recommended to ensure the funding required is made available.

Land Disposal

The high level capital cost estimates for land disposal options are shown to be more than high rate treatment. Whilst the long-term operation of land disposal is slightly more cost effective, with opportunities to generate an income through selling harvested crops. Land disposal capital costs were found to be highly sensitive to flow volumes and days of irrigation (and/or application rates) because the two main cost components, land purchase and irrigation infrastructure, are directly proportional to the volume of wastewater that must be irrigated and storage requirements. Therefore there may be opportunity to optimise the design through further validation of irrigation assumptions made in this analysis.

We further conclude that individual land disposal schemes require less capital investment to an integrated scheme. Even though an integrated scheme has advantages such as economies of scale, both in the long-term operation and land purchases (i.e. large blocks of land are generally cheaper than multiple smaller blocks (in $/ha)), significant investment in reticulation infrastructure is required. We note that the reticulation cost estimate is highly dependent on the location of the proposed disposal site selected in this analysis, therefore further verification on potential site locations and validation of reticulation costs may be warranted if an integrated scheme were to be pursued.

Finally we note that there are cultural and environmental advantages to discharging effluent to land over water which have not been explored as part of this analysis.

The following recommendations have been made with regard to assessing the land disposal options:

- Assess the feasibility of potential locations for the separate and/or integrated land disposal schemes to validate scheme design and costing.
- Undertake more detailed investigations of irrigation infrastructure options, crop selection, management and monitoring systems to refine scheme sizing and costs etc.
- Technical review to confirm whether additional pond or other treatment is necessary and/or how best to manage algae as part of a land disposal scheme to minimise risks of filter/sprinkler blockages and soil blinding.
- Consider and discuss with the regulator seasonal land disposal in conjunction with wet weather water disposal and the savings that could be achieved by this approach.

Inclusion of Carterton WWTP in an Integrated Land Disposal Scheme

Including Carterton WWTP in a land disposal scheme increases the capital costs by approximately 28%, which is appropriate given there would be around 30% increase in the population being serviced. Significant uncertainties around the flow data provided for Carterton WWTP have been identified, and we have assumed that CDC will treat and dispose of 1,000m^3/d of flow at their own land disposal site. These uncertainties and assumptions could potentially change the land disposal scheme design significantly, so there is some risk that the cost estimate presented has been under- or over-estimated. Furthermore, there is a risk that changes to CDC’s long term plans and funding could impact on either the flow or financial contribution to the joint land disposal scheme.

It is therefore recommended if SWDC decide to pursue a combined scheme approach, that:

- CDC calibrate flow monitors and undertake a comprehensive flow monitoring programme.
- Confirm timing of CDC’s proposed upgrades and commencement of land disposal site operations.

High Rate Treatment

Based on this evaluation individual treatment plant schemes have the lowest Capex and NPV costs of all options presented. Thus from a financial perspective individual high rate treatment plants could be considered the preferred option. High rate treatment plants are a low risk alternative to the existing oxidation ponds because they can offer a high level of secondary and tertiary treatment. This would significantly improve the quality of the wastewater that is discharged to surface water, however, may not mitigate other social and cultural effects. The risk of community and iwi opposition to continuing surface water discharge may be a barrier towards obtaining consent for a high rate treatment and water discharge system.

As with an integrated disposal scheme, an integrated treatment scheme would have higher capital costs compared with separate treatment plants because of the additional reticulation infrastructure that is required.

The following recommendations have been made with regard to assessing the high rate treatment plant options:

- Undertake a more detailed options and costing analysis of various treatment technologies alongside identifying with the regulator agreed effluent quality limits, including analysis of potential social, cultural and environmental impacts.
- If an integrated treatment scheme is sought, confirm suitability of land at Greytown WWTP for plant construction.

I/I Reduction

The I/I sensitivity analysis tool has shown that reducing I/I through rehabilitation works has the potential to reduce the costs of the treatment and disposal schemes, and in particular at Featherston.

Treatment and disposal options at Greytown and Martinborough appear less sensitive to I/I flow reduction, however, this is possibly due to the conservative I/I rehabilitation cost assumptions that have been used. It is considered that a targeted I/I reduction programme of works has potential to provide long-term cost efficiencies, with a particular focus on the community of Featherston. It is also noted that the influent flow data into the WWTPs have not been compared against actual rain events to confirm/validate the portion of flows that are in fact attributable to I/I. Therefore, we recommend the following actions:

- Identify large users connected to the wastewater network (commercial properties, industry, wineries etc) and check assumptions as this will affect the per capita wastewater inputs we have calculated.
- Review flow and rainfall monitoring data to identify an accurate dry weather ('base flow') pattern and confirm the proportion of flows that are attributable to I/I. We understand that this can be undertaken using some of the existing data available from previous work.
- Implement a source detection strategy to provide the necessary data for a targeted I/I remediation programme, with a focus on Featherston initially. This work will focus on quantifying the savings that can be achieved for the "end of pipe" solution against the likely cost of remediation.
- Update the I/I sensitivity analysis with targeted information to get a more accurate picture of the effect of I/I works on treatment and disposal options across the district.

In summary, this study has provided high level costing and feasibility information on a number of long-term wastewater solutions for SWDC's consideration. Based on this analysis, individual high rate treatment plant schemes appear to be the most cost-effective solution in terms of Capex and over the long-term, although further validation of assumptions made is recommended to assist in refinement of options prior to the next stage of more detailed scheme planning and design.

In the interim it is recommended that SWDC use the findings of this investigation as part of any discussions/negotiations with the regulator on proposed consent conditions in an attempt to align agreed outcomes with an affordable solution.

Suggested work / task program looking forward	Aug	Sept	Oct	Nov	Dec	Jan
Confirm outputs - confirm assimilative capacity of receiving environments (mixing zones and effluent quality requirements during summer & winter stream flows)						
Confirm inputs - undertake targeted I/I investigations to quantify the extent of reticulation requiring rehabilitation and quantify project savings						
Refine land disposal options – site selection, soil application rates to refine assumptions made.						
Meet with the regulator to discuss and agree on effluent quality limits for both water and land discharges						
Treatment options evaluation.						
Costing re-evaluation based on agreed inputs/outputs identified from above investigations & review in line with capital expenditure review to select preferred solution						
Regularly engage with key stakeholders						
Continue consenting process						

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APPENDIX 1

SHORT TERM OPTIONS COST ESTIMATES

Live Path: R:\Projects\1250_Combined_Scheme_Review\400 Technical\450 Civil\[130613 Short Term Cost Estimates.xlsx]To print
Original R:\Projects\1250_Combined_Scheme_Review\400 Technical\450 Civil\[130613 Short Term Cost Estimates.xlsx]To print
Revision

6 August 2013

Job Name: Combined Scheme Review
Job No. 1250
Client: SWDC
Currency: NZD
Prepared by: YY
Checked by: SS
Revision:
Date: 1/07/2013
Date: 6/08/2013

Featherston Short Term Upgrades

Level of Accuracy: ± 25%

	Description	Unit	QTY	Rate	Estimate	Work Plan	Comments
1.0	**Mandatory Upgrades**				**$ 200,000**	**$ 500,000**	
1.1	Primary screening	LS	1	$ 200,000	$ 200,000	$ 500,000	Pro-rata from past projects. Includes supply and installation of all mechanical equipment. Excludes building for screening works (typically not required for smaller plants). Work Plan costs includes flow directional modifications, pond lining
2.0	**Additional Treatment Upgrades**				**$ 2,174,400**	**$ 295,450**	
2.1	P and suspended solids removal for surface water discharge					$ 295,450	
	Floating wetland technology	LS	1	$ 2,000,000	$ 2,000,000		Scaled up from Martinborough FTW proposal by Waterclean.
	Coagulation for P removal	LS	1	$ 85,000	$ 85,000		Pro-rata from past projects. Capital costs for coagulation dosing system and pipework only. Excludes filtration; sludge is assumed to settle in the pond. Does not include opex costs.
2.2	Flow directional modifications						Assume 2 baffle curtains to be installed, each approx. 220m long and average 1.2m deep. Cost pro-rata from past projects. 
	Supply and install baffle curtains	m	440	$ 160	$ 70,400		
	Supply and install cross anchor units	Pair	8	$ 2,000	$ 16,000		
	Supply and install anchor weights	LS	1	$ 3,000	$ 3,000		
3.0	**Combined Land / Water Discharge**				**$ 4,029,000**	**$ 2,277,580**	
3.1	Acquire land for partial discharge to land	ha	70	$ 25,000	$ 1,750,000	$ 1,527,580	Work plan Stage 2 - identify, secure consents and purchase land for 60-70ha fattening land. We have assumed 70ha is purchased. The cost of securing consents is excluded from this item as it is covered by the professional services fee.
3.2	Irrigation pumps, pump station and irrigation infrastructure for full discharge to land	ha	56	$ 30,000	$ 1,680,000	$ 750,000	Assumed area available for irrigation (based on 75% of land being irrigable and the remaining 25% used as buffer area). Irrigation costs pro-rata from past projects.
3.3	Reticulation pump station	LS	1	$ 200,000	$ 200,000		Assumed lump sum cost.
3.4	Supply and install 250ND PE pipe	m	1 000	$ 399	$ 399,000		Rawlinsons. Distance based on reticulating flows to the area proposed for a full land discharge scheme (adjacent to the Golf Course).
	Sub-Total				**$ 6,403,400**	**$ 3,073,030**	Work plan costs exclude sludge survey, removal and I/I works.
	Professional Services	%	20		**$ 930,680**		Land cost excluded
	Contingency	%	25		**$ 1,163,350**	**$ 460,955**	Land cost & professional services excluded. The contingency in the Work Plan is 10% of the total Work Plan costs.
	Total Cost				**$ 8,497,430**	**$ 3,533,985**	Work plan costs exclude sludge survey, removal and I/I works.

NOTES

The above costs do not include GST and are a best estimate at the time of pricing. No allowance has been made for inflation, currency and commodity fluctuations and other factors unknown at the time. These costs have been prepared for the Project & Client listed above based on the project described to us and its extent is limited to the scope of work agreed between the client and AWT Water. No responsibility is accepted by AWT Water or its directors, servants, staff or employees for the accuracy of information provided by third parties and/or the use of any part of these costs in any other context or for any other purposes. These costs do not include the following services which cannot be quantified at this time; Geotechnical Investigations, Surveying, Feasibility Studies & Fast Tracking.

