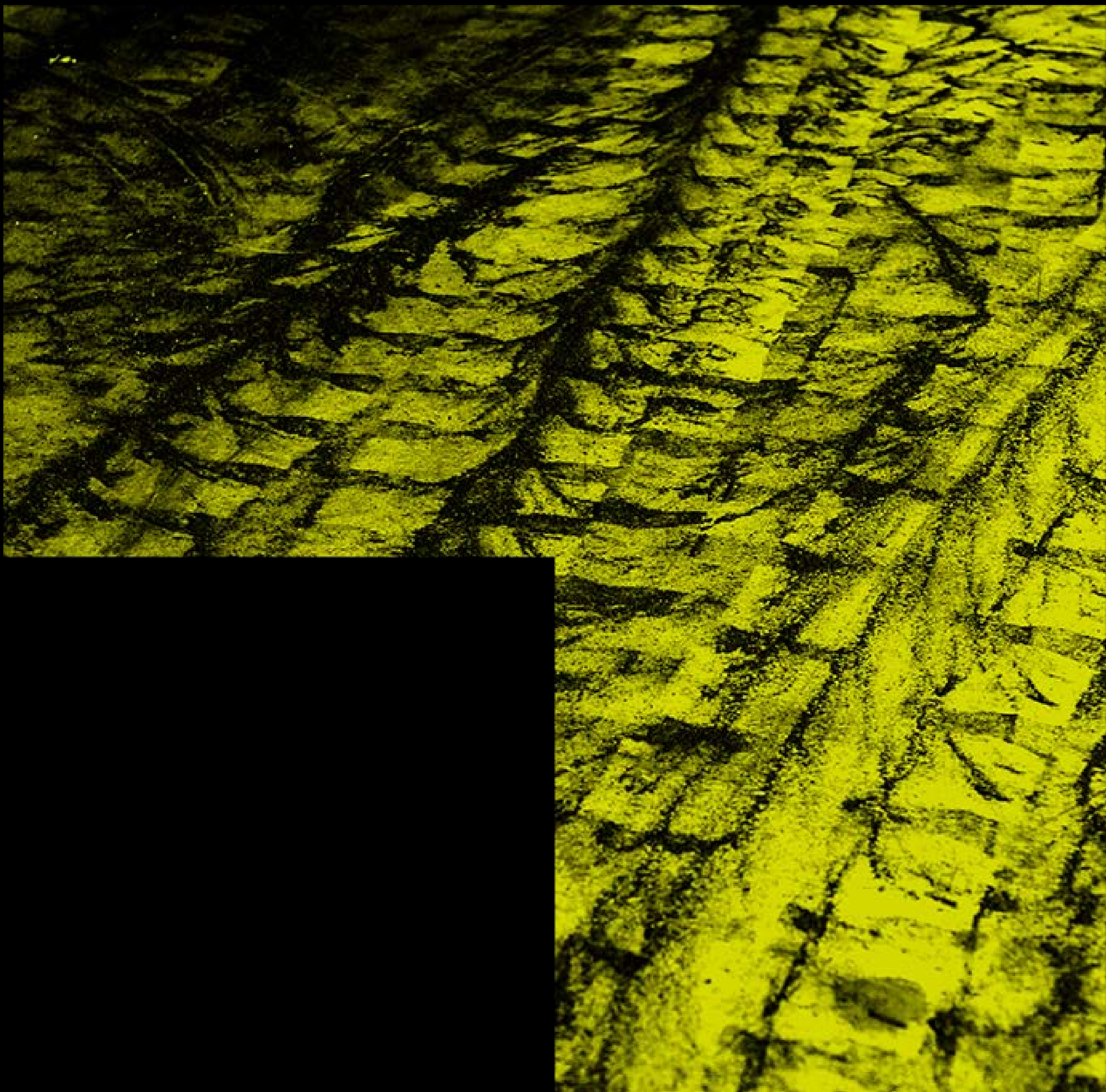
STRATFORD WWTP Land Disposal Options

Stratford District Council



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1.0	03/16	Client Review	TJM	AMS	
2.0	04/16	Final	TJM	AMS	AMD

CONTENTS

EXECUTIVE SUMMARY

In response to the application for the renewal of resource consent #0196-4, Taranaki Regional Council have requested additional information on alternative disposal options for the Stratford Wastewater Treatment Plant.