Martinborough Short Term Upgrades

Level of Accuracy: ± 25%

Stage	Description	Unit	QTY	Rate	Estimate	Work Plan	Comment
1.0	**Mandatory Upgrades**				**$ 300,000**	**$ 398,595**	
1.1	Primary screening	LS	1	$ 150,000	$ 150,000	$ 198,410 includes flow directional modifications	Pro-rata from past projects. Includes supply and installation of all mechanical equipment. Excludes building (not typically required for smaller plants).
1.2	Increase waveband height by 0.5m	m3	300	$ 500	$ 150,000	$ 200,185 includes leakage investigation	Rawlinsons. Rate includes demoliton of existing waveband and installation of ready-mixed reinforced concrete slabs, delivery to site, discount, wastage and loss, handling and placing in position (plus 50% for additional handling costs). Assume increase TWL by 0.5m, therefore additional concrete waveband of approximately 1.58m high, 600m perimeter and 150mm thick is installed (assumes 3:1 side slope). This is an indicative number only as there is little information on the condition of the existing waveband.
2.0	**Additional Treatment Upgrades**				**$ 749,600**	**$ 750,000**	
2.1	Flow directional modifications						Assume 2 baffle curtains to be installed, each approx. 120m long and average 1.4m deep. Cost pro-rata from past projects. 
	Supply and install baffle curtains	m	240	$ 160	$ 38,400		
	Supply and install cross anchor units	Pair	8	$ 2,000	$ 16,000		
	Supply and install anchor weights	LS	1	$ 20,000	$ 20,000		
2.2	Leakage investigation						
	Drill 4 test bores to groundwater table (assume max depth of 2m), includes reinstatement.	LS	1	$ 10,000	$ 10,000		Assumes 4 sampling bores around the pond will be drilled to take samples for E Coli/ Faecal Coliforms contamination. If E Coli/FC are detected, this would indicate there is some leakage from the pond. Further investigations could include isolating the pond and measuring the water level drop compared with a control container. This would determine the rate of leakage. This second stage of testing has not been costed as it would be provisional based on the results of the first stage of the investigation.
	E Coli sampling	No	8	$ 25	$ 200		
2.3	FTW (with nitrogen removal)	LS	1	$ 600,000	$ 600,000	$ 600,000	As per Waterclean's FTW proposal.
2.4	P removal inc trialling and infrastructure					$ 150,000	Cost budgeted in Work Plan.
	Coagulation for P removal bench and pilot scale trials	LS	1	$ 5,000	$ 5,000		Estimate for the supply of materials and two days of technician's time running jar tests and reporting.
	Coagulation for P removal pilot scale trials	LS	1	$ 10,000	$ 10,000		Estimate for set up and implementation of pilot scale trials
	Supply and install coagulant storage tank and dosing equipment	LS	1	$ 50,000	$ 50,000		Approx. 10-20m3 coagulant storage tank + dosing pump and control. Cost pro-rata from past projects.
3.0	**Combined Land / Water Discharge**				**$ 2,979,700**	**$ 1,800,000**	
3.1	Acquire land for partial land disposal scheme	ha	50	$ 25,000	$ 1,250,000	$ 1,250,000	Work plan Stage 3 A - identify and purchase 50ha of land for a composite regime.
3.2	Irrigation pumps, pump station and irrigation infrastructure	ha	40	$ 30,000	$ 1,200,000	$ 550,000	Based on assumption that 75% of land purchased can be used for irrigation. Irrigation costs pro-rata from past projects.
3.3	Reticulation pump station	LS	1	$ 200,000	$ 200,000		Assumed lump sum cost.
3.4	Supply and install 125NB PE pipe	m	2 100	$ 157	$ 329,700		Rawlinsons. Distance based on reticulating flows to Pain Farm (proposed location of the full land discharge scheme).
	Sub-Total				**$ 4,029,300**	**$ 2,948,595**	Work plan costs exclude sludge survey, removal and I/I works.
	Professional Services	%	20		**$ 555,860**	**$ -**	Land cost excluded
	Contingency	%	25		**$ 694,825**	**$ 442,289**	Land cost & professional services excluded. The contingency in the Work Plan is 10% of the total Work Plan costs.
	Total Cost				**$ 5,279,985**	**$ 3,390,884**	Work plan costs exclude sludge survey, removal and I/I works.

NOTES

The above costs do not include GST and are a best estimate at the time of pricing. No allowance has been made for inflation, currency and commodity fluctuations and other factors unknown at the time. These costs have been prepared for the Project & Client listed above based on the project described to us and its extent is limited to the scope of work agreed between the client and AWT Water. No responsibility is accepted by AWT Water or its directors, servants, staff or employees for the accuracy of information provided by third parties and/or the use of any part of these costs in any other context or for any other purposes. These costs do not include the following services which cannot be quantified at this time; Geotechnical Investigations, Surveying, Feasibility Studies & Fast Tracking.

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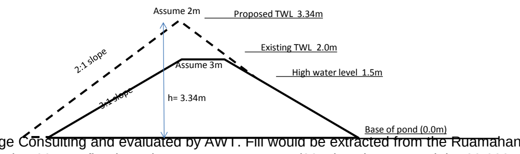
Original R:\Projects\1250_Combined_Scheme_Review\400 Technical\450 Civil\[130613 Short Term Cost Estimates.xlsx]Greytown Short Term
Revision 6 August 2013

AWT H2knOw-how

Job Name: Greytown WWTP Upgrade Review
Job No. 1250 ref also 1246
Client: SWDC
Currency: NZD Revision:
Prepared by: YY Date: 1/07/2013
Checked by: TM Date: 2/07/2013

Greytown Short Term Upgrades

Level of Accuracy: ± 25%

	Description	Unit	QTY	Rate	Estimate	Work Plan	Comments
1.0	**Mandatory Upgrades**				**$ 2,387,695**	**$ 1,100,000**	
1.1	Pond desludging and removal of sludge	t	23	$ 10,500	$ 239,715	$ 300,000	Based on removal of 22,830m3 of sludge at 5% solids. Cost includes set up, dredging, placing in geobags and disposal of geobags. Does not include ancillary site works required for desludging or disposal of geobags. Costs pro-rata from past projects.
1.2	Primary screening	LS	1	$ 150,000	$ 150,000	$ 100,000	Pro-rata from past projects. Includes supply and installation of all mechanical equipment. Excludes building (not typically required for smaller plants).
1.3	UV Disinfection					$ 300,000	
	Medium pressure closed pipe reactor (Berson IL 1250 + WW)	LS	1	$ 250,000	$ 250,000		Pro-rata from past projects. Excludes filtration.
	Supply and install UV transmissivity meter and control system	LS	1	$ 100,000	$ 100,000		Pro-rata from past projects.
	UV building	LS	1	$ 10,000	$ 10,000		Pro-rata from past projects.
1.4	Raise embankment height					$ 400,000	Increase bund height and lining for flood protection and extra storage
	Remove exisiting topsoil/organic layer from top of embankments and stockpile for later re-spreading	m2	11 400	$ 3.7	$ 42,180		Based on an estimated existing and proposed average cross section as shown below, total embankment length of 1200m and an average top soil depth of 150mm. 
	Excavate suitable material from river embankment, place and compact to increase the pond embankment height by an average of 1.34m	m3	20 000	$ 60	$ 1,202,000		Fill volume estimated by River Edge Consulting and evaluated by AWT. Fill would be extracted from the Ruamahanga riverbank. Height of 1.34m required to meet 1 in 100 year flood requirements as per NZET (2011). It is assumed the 20,000m3 is the bulk volume of uncompacted fill required. We understand the pond does not fall within the definition of a 'dam' under the Building Act and therefore specific earthquake engineering is not required by law. Costs related to the design and building of earthquake proofing works are therefore not included in this cost estiamte.
	Extra over item 2.1 for use of proprietary products (gabion baskets) to increase embankment height where widening of existing embankment is impractical	No	300	$ 235	$ 70,500		The embankment on the western bank is already very steep and constrained on being widened by the presence of two waterways. Options include using rock filled gabion baskets and a vertical impermeable wall (e.g. clay layer and geotextile wedged between the baskets etc.) to increase height. This provision item assumes the use of 1x0.45x0.45m gabion baskets to build up approx. 100m of pond wall.
	Lining of embankment with geosynthetic materials eg. GCL bentonite clay matting or high density polyethylene sheet	m2	4 000	$ 68	$ 272,000		Rates from Rawlinsons 2010. Assume Voltex Bentonite Geotextile Waterproofing, comprising 2 geotextile layers filled with sodium bentonite. $68/m2. Assume area of 4m x 1000m (perimeter of pond) = 4000m2.
	Respread and compact stockpiled topsoil on top of embankment.	m2	11 400	$ 4	$ 42,180		Excavate topsoil from stockpile, spread onto new embankment at 150mm thickness, rake and level on battered slopes. Does not include provision for removing excess material or importing additional required material.
	Stabilise and regrass	m2	11 400	$ 1	$ 9,120		Includes grading, preparing and sowing grass seed, fertilizing, watering and maintaining for six months.
2.0	**Additional Upgrades**				**$ 463,723**	**$ 600,000**	
2.1	Relocating surface water discharge					$ 600,000	
	Supply and install dedicated river discharge pump station	LS	1	$ 250,000	$ 250,000		Pro-rata from past projects. It is assumed that this would be a separate pump station to that for the irrigation scheme. One pump to service both irrigation and river discharge is not considered feasible because different duty points would be required for the different discharge methods. While economies of scale could be achieved by housing pumps in one pump station building with a common suction manifold, two sets of pumps and related infrastructure will likely be required.
	Supply and install 160NB uPVC pipe	m	800	$ 256	$ 205,180		Assuming a pumped system, a 160NB pipe is required. The gravity line option (300mm NB) has not been costed.
2.2	Supply and install PE pipe diffuser						This costing is based on the design described in NZET 2011 'Summary of existing treatment plant and proposed upgrades'. It is noted that we have not costed up the boulder trench discharge option as this has been discounted in favour of the diffuser pipe option within the NZET report.
	Supply and install of gravel bed	m3	12	$ 120	$ 1,444		Assume gravel volume = 12m3 (based on xsectional area of 0.28m2 and length of 40m). GAP20 rock = $25.3/m3 in Wgtn (Rawlinsons) + $14.80/m3 for transport. x3 for install and diversion works etc.
	Supply and install of 200mm PN12.5 PE diffuser pipe	m	10	$ 600	$ 6,000		The NZET report states approximately 10m length of pipe to extend across half the width of the low flow river cross-section.
	Supply and install of 5x 75mm PN12.5 PE diffuser risers with 45deg bends	m	1	$ 200	$ 250		Rates from rawlinsons.
	Excavation and removal of material in riverbed for installation of diffuser	m3	12	$ 71	$ 850		Assume gravel bed displaces 12m3 of riverbed material (soft, rippable rock). Rates from Rawlinsons: $20.60/m3 excavate + $14.80/m3 disposal within 10km.
3.0	**Combined Land / Water Discharge**				**$ 789,900**	**$ 350,000**	
3.1	Irrigation pumps, pump station, pipework and irrigation infrastructure	ha	16	$ 30,000	$ 480,000	$ 350,000	Assuming centre pivot system over 16ha with average application of 5mm/d over 108 day period. Includes soil moisture probe and control and filtration. Excludes harvesting equipment and any major earthworks for recontouring if required. No additional land purchases are included in the short term estimate (20ha of total land already currently available).
3.2	Reticulation Pump Station	LS	1	$ 200,000	$ 200,000		Assumed lump sum cost.
3.3	Supply and install 125NB PE pipe	m	700	$ 157	$ 109,900		Distance based on discharging to the land currently owned by SWDC that is adjacent to the WWTP.
	Sub-Total				**$ 3,641,318**	**$ 2,050,000**	Work plan costs exclude sludge survey, removal and I/I works. Purchase of additional land sites have been excluded as this is incorporated in the long term cost estimate.
	Professional Services	%	20		**$ 728,264**	**$ -**	Land cost excluded
	Contingency	%	25		**$ 910,330**	**$ 307,500**	Land cost & professional services excluded. The contingency in the Work Plan is 10% of the total Work Plan costs.
	Total Cost				**$ 5,279,912**	**$ 2,357,500**	Work plan costs exclude sludge survey, removal and I/I works.

NOTES

The above costs do not include GST and are a best estimate at the time of pricing. No allowance has been made for inflation, currency and commodity fluctuations and other factors unknown at the time. These costs have been prepared for the Project & Client listed above based on the project described to us and its extent is limited to the scope of work agreed between the client and AWT Water. No responsibility is accepted by AWT Water or its directors, servants, staff or employees for the accuracy of information provided by third parties and/or the use of any part of these costs in any other context or for any other purposes. These costs do not include the following services which cannot be quantified at this time; Geotechnical Investigations, Surveying, Feasibility Studies & Fast Tracking.

APPENDIX 2

INTEGRATED DISPOSAL SCHEME DESIGN AND COST ESTIMATE

Live Path: R:\Projects\1250 Combined Scheme Review\400 Technical\450 Civil\[Land Disposal Scheme Design (formatted for printing).xlsx]Integrated Scheme
Original R:\Projects\1250 Combined Scheme Review\400 Technical\450 Civil\[Land Disposal Scheme Design (formatted for printing).xlsx]Integrated Scheme

Job Name: South Wairarapa Combined Scheme Review
Client: SWDC
Prepared by: YY
Checked by: ND

Job No. 1250
Rev. & Date: 18/03/2013
Rev. & Date: 15/05/2013

INTEGRATED SCHEME IRRIGATION LAND REQUIREMENTS - DEFERRED IRRIGATION + STORAGE

Combined Scheme Design Criteria		
Median daily flow	4309	m3/d
90%ile flows	7545	m3/d
TN Load	60.3	kg/d
P Load	14.9	kg/d

Nutrient Loading Rates (kg/ha/yr)

Nitrogen	Phosphorus	*Source*
240	70	Average uptake values for ryegrass, from EPA Vic Guidelines for Wastewater Irrigation
150	60	Used by NZET in previous study
300	40	LEI Greytown report - these are lower because they assume some N and P return from animal excreta
500	130	Ave nutrient uptakes for a cut and carry cropping operation from NZ Land Treatment Collective Guidelines for utilisation of sewege effluent on land

Land and Storage Requirements

Scenarios based on assumed soil category (TP58 Soils 3-5)

		Scenario				
		A Good draining	B Moderate	C Slow-moderate	D Design	*Comments*
Irrigation period	Months/ yr	5	5	5	5	Assume irrigation between Nov - Mar
Application rate	mm/d	15	5	3.5	10.7	Assume application rate of 15mm/d for 5 days with 2 day rest period after each application ie. Average rate of 10.7mm/d.
Days in irrigation period	d	152	152	152	152	
Wind down time	d	4	4	4	4	Based on assumption that 2% of days each year have wind speeds > 12m/s.
Harvesting down time	d	35	35	35	35	Based on Taupo/ Masterton Land Application work. Assume 10 days / harvest and 5 harvests between September - March - this is approx. 35 days of downtime during the irrigation period (Nov-Mar)
Total days irrigating	d	113	113	113	113	
Area Required - hydrualics	ha	93	278	397	130	
Area Required - TN	ha	44	44	44	44	Based on max nitrogen loading of 500kg/ha/yr
Area Required - TP	ha	42	42	42	42	Based on max phosphorus loading of 130kg/ha/yr
Max area required	ha	93	278	397	130	
+ 25% extra for buffer/reserve	**ha**	**116**	**348**	**497**	**162**	
Storage Vol Required	m3	1,086,137	1,086,137	1,086,137	1,086,137	
Storage Vol Available in Existing Ponds	m3	23,500	23,500	23,500	23,500	Assume some of the existing pond volume can be used for storage, particularly at Greytown and Martinborough where TWL are proposed to be raised.
New Pond Storage Required	m3	1,060,000	1,060,000	1,060,000	1,060,000	
Area required for pond storage	ha	22	22	22	22	Assume the storage will be divided between the four existing treatment plants and a flow balancing pond will be built within the the irrigation buffer area (ie. minimising total amount of land required).
Total Land Area Required	**ha**	**116**	**348**	**497**	**162**	

Nutrient Balance	Range	Unit	Use	*Source*
Yield	15-20	t DM/ha/year	16	NZ Guidelines for utilisation of sewage effluent on land. Scion 2000.
Typical %N in grass		3.5 %		
Typical N uptake	500-600	kg/ha/yr	500	Chapter 6 (Jeff Morton, Mike O'Connor, Jean-Michael Carnus and Hailong Wang)
Typical P uptake	130-160	kg/ha/yr	130	Chapter 2 (Louise Bartin, Loius Schipper, Malcolm McLeod, Jackie Aislabie and Bob Lee)
Harvests required	3-5	times/year	5	
P retention in soil				Based on assumptions set out in LEI Greytown report
Storage capacity		300 mg/kg		Note storage capacity possibly lower in clayey Zone A soils
Storage depth		0.4 m		Assumed storage depth
Soil density		1.1 tonnes/m3		
Site lifespan		50.00 years		Assumed lifespan
Storage capacity		26.40 kg/ha/yr		
Max soil retention (over 50 yr lifespan)		1.32 t P/ha		

		Scenario			
		A	B	C	D
Irrigation area	ha	93	278	397	130
DM Yield	t DM/yr	1483.2	4449.6	6356.5	2079.2
N uptake	t/yr	46.3	139.0	198.6	65.0
N loading	t/yr	22.0	22.0	22.0	22.0
N loading > removal?	**Y/N**	**N**	**N**	**N**	**N**
P uptake	t/yr	12.1	36.2	51.6	16.9
P Soil retention	t/yr	2.4	7.3	10.5	3.4
P loading	t/yr	5.4	5.4	5.4	5.4
P loading > removal?	**Y/N**	**N**	**N**	**N**	**N**

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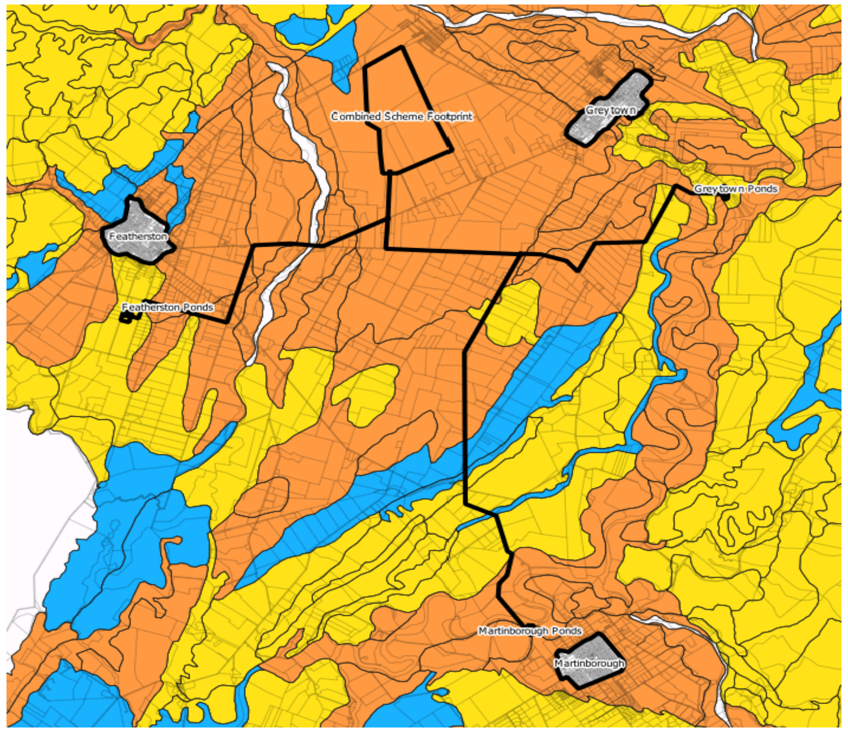
Original R:\Projects\1250_Combined_Scheme_Review\400 Technical\450 Civil\[Land Disposal Scheme Design (formatted for printing).xlsx]Integrated-Retic

Job Name: South Wairarapa Combined Scheme Review
Client: SWDC
Job No. 1250
Prepared by: YY
Rev. & Date: 1/07/2013
Checked by: TM
Rev. & Date: 2/07/2013

RETICULATION TO INTEGRATED SCHEME DISPOSAL AREA

Pipe ID	From	To	Distance (km)	Start Elevation	Maximum Elevation	ADF (m3/d)	Pump flow assuming all flow pumped in six months (m3/s)	Nominal velocity (m/s)	Diameter (mm)	Nominal dia (mm)	Actual velocity (m/s)	Friction head	Static head	Design head	Comments
F01	Featherston	CS Inlet	9.7	19	56	2811	0.065	1	288	300	0.92	41.9	37	78.9	Follows SH2: 1 stream crossing
M01	Martinborough	G-M	11.5	20	48	653	0.015	1	139	160	0.75	62.1	28	90.1	Mostly on road, some crossing through private property and 2 stream crossi
G01	Greytown	G-M	6.5	38	53	845	0.020	1	158	160	0.97	58.8	15	73.8	Drilling/open trenching through primate property required
G-M01	G-M	CS Inlet	5.3	48	56	1498	0.035	1	210	200	1.10	49.4	8	57.4	



Live Path: R:\Projects\1250_Combined_Scheme_Review\400 Technical\450 Civil\[130708 Land Disposal Cost Estimates V2.xlsx]Combined Scheme
Original R:\Projects\1250_Combined_Scheme_Review\400 Technical\450 Civil\[130708 Land Disposal Cost Estimates V2.xlsx]Combined Scheme
Revision

10 July 2013

Job Name: Combined Scheme Review
Job No. 1250
Client: SWDC
Currency: NZD *Revision:*
Prepared by: YY *Date:* 6/05/2013
Checked by: TM *Date:* 2/07/2013

Integrated Land Disposal Scheme

Level of Accuracy: ± 25%

	Description	Unit	QTY	Rate	Estimate	Comments
1.0	**Combined Deferred Irrigation Scheme**	-	-	-	**$ 19,648,500**	
1.1	Acquire land for irrigation scheme	ha	162	$ 25,000	$ 4,050,000	Total estimated land area required for land disposal scheme.
1.2	Irrigation pumps, pump station and irrigation infrastructure	ha	130	$ 30,000	$ 3,900,000	Assuming centre pivot + corner arm system over 130ha with average application of 10.7mm/d over 113 day period. Includes one irrigation pump station, pipework, soil moisture probe, filtration and control system and allowance for roading and earthworks (levelling, grading etc). Excludes harvesting equipment. Excludes professional services for design of system.
1.3	Construct storage pond	m3	1063 500	$ 11	$ 11,698,500	Based on past projects. Includes pipework, inlet/outlet structures, earthworks, PE lining, testing and commissioning, access road, security fence and gate and reinstatement. Assumes storage pond is approx. 6m deep.
2.0	**Reticulation**				**$ 12,866,300**	
2.1	Supply and install pipes to SWDC standards, including bedding, trenching and testing.					Reticulation is for rising mains from existing WWTPs to proposed land disposal site. Pipe unit costs based on Humes rates x 1.2 for install. It is noted that PN 16 PE or other materials (eg. steel) may be required, particularly for the very long distance rising mains.
	160ND PN12.5 PE pipe	m	18 000	$ 255	$ 4,590,000	
	200ND PN12.5 PE pipe	m	4 000	$ 319	$ 1,276,000	
	300ND PN12.5 PE pipe	m	8 400	$ 479	$ 4,023,600	
	350ND PN12.5 PE pipe	m	1 300	$ 559	$ 726,700	
2.2	Pump Stations					Assumed lump sum costs. Larger rising mains require greater pumping infrastructure. It is assumed that two pump stations would be needed for the Martinborough rising main given the large pumping distance.
	For rising mains 2-5km	LS	1	$ 250,000	$ 250,000	
	For rising mains 5-10km	LS	4	$ 500,000	$ 2,000,000	
3.0	**Martinborough Pond Upgrades**				**$ 275,000**	
3.1	Primary screening	LS	1	$ 125,000	$ 125,000	Pro-rata from past projects. Includes supply and installation of all mechanical equipment for inlet screens. Excludes building.
3.2	Waveband upgrade	LS	1	$ 150,000	$ 150,000	Proposed short term upgrade, required to provide an additional 8,500m3 storage.
4.0	**Greytown Pond Upgrades**				**$ 2,362,695**	
4.1	Pond sludge survey, removal and disposal	t	23	$ 10,500	$ 239,715	Based on removal of 22,830m3 of sludge at 5% solids. Cost includes dredging and placing in geobags. Does not include ancillary site works required for desludging or disposal of geobags. Costs pro-rata from past projects.
4.2	Increase bund height	LS	1	$ 1,637,980	$ 1,637,980	Detailed costing provided in Short term cost estimates
4.3	Primary Screening	LS	1	$ 125,000	$ 125,000	Pro-rata from past projects. Includes supply and installation of all mechanical equipment for inlet screens. Excludes building.
4.4	UV Disinfection	LS	1	$ 360,000	$ 360,000	Detailed costing provided in Short term cost estimates
5.0	**Featherston Pond Upgrades**				**$ 125,000**	
5.1	Primary screening	LS	1	$ 125,000	$ 125,000	Pro-rata from past projects. Includes supply and installation of all mechanical equipment for inlet screens. Excludes building.
	Sub-Total				**$ 35,277,495**	
6.0	**Professional Services**	%	20		**$ 6,245,499**	Land cost excluded
7.0	**Contingency**	%	25		**$ 7,806,874**	Land cost & professional services excluded
	Total Cost				**$ 49,329,868**	

NOTES

The above costs do not include GST and are a best estimate at the time of pricing. No allowance has been made for inflation, currency and commodity fluctuations and other factors unknown at the time. These costs have been prepared for the Project & Client listed above based on the project described to us and its extent is limited to the scope of work agreed between the client and AWT Water. No responsibility is accepted by AWT Water or its directors, servants, staff or employees for the accuracy of information provided by third parties and/or the use of any part of these costs in any other context or for any other purposes. These costs do not include the following services which cannot be quantified at this time; Geotechnical Investigations, Surveying, Feasibility Studies & Fast Tracking.

APPENDIX 3

SEPARATE DISPOSAL SCHEME DESIGN AND COST ESTIMATE

Live Path:	R:\Projects\1250 Combined Scheme Review\400 Technical\450 Civil\[130508 Combined Scheme Review Calcs.xlsx]Scheme Data
Original	R:\Projects\1250 Combined Scheme Review\400 Technical\450 Civil\[130508 Combined Scheme Review Calcs.xlsx]Scheme Data

Job Name: South Wairarapa Combined Scheme Review
Client: SWDC *Job No.* 1250
Prepared by: YY *Rev. & Date:* 1/07/2013
Checked by: KB *Rev. & Date:* 4/07/2013

FEATHERSTON IRRIGATION SCHEME

Design Criteria

AADF	m3/d	2811	
AWWF	m3/d	4799	Assume 3 months peak / yr
N Loading	kg/d	26.1	
P Loading	kg/d	6.4	
N Uptake	kg/ha/yr	500	
P Uptake	kg/ha/yr	130	

Irrigation Scheme - Year Round Deferred Irrigation

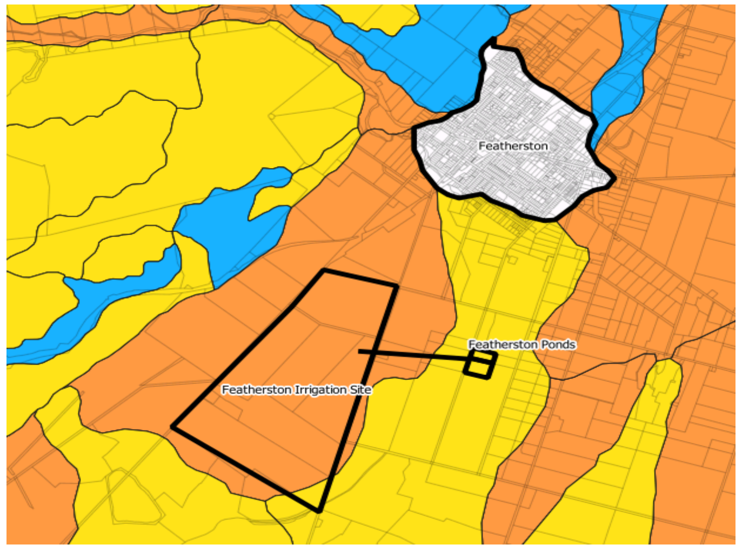
		A Good draining	B Moderate	C Slow-moderate	Design	
Irrigation period	Months/ yr	5	5	5	5	Assume irrigation between Nov - Mar
Application rate	mm/d	15	5	3.5	10.7	Assume application rate of 15mm/d with 2 day rest period after each application ie. Average rate of 10.7mm/d (use 11)
Days in irrigation period	d	152	152	152	152	
Wind down time	d	4	4	4	4	Based on assumption that 2% of days each year have wind speeds > 12m/s.
Harvesting down time	d	35	35	35	35	Based on Taupo/ Masterton Land Application work. Assume 10 days / harvest and 5 harvests between September - March - this is approx. 35 days of downtime during the irrigation period (Nov-Mar)
Total days irrigating	d	113	113	113	113	
Area Required - hydraulics	ha	60	181	259	85	
Area Required - TN	ha	19	19	19	19	Based on max nitrogen loading of 500kg/ha/yr
Area Required - TP	ha	18	18	18	18	Based on max phosphorus loading of 130kg/ha/yr
Max area required	**ha**	**60**	**181**	**259**	**85**	
+ 25% extra for buffer/reserve	ha	15	45	65	21	
Sub-total area	**ha**	**76**	**227**	**324**	**106**	
Storage Vol Required	m3	708,548	708,548	708,548	708,548	
Area required for pond storage	ha	12	12	12	12	Assume 12ha for storage ponds (pond volume calculator)
Total Land Area Required	**ha**	**76**	**227**	**324**	**106**	Assume pond storage area can be included within buffer area

Reticulation

Pipe ID	From	To	Distance (km)	Start Elevation	Maximum Elevation	ADF (m3/d)	Nominal pump flow (m3/s)	Nominal velocity (m/s)	Diameter (mm)	Nominal dia (mm)	Actual velocity (m/s)	Friction head	Static head	Design head	Pipe Class
F01	Featherston	Irrigation site	1	19	20	4799	0.056	1	265.93381	250	1.13	7.8	1	8.8	350

Nutrient Balance

		Scenario			
		A	B	C	C
Irrigation area	ha	60	181	259	85
DM Yield	t DM/yr	967.6	2902.7	4146.7	1356.4
N uptake	t/yr	30.2	90.7	129.6	42.4
N loading	t/yr	9.5	9.5	9.5	9.5
P uptake	t/yr	7.9	23.6	33.7	11.0
P Soil retention	t/yr	1.6	4.8	6.8	2.2
P loading	t/yr	2.3	2.3	2.3	2.3
N loading > removal?	Y/N	N	N	N	N
P loading > removal?	Y/N	N	N	N	N



Live Path: R:\Projects\1250 Combined Scheme Review\400 Technical\450 Civil\[130508 Combined Scheme Review Calcs.xlsx]Scheme Data
Original R:\Projects\1250 Combined Scheme Review\400 Technical\450 Civil\[130508 Combined Scheme Review Calcs.xlsx]Scheme Data

Job Name: South Wairarapa Combined Scheme Review
Client: SWDC *Job No.* 1250
Prepared by: YY *Rev. & Date:* 1/07/2013
Checked by: KB *Rev. & Date:* 4/07/2013

This information has been prepared for the benefit of SWDC. No reliability is accepted by this company or any employee or sub-consultant of this company with respect to its use by another person.

MARTINBOROUGH IRRIGATION SCHEME

Design Criteria		
Median daily flow	m3/d	653
90%ile flows	m3/d	1299
N Loading	kg/d	17.8
P Loading	kg/d	4.1
N Uptake	kg/ha/yr	500
P Uptake	kg/ha/yr	130

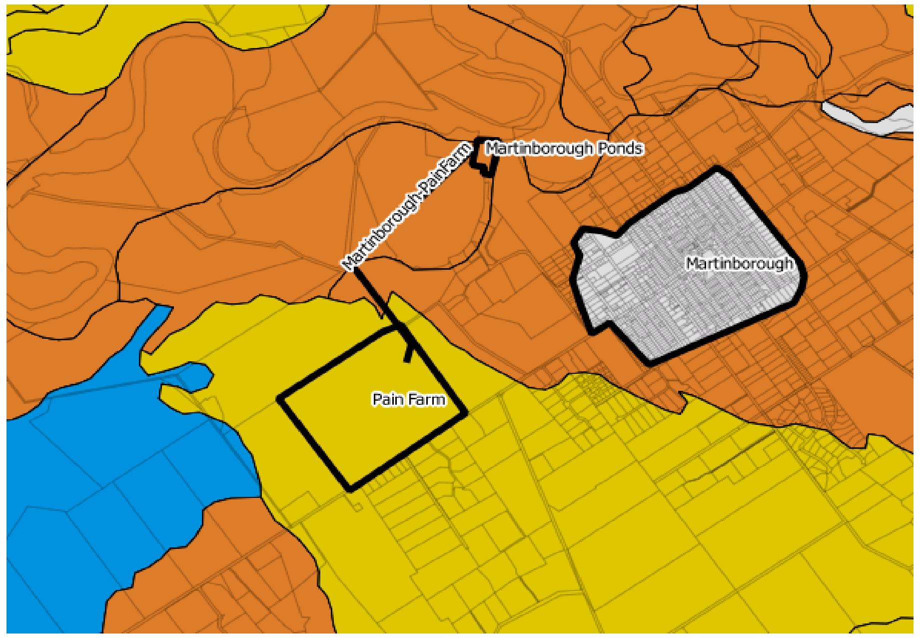
Irrigation Scheme - Year Round Deferred Irrigation		A Good draining	B Moderate	C Slow-moderate	
Irrigation period	Months/ yr	5	5	5	Assume irrigation between Nov - Mar
Application rate	mm/d	15	5	3.5	
Days in irrigation period	d	152	152	152	
Wind down time	d	4	4	4	Based on assumption that 2% of days each year have wind speeds > 12m/s.
Harvesting down time	d	35	35	35	Based on Taupo/ Masterton Land Application work. Assume 10 days / harvest and 5 harvests between September - March - this is approx. 35 days of downtime during the irrigation period (Nov-Mar)
Total days irrigating	d	113	113	113	
Area Required - hydraulics	ha	14	42	60	
Area Required - TN	ha	13	13	13	Based on max nitrogen loading of 500kg/ha/yr
Area Required - TP	ha	12	12	12	Based on max phosphorus loading of 130kg/ha/yr
Max area required	**ha**	**14**	**42**	**60**	
+ 25% extra for buffer/reserve	ha	4	11	15	
Sub-total area	**ha**	**18**	**53**	**75**	
Existing storage to be utilised	m3	8,500	8,500	8,500	Assumed additional volume available from waveband upgrade.
Storage Vol Required	m3	156,097	156,097	156,097	
Area required for pond storage	ha	4	4	4	Assume 4ha for storage ponds (pond volume calculator)
Total Land Area Required	**ha**	**22**	**53**	**75**	Assume pond storage area can be included within buffer area

Reticulation

Pipe ID	From	To	Distance (km)	Start Elevation	Maximum Elevation	ADF (m3/d)	Nominal pump flow (m3/s)	Nominal velocity (m/s)	Diameter (mm)	Nominal dia (mm)	Actual velocity (m/s)	Friction head	Static head	Design head	Pipe Class
M01	Martinborough	Pain Farm	2.1	20	21	653	0.008	1	98.096786	125	0.62	9.7	1	10.7	200

Nutrient Balance

		Scenario		
		A	B	C
Irrigation area	ha	14	42	60
DM Yield	t DM/yr	224.8	674.3	963.3
N uptake	t/yr	7.0	21.1	30.1
N loading	t/yr	6.5	6.5	6.5
P uptake	t/yr	1.8	5.5	7.8
P Soil retention	t/yr	0.4	1.1	1.6
P loading	t/yr	1.5	1.5	1.5
N loading > removal?	Y/N	N	N	N
P loading > removal?	Y/N	N	N	N



Live Path:	R:\Projects\1250 Combined Scheme Review\400 Technical\450 Civil\130508 Combined Scheme Review Calcs.xlsx]Scheme Data
Original	R:\Projects\1250 Combined Scheme Review\400 Technical\450 Civil\130508 Combined Scheme Review Calcs.xlsx]Scheme Data

Job Name: South Wairarapa Combined Scheme Review
Client: SWDC
Prepared by: YY
Checked by: KB

Job No. 1250
Rev. & Date: 1/07/2013
Rev. & Date: 4/07/2013

GREYTOWN IRRIGATION SCHEME

Design Criteria

AADF	m3/d	845
AWWF	m3/d	1447
N Loading	kg/d	16.4
P Loading	kg/d	4.4
N Uptake	kg/ha/yr	500
P Uptake	kg/ha/yr	130

Irrigation Scheme - Year Round Deferred Irrigation

		A Good draining	B Moderate	C Slow-moderate	Weighted	
Irrigation period	Months/ yr	5	5	5	5	
Application rate	mm/d	15	5	3.5	7.4	
Days in irrigation period	d	152	152	152	152	
Wind down time	d	4	4	4	4	
Harvesting down time	d	35	35	35	35	Based on assumption that 2% of days each year have wind speeds > 12m/s.
Total days irrigating	d	113	113	113	113	Based on Taupo/ Masterton Land Application work. Assume 10 days / harvest and 5 harvests between September - March - this is approx. 35 days of downtime during the irrigation period (Nov-Mar)
Area Required - hydraulics	ha	18	55	78	37	
Area Required - TN	ha	12	12	12	12	Based on max nitrogen loading of 500kg/ha/yr
Area Required - TP	ha	12	12	12	12	Based on max phosphorus loading of 130kg/ha/yr
Max area required	**ha**	**18**	**55**	**78**	**37**	
+ 25% extra for buffer/reserve	ha	5	14	19	9	
Sub-total area	**ha**	**23**	**68**	**97**	**46**	
Existing storage to be utilised	m3	15000	15000	15000	15000	Assumed additional volume from raising embankment height.
Storage Vol Required	m3	197.993	197.993	197.993	197.993	
Area required for pond storage	ha	4	4	4	4	Assume 4ha for storage ponds (pond volume calculator)
Total Land Area Required	**ha**	**23**	**68**	**97**	**46**	Assume pond storage area can be included within buffer area

Area (estimated from GIS)

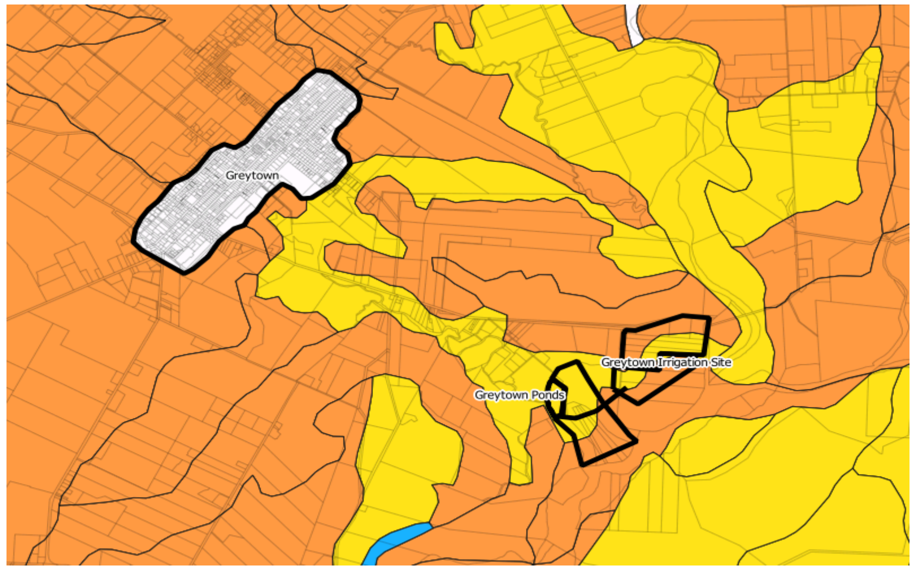
Total Area	Zone A	Zone B	
84	**46**	**38**	ha
	10.7	3.5	mm/d
	Weighted	**7.442857143**	**mm/d**

Reticulation

Pipe ID	From	To	Distance (km)	Start Elevation	Maximum Elevation	ADF (m3/d)	Nominal pump rate (m3/s)	Nominal velocity (m/s)	Diameter (mm)	Nominal dia (mm)	Actual peak velocity (m/s)	Friction head	Static head	Design head
G01	Greytown	Irrigation site	0.7	19	20	845	0.010	1	111.59033	125	0.80	5.4	1	6.4

Nutrient Balance

		Scenario A	Scenario B	Scenario C	Scenario D
Irrigation area	ha	18	55	78	37
DM Yield	t DM/yr	290.9	872.6	1246.5	589.6
N uptake	t/yr	9.1	27.3	39.0	18.4
N loading	t/yr	6.0	6.0	6.0	6.0
P uptake	t/yr	2.4	7.1	10.1	4.8
P Soil retention	t/yr	0.5	1.4	2.1	1.0
P loading	t/yr	1.6	1.6	1.6	1.6
N loading > removal?	Y/N	N	N	N	N
P loading > removal?	Y/N	N	N	N	N



Live Path: R:\Projects\1250_Combined_Scheme_Review\400 Technical\450 Civil\[130708 Land Disposal Cost Estimates V2.xlsx]To print
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Revision 10 July 2013

Job Name: Combined Scheme Review
Job No. 1250 ref also 1246
Client: SWDC
Currency: NZD *Revision:*
Prepared by: YY *Date:* 8/05/2013
Checked by: TM *Date:* 2/07/2013

Greytown Full Land Discharge

Level of Accuracy: ± 25%

	Description	Unit	QTY	Rate	Estimate	Comments
1.0	**Pond desludging**				**$ 239,715**	
1.1	Pond desludging and removal of sludge	t	23	$ 10,500	$ 239,715	Based on removal of 22,830m3 of sludge at 5% solids. Cost includes dredging, placing in geobags and disposal of geobags. Does not include ancillary site works required for desludging or disposal of geobags. Costs pro-rata from past projects.
2.0	**Pond Optimisation**				**$ 1,787,980**	
2.1	Increase embankment height	LS	1	$ 1,637,980	$ 1,637,980	Details provided in short term cost estimates.
2.2	Primary screening	LS	1	$ 150,000	$ 150,000	Details provided in short term cost estimates.
3.0	**UV Disinfection**				**$ 360,000**	
3.1	UV disinfection plant, control system and building.	LS	1	$ 360,000	$ 360,000	Details provided in short term cost estimates.
4.0	**Land Treatment (Full Discharge)**				**$ 4,507,900**	
4.1	Acquire additional land for future land disposal	ha	26	$ 35,000	$ 910,000	Concept design land requirements. Assumes 20ha of land has already been purchased (and 16ha of that land is irrigable). Land cost based on indicative costs of $25,000 for sections > 50ha and $50,000 for sections <50ha (sourced from realtor in Masterton).
4.2	Irrigation pumps, pump station, pipework and irrigation infrastructure	ha	37	$ 30,000	$ 1,110,000	Assuming centre pivot system over 66ha with average application of 4.3mm/d over 108 day period. Includes soil moisture probe and control and filtration. Excludes harvesting equipment and any major earthworks for recontouring if required.
4.3	Storage	m3	198 000	$ 11	$ 2,178,000	Based on past projects. Includes pipework, inlet/outlet structures, earthworks, PE lining, testing and commissioning, access road, security fence and gate and reinstatement. Assumes storage pond is approx. 6m deep.
4.4	Reticulation Pump Station	LS	1	$ 200,000	$ 200,000	Assumed lump sum cost.
4.5	Supply and install 125NB PE pipe	m	700	$ 157	$ 109,900	Based on Humes x 1.2 for install.
5.0	**Sub-Total**				**$ 6,895,595**	
6.0	**Professional Services**	%	20		**$ 1,197,119**	Land cost excluded
7.0	**Contingency**	%	25		**$ 1,496,399**	Land cost & professional services excluded
	Total Cost				**$ 9,589,113**	

NOTES

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Martinborough Full Land Discharge

Level of Accuracy: ± 25%

Stage	Description	Unit	QTY	Rate	Estimate	Comments
1.0	**Pond Optimisation**				**$ 275,000**	
1.1	Primary screening	LS	1	$ 125,000	$ 125,000	Pro-rata from past projects. Includes supply and installation of all mechanical equipment and construction of building to house screening works.
1.2	Increase waveband height by 0.5m	m3	300	$ 500	$ 150,000	Deatils provided in short term cost estimate.
3.0	**Land treatment (full discharge)**				**$ 4,045,700**	
3.1	Irrigation pumps, pump station and irrigation infrastructure	ha	60	$ 30,000	$ 1,800,000	Land requirement based on disposal of all flows to land between Dec - March, at rate of 3.5mm/d. It is assumed that no land purchases are required because the irrigation scheme will be located on SWDC-owned land (Pain Farm)
3.2	Storage ponds	m3	156 000	$ 11	$ 1,716,000	
3.3	Reticulation pump station	LS	1	$ 200,000	$ 200,000	Assumed lump sum cost.
3.4	Supply and install 125NB PE pipe	m	2 100	$ 157	$ 329,700	Based on Humes x 1.2 for install
	Sub-Total				**$ 4,320,700**	
	Professional Services	%	20		**$ 864,140**	Land cost excluded
	Contingency	%	25		**$ 1,080,175**	Land cost & professional services excluded
	Total Cost				**$ 6,265,015**	

NOTES

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Featherston Full Land Discharge

Level of Accuracy: ± 25%

	Description	Unit	QTY	Rate	Estimate	Comments
1.0	**Pond Optimisation**				**$ 200,000**	
1.1	Primary screening	LS	1	$ 200,000	$ 200,000	Pro-rata from past projects. Includes supply and installation of all mechanical equipment for inlet screening works.
2.0	**Land Treatment (Full Discharge)**				**$ 13,598,000**	
2.1	Acquire land for full discharge to land	ha	106	$ 25,000	$ 2,650,000	Land requirement based on disposal of all flows to land between Dec - March, at rate of 5mm/d.
2.2	Irrigation pumps, pump station and irrigation infrastructure for full discharge to land	ha	85	$ 30,000	$ 2,550,000	Assuming centre pivot system over 66ha with average application of 4.3mm/d over 108 day period. Includes soil moisture probe and control and filtration. Excludes harvesting equipment and any major earthworks for recontouring if required.
2.3	Storage for deferred irrigation	m3	709 000	$ 11	$ 7,799,000	Based on past projects. Includes pipework, inlet/outlet structures, earthworks, PE lining, testing and commissioning, access road, security fence and gate and reinstatement. Assumes storage pond is approx. 6m deep.
2.4	Reticulation pump station	LS	1	$ 200,000	$ 200,000	Assumed lump sum cost.
2.5	Supply and install 250ND PE pipe	m	1 000	$ 399	$ 399,000	Based on Humes x 1.2 for install.
	Sub-Total				**$ 13,798,000**	
	Professional Services	%	20		**$ 2,229,600**	Land cost excluded
	Contingency	%	25		**$ 2,787,000**	Land cost & professional services excluded
	Total Cost				**$ 18,814,600**	

NOTES

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APPENDIX 4

CARTERTON DC JOINT LAND DISPOSAL SCHEME DESIGN AND COST ESTIMATE

Live Path: R:\Projects\1250_Combined_Scheme_Review\400 Technical\450 Civil\[Land Disposal Scheme Design (formatted for printing).xlsx]IncludingCarterton
Original R:\Projects\1250_Combined_Scheme_Review\400 Technical\450 Civil\[Land Disposal Scheme Design (formatted for printing).xlsx]IncludingCarterton

Job Name:	South Wairarapa Combined Scheme Review		
Client:	SWDC	*Job No.*	1250
Prepared by:	YY	*Rev. & Date:*	1/07/2013
Checked by:	KB	*Rev. & Date:*	4/07/2013

IRRIGATION LAND REQUIREMENTS - DEFERRED IRRIGATION + STORAGE JOINT SCHEME + CDC

Combined Scheme + Carterton Design Criteria

Median daily flow	6309	m3/d
TN Load	64.1	kg/d
P Load	15.5	kg/d

Nutrient Loading Rates (kg/ha/yr)

Nitrogen	Phosphorus	Source
240	70	Average uptake values for ryegrass, from EPA Vic Guidelines for Wastewater Irrigation
150	60	Used by NZET in previous study
300	40	LEI Greytown report
500	130	Ave nutrient uptakes from NZ Land Treatment Collective Guidelines for utilisation of sewege effluent on land

Land and Storage Requirements

Scenarios based on assumed soil category (TP58 Soils 3-5)

		Scenario				
		A Good draining	B Moderate	C Slow-moderate	D Design	
Irrigation period	Months/ yr	5	5	5	5	
Application rate	mm/d	15	5	3.5	10.7	
Days in irrigation period	d	152	152	152	152	
Wind down time	d	4	4	4	4	Based on assumption that 2% of days each year have wind speeds > 12m/s.
Harvesting down time	d	35	35	35	35	Based on Taupo/ Masterton Land Application work. Assume 10 days / harvest and 5 harvests between September - March - this is approx. 35 days of downtime during the irrigation period (Nov-Mar)
Total days irrigating	d	113	113	113	113	
Area Required - hydrualics	ha	136	407	582	190	
Area Required - TN	ha	47	47	47	47	
Area Required - TP	ha	43	43	43	43	
Max area required	ha	136	407	582	190	
+ 25% extra for buffer/reserve	**ha**	**170**	**509**	**727**	**238**	
Storage Vol Required	m3	1,590,262	1,590,262	1,590,262	1,590,262	
Storage Vol Available in Existing Ponds	m3	61,500	61,500	61,500	61,500	Assume some of the existing pond volume can be used for storage, particularly at Greytown, Martinborough and Carterton
New Pond Storage Required	m3	1,528,762	1,528,762	1,528,762	1,528,762	
Area required for pond storage	**ha**	**30**	**30**	**30**	**31**	Assume the storage will be divided between the four existing treatment plants and a flow balancing pond will be built within the the irrigation buffer area (ie. minimising total amount of land required).
Total Land Area Required	**ha**	**170**	**509**	**727**	**238**	

Nutrient Balance	Range		Unit	Use	*Source*
Yield	15-20		t DM/ha/year	16	NZ Guidelines for utilisation of sewage effluent on land. Scion 2000.
Typical %N in grass		3.5	%		
Typical N uptake	500-600		kg/ha/yr	500	Chapter 6 (Jeff Morton, Mike O'Connor, Jean-Michael Carnus and Hailong Wang)
Typical P uptake	130-160		kg/ha/yr	130	Chapter 2 (Louise Bartin, Loius Schipper, Malcolm McLeod, Jackie Aislabie and Bob Lee)
Harvests required	3-5		times/year	5	
P retention in soil					Based on assumptions set out in LEI Greytown report
Storage capacity		300	mg/kg		Note storage capacity possibly lower in clayey Zone A soils
Storage depth		0.4	m		Assumed storage depth
Soil density		1.1	tonnes/m3		
Site lifespan		50.00	years		Assumed lifespan
Storage capacity		26.40	kg/ha/yr		
Max soil retention (over 50 yr lifespan)		1.32	t P/ha		

		Scenario			
		A	B	C	D
Irrigation area	ha	135.7	407.2	581.7	190.3
DM Yield	t DM/yr	2171.6	6514.8	9306.9	3044.3
N uptake	t/yr	67.9	203.6	290.8	95.1
N loading	t/yr	23.4	23.4	23.4	23.4
N loading > removal?	**Y/N**	**N**	**N**	**N**	**N**
P uptake	t/yr	17.6	52.9	75.6	24.7
P immobilised in soil	t/yr	3.7	11.2	16.1	16.1
P loading	t/yr	5.7	5.7	5.7	5.7
P loading > removal?	**Y/N**	**N**	**N**	**N**	**N**

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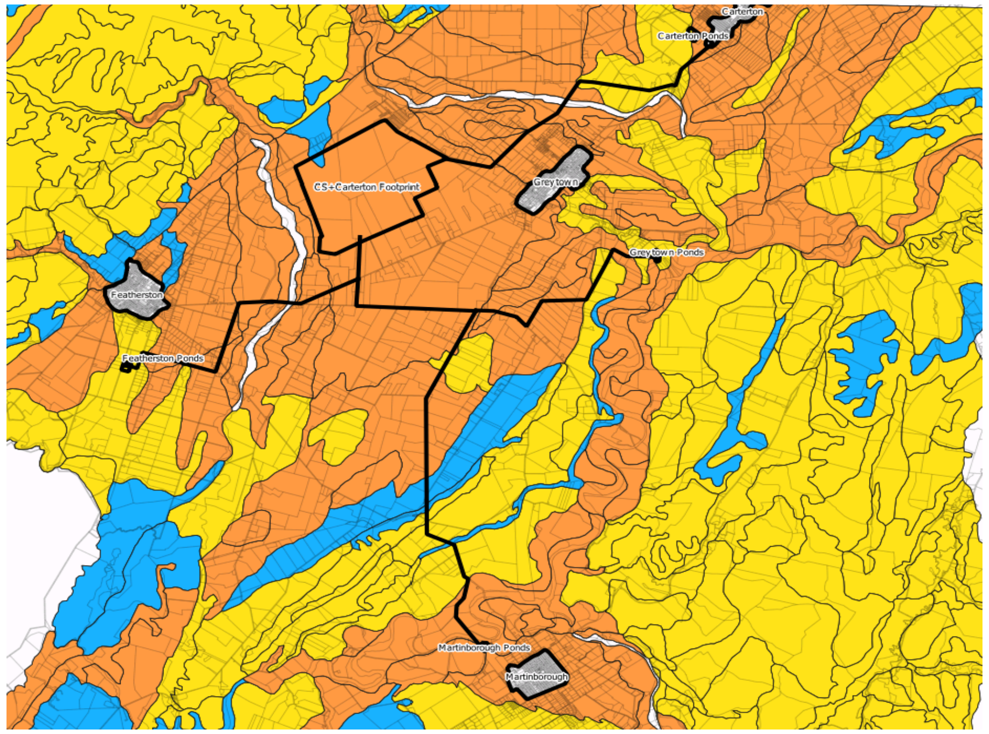
Job Name: South Wairarapa Combined Scheme Review
Client: SWDC
Job No. 1250
Prepared by: YY
Rev. & Date: 1/07/2013
Checked by: TM
Rev. & Date: 2/07/2013

RETICULATION TO INTEGRATED + CARTERTON SCHEME DISPOSAL AREA

Pipe ID	From	To	Distance (km)	Start Elevation	Maximum Elevation	ADF (m3/d)	Pump flow assuming all	Nominal velocity (m/s)	Diameter (mm)	Nominal dia (mm)	Actual velocity	Friction head	Static head	Design head	Comments
F01	Featherston	Trunk	8.4	19	52	2811	0.065	1	288	300	0.92	36.3	33	69.3	Follows SH2; 1 stream crossing
M01	Martinborough	G-M	11.5	20	48	653	0.015	1	139	160	0.75	62.1	28	90.1	Mostly on road, some crossing through private property and 2 stream crossings
G01	Greytown	G-M	6.5	38	53	845	0.020	1	158	160	0.97	58.8	15	73.8	
G-M01	G-M	Trunk	4	48	52	1498	0.035	1	210	200	1.10	37.3	4	41.3	
CS Trunk	Trunk	CS Inlet	1.3	52	56	4309	0.100	1	356	350	1.04	6.1	4	10.1	
C01	Carterton	CS Inlet 2	9.7	62	65	2000	0.046	1	243	250	0.94	52.8	3	55.8	



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Revision 10 July 2013

Job Name: Combined Scheme Review
Job No. 1250
Client: SWDC
Currency: NZD *Revision:*
Prepared by: YY *Date:* 30/05/2013
Checked by: TM *Date:* 2/07/2013

Combined Land Disposal Scheme Including Carterton

Level of Accuracy: ± 25%

	Description	Unit	QTY	Rate	Estimate	Comments
1.0	**Combined Deferred Irrigation Scheme**	-	-	-	**$ 28,480,000**	
1.1	Acquire land for irrigation scheme	ha	238	$ 25,000	$ 5,950,000	Total estimated land area required including 690ha for land application site and the balance as reserve/ buffer land.
1.2	Irrigation pumps, pump station and irrigation infrastructure	ha	190	$ 30,000	$ 5,700,000	Assuming centre pivot system over 690ha with average application of 5mm/d over 108 day period. Includes soil moisture probe and control and filtration system. Excludes harvesting equipment and any major earthworks for recontouring if required.
1.3	Construct storage pond	m3	1530 000	$ 11	$ 16,830,000	Based on past projects. Includes pipework, inlet/outlet structures, earthworks, PE lining, testing and commissioning, access road, security fence and gate and reinstatement. Assumes storage pond is approx. 6m deep.
2.0	**Reticulation**				**$ 17,436,600**	
2.1	Supply and install pipes to SWDC standards, including bedding, trenching and testing.					
	160ND PE pipe.	m	18 000	$ 255	$ 4,590,000	Based on Humes x 1.2 for install
	200ND PE pipe.	m	4 000	$ 319	$ 1,276,000	Based on Humes x 1.2 for install
	250ND PE pipe.	m	9 700	$ 399	$ 3,870,300	Based on Humes x 1.2 for install
	300ND PE pipe.	m	8 400	$ 479	$ 4,023,600	Based on Humes x 1.2 for install
	350ND PE pipe.	m	1 300	$ 559	$ 726,700	Based on Humes x 1.2 for install
2.2	Pump Stations					
	For rising mains <2km	LS	1	$ 200,000	$ 200,000	Assumed lump sum costs. Larger rising mains require greater pumping infrastructure. It is assumed that two pump stations would be needed for the Martinborough rising main given the large pumping distance.
	For rising mains 2-5km	LS	1	$ 250,000	$ 250,000	
	For rising mains 5-10km	LS	5	$ 500,000	$ 2,500,000	
3.0	**Martinborough Pond Upgrades**				**$ 275,000**	
3.1	Primary screening	LS	1	$ 125,000	$ 125,000	Pro-rata from past projects. Includes supply and installation of all mechanical equipment for inlet screens. Excludes building.
3.2	Waveband upgrade	LS	1	$ 150,000	$ 150,000	
4.0	**Greytown Pond Upgrades**				**$ 2,362,695**	
4.1	Pond sludge survey, removal and disposal	t	23	$ 10,500	$ 239,715	Based on removal of 22,830m3 of sludge at 5% solids. Cost includes dredging and placing in geobags. Does not include ancillary site works required for desludging or disposal of geobags. Costs pro-rata from past projects.
4.2	Increase bund height	LS	1	$ 1,637,980	$ 1,637,980	Detailed costing provided in Short term cost estimates
4.3	Primary Screening	LS	1	$ 125,000	$ 125,000	Pro-rata from past projects. Includes supply and installation of all mechanical equipment for inlet screens. Excludes building.
4.4	UV Disinfection	LS	1	$ 360,000	$ 360,000	Detailed costing provided in Short term cost estimates
5.0	**Featherston Pond Upgrades**				**$ 125,000**	
5.1	Primary screening	LS	1	$ 125,000	$ 125,000	Pro-rata from past projects. Includes supply and installation of all mechanical equipment for inlet screens. Excludes building.
	Sub-Total				**$ 48,679,295**	
6.0	**Professional Services**	%	20		**$ 8,545,859**	Land cost excluded
7.0	**Contingency**	%	25		**$ 10,682,324**	Land cost & professional services excluded
	Total Cost				**$ 67,907,478**	

NOTES

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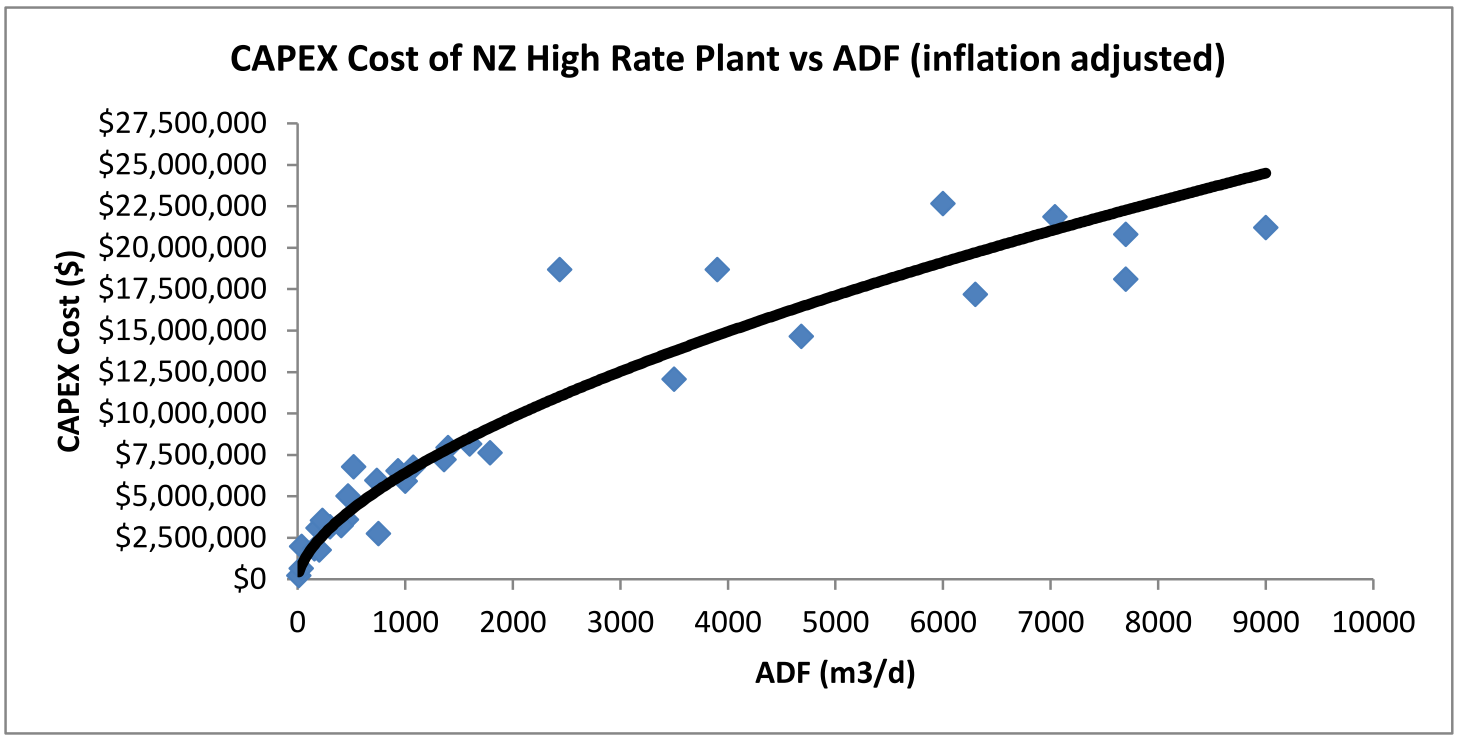
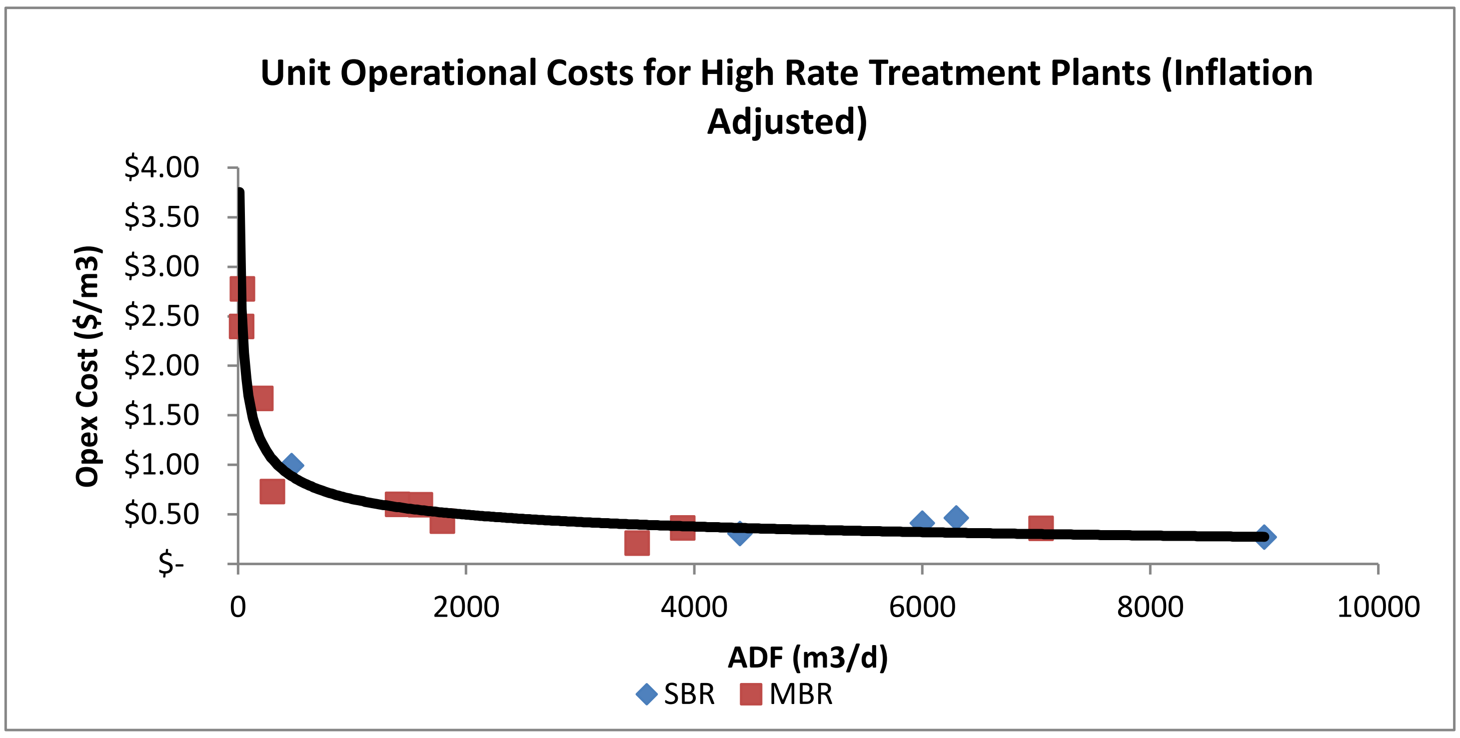
APPENDIX 5

HIGH RATE TREATMENT PLANT COST ESTIMATES

High Rate Treatment Plant Cost Curves





Live Path: R:\Projects\1250_Combined_Scheme_Review\400 Technical\450 Civil\[130611 Treatment plant schemes inc cost estimates. V2.xlsx]Integreated-Reticulation
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Job Name: South Wairarapa Combined Scheme Review
Client: SWDC
Prepared by: YY
Checked by: TM

Job No. 1250
Rev. & Date: 25/06/2013
Rev. & Date: 2/07/2013

This information has been prepared for the benefit of SWDC.
No reliability is accepted by this company or any employee or sub-consultant of this company with respect to its use by another person.

RETICULATION TO INTEGRATED TREATMENT PLANT

Pipe ID	From	To	Distance (km)	Start Elevation	Maximum Elevation	AWWF - influent (m3/d)	Peak flow assuming max 10 pump starts per hr and 3 min pump runs (L/s)	Static head	Nominal Pump	Pump flow (L/s)	@ head (m)
F01	Featherston	F-M	15	19	50	4669	108.079	31	CS 3240	106.2	117
M01	Martinborough	F-M	12.3	20	52	1106	25.602	32	NS 3315	26	82
F-M01	F-M	G	2.9	41	44	5775	133.681	3	cs 3231	129.3	18.8

From	To	Nominal vel (m/s)	Calculated dia (mm)	Nominal dia (mm)	Actual vel at peak flow (m/s)	ADF (m3/d)	Actual vel at average flow (m/s)	Friction head	Actual head	
Featherston	F-M	1.00	367.7	350.0	1.1	2711.0	1.10	79.8	110.8	
Martinborou	F-M	1.00	181.9	180.0	1.0	653.0	1.02	109.1	141.1	Two PS required
F-M	G	1.00	405.7	400.0	1.0	3364.0	1.03	11.7	14.7	

COST ESTIMATE

Integrated High Rate Treatment Plant

Level of Accuracy: ± 25%

	Description	Unit	QTY	Rate	Estimate	Comments
1.0	**High Rate Treatment Plant**	-	-	-	**$ 12,750,000**	
1.1	High rate treatment plant (SBR or MBR)	LS	1	$ 12,750,000	$ 12,750,000	Based on cost curve and averge daily flow of 4155m3/d. It is assumed the treatment plant can be sited on existing SWDC land eg. Greytown WWTP.
2.0	**Reticulation**				**$ 16,015,300**	
2.1	Supply and install pipes to SWDC standards, including bedding, trenching and testing.					Reticulation is for rising mains from Featherston and Martinborough to the Greytown WWTP site. Pipe unit costs based on Humes rates x 1.2 for install. It is noted that PN16 PE or other materials (eg. steel) may be required, particularly for the very long distance rising mains.
	180ND PN12.5 PE pipe	m	12 300	$ 287	$ 3,530,100	Pipe from Martinborough. Hydraulic analysis indicates that two pump stations will be required because of the long distance and high friction head.
	350ND PN12.5 PE pipe	m	15 000	$ 559	$ 8,385,000	Pipe from Featherston.
	400ND PN12.5 PE pipe	m	2 900	$ 638	$ 1,850,200	Inlet pipe with flows from Featherston and Martinborough.
2.2	Pump Stations					
	For rising mains 2 - 5km	LS	1	$ 250,000	$ 250,000	Assumed lump sum costs. Larger rising mains require greater pumping heads and hence larger pumps/ pump station infrastructure.
	For rising mains 5 - 10km	LS	2	$ 500,000	$ 1,000,000	
	For rising mains >10km	LS	1	$ 1,000,000	$ 1,000,000	
3.0	**Works at Existing WWTPs**				**$ 600,000**	
3.1	Primary screening works and associated reticulation to pump station	No	3	$ 200,000	$ 600,000	Pro-rata from past projects. Includes supply and installation of screening works (excluding building). It is noted that works associated with decommissioning the existing ponds has not been included.
	Sub-Total				**$ 29,365,300**	
4.0	**Professional Services**	%	20		**$ 5,873,060**	
5.0	**Contingency**	%	25		**$ 7,341,325**	
	Total Cost				**$ 42,579,685**	

NOTES

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Live Path: R:\Projects\1250_Combined_Scheme_Review\400 Technical\450 Civil\[Copy of 130611 Treatment plant schemes inc cost estimates. V3.xlsx]Stand Alone Treatment Capex
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Revision

6 August 2013

AWT H2knOw-how

Job Name: Combined Scheme Review
Job No. 1250
Client: SWDC
Currency: NZD *Revision:*
Prepared by: YY *Date:* 1/07/2013
Checked by: SS *Date:* 6/08/2013

Featherston High Rate Treatment Plant

Level of Accuracy: ± 25%

	Description	Unit	QTY	Rate	Estimate	Comments
1.0	**Featherston**	-	-	-	**$ 10,612,833**	
1.1	Reticulation pump station	LS	1	$ 500,000	$ 500,000	Assumed lump sum.
1.2	High rate treatment plant (SBR or MBR)	LS	1	$ 9,833,333	$ 9,833,333	Based on cost curve and ADF of 2721m3/d. This includes primary screening works. Excludes decommissioning of the existing ponds.
1.3	350ND PN12.5 PE Pipe	m	500	$ 559	$ 279,500	Estimated distance.
	Sub-Total				**$ 10,612,833**	
4.0	**Professional Services**	%	20		**$ 2,122,567**	
5.0	**Contingency**	%	25		**$ 2,653,208**	
	Total Cost				**$ 15,388,608**	

Martinborough High Rate Treatment Plant

Level of Accuracy: ± 25%

	Description	Unit	QTY	Rate	Estimate	Comments
2.0	**Martinborough**				**$ 4,126,833**	
2.1	Reticulation pump station	LS	1	$ 150,000	$ 150,000	Assumed lump sum.
2.2	High rate treatment plant (SBR or MBR)	LS	1	$ 3,833,333	$ 3,833,333	Based on cost curve and ADF of 574m3/d. This includes primary screening works. Excludes decommissioning of the existing ponds.
2.3	180ND PN12.5 PE Pipe	m	500	$ 287	$ 143,500	Estimated distance.
	Sub-Total				**$ 4,126,833**	
4.0	**Professional Services**	%	20		**$ 825,367**	
5.0	**Contingency**	%	25		**$ 1,031,708**	
	Total Cost				**$ 5,983,908**	

Greytown High Rate Treatment Plant

Level of Accuracy: ± 25%

	Description	Unit	QTY	Rate	Estimate	Comments
3.0	**Greytown**				**$ 5,176,833**	
3.1	Reticulation pump station	LS	1	$ 200,000	$ 200,000	Assumed lump sum.
3.2	High rate treatment plant (SBR or MBR)	LS	1	$ 4,833,333	$ 4,833,333	Based on cost curve and averge daily flow of 860m3/d. This includes primary screening works. Excludes decommissioning of the existing ponds.
3.3	180ND PN12.5 PE Pipe	m	500	$ 287	$ 143,500	Estimated distance.
	Sub-Total				**$ 5,176,833**	
4.0	**Professional Services**	%	20		**$ 1,035,367**	
5.0	**Contingency**	%	25		**$ 1,294,208**	
	Total Cost				**$ 7,506,408**	

NOTES

The above costs do not include GST and are a best estimate at the time of pricing. No allowance has been made for inflation, currency and commodity fluctuations and other factors unknown at the time. These costs have been prepared for the Project & Client listed above based on the project described to us and its extent is limited to the scope of work agreed between the client and AWT Water. No responsibility is accepted by AWT Water or its directors, servants, staff or employees for the accuracy of information provided by third parties and/or the use of any part of these costs in any other context or for any other purposes. These costs do not include the following services which cannot be quantified at this time; Geotechnical Investigations, Surveying, Feasibility Studies & Fast Tracking.

APPENDIX 6

INFLOW AND INFILTRATION SENSITIVITY ANALYSIS SPREADSHEET OVERVIEW

Job Name:	South Wairarapa Combined Scheme Review		
Client:	SWDC	*Job No.*	1250
Prepared by:	YY	*Rev. & Date:*	14/06/2013
Checked by:	MU	*Rev. & Date:*	21/06/2013

OVERVIEW OF I/I ANALYSIS SPREADSHEET - WORKING DRAFT

Inflow and infiltration has been identified to be a significant issue in the South Wairarapa District wastewater network.
High I/I can affect the cost of treatment and disposing of wastewater because of the following impacts:
- Larger reticulation pipework required to convey high peak flows (or increased risk of overflows if pipes are undersized);
- Larger pond volumes required to provide storage and flow balancing;
- Greater treatment capacity and operational costs to provide sufficient treatment of flows during high flow, or else a larger proportion of flows must be bypassed and discharged without treatment (increasing risk of non-compliance with effluent quality limits);
- Greater land, storage and irrigation infrastructure required to fully discharge wastewater to land.

This I/I Analysis Spreadsheet has been developed to assess the sensitivity of proposed long-term treatment and disposal options to