This is a high level study and not meant to be a detailed investigation report.

OPTIONS CONSIDERED

To minimise the nutrient load on the Patea River, a range of land disposal schemes were considered, along with disposal via a constructed wetland, as requested by TRC. A previous report, *Issues and Options* (2015) has addressed effluent quality upgrades.

COMPARISON OF OPTIONS

As the majority of the options considered in this report were land disposal based options, there is a strong correlation between cost and load reductions.

Total land disposal provides the greatest potential load reductions but has a high cost and risks associated with it. Cost may be reduced through a partial disposal to land scheme, but the potential for reductions will be decreased.

CONCLUSIONS

Based on the high cost of the options considered in this report and the limited availability of funding, Stratford District Council are likely to implement treatment upgrades as discussed in the resource consent renewal application.

1.0 INTRODUCTION

The Stratford Wastewater Treatment Plant is situated approximately 1.5km to the west of Stratford. It receives municipal wastewater from approximately 2,500 connections in the township. The plant consists of an oxidation pond, a maturation pond and associated inflow and outflow structures. The plant is bordered by the Patea River to the north, Victoria Road to the south, Council owned reserve to the east, and privately owned land to the west.

Stratford Wastewater Treatment Plant operates under a consent (#0196-4) authorising discharge of treated effluent to the Patea River, which expires on the 1st June 2016. An application for the renewal of the consent was submitted to Taranaki Regional Council (TRC) in November 2015. A letter from TRC dated 18 February 2016 has requested further information into alternative disposal methods, specifically discharge of treated effluent to land.

This report provides a high level comparison between different land disposal schemes and is not meant to be a detailed investigation report.

2.0 BACKGROUND

2.1 HISTORY

The previous consent (#0196-3) was granted in April 2008 on the condition that upgrades were carried out on the plant by June 2009. A report, *Issues and Options,* was also requested, to be completed by June 2012. It was later agreed upon between TRC and Council that this would be undertaken in two stages: an ecological study, followed by evaluation of options based on the study. The ecological study recommended a further 18 months of study, which concluded in April 2014. As this consent expired on June 1, 2013 this condition was carried forward into the renewed consent. This was completed by HG in October 2015[1].

2.2 ISSUES AND OPTIONS REPORT

The report determined that the plant performs to an acceptable level within its original design, and is generally compliant with the consent. Details pertaining to the plants performance, effects on the receiving environment and areas where improvements can be made are summarised below.

2.2.1 PLANT PERFORMANCE

The reticulation network suffers from significant inflow and infiltration which under high flow conditions, exceeds the capacity of the plant. This is reflected in the influent flow data, taken via a flume and ultrasonic flow meter, which is often inundated in high flow scenarios.

Prior to flow measurement, the wastewater is screened using a step screen, installed in 2009 as part of the required upgrades. Screenings are collected in a sealed bin before disposal offsite.

[1] Stratford WWTP, Issues and Options; *Harrison Grierson, 2015*

Pond 1 is a facultative pond and provides primary treatment of the wastewater. It has a retention time of approximately 11 days under average flows, which reduces to an approximately 1.8 days under high flow conditions. With the installed aerators, the pond has sufficient treatment capacity to adequately treat the TKN and BOD content of the wastewater.

Pond 2 is a maturation pond which provides pathogen removal of the wastewater. The pond is partitioned into three cells through rock partitions installed in 2009-2010. The pond provides pathogen reduction through the use of UV light, and achieves an approximate three log reduction from typical influent concentrations, in line with that expected from typical maturation ponds of this size.

Post Pond 2, a rock riprap structure is used to provide land contact for the treated effluent prior to discharge.

Final effluent quality is generally acceptable for the plant design, however unexplained spikes in total nitrogen, total phosphorous and ammonia have been observed. As no additional growth is expected in the Stratford region over the next 15 years, no upgrades are required for capacity purposes.

2.2.2 ASSESSMENT OF ENVIRONMENT EFFECTS

An ecological report[2] was prepared based on the finding of four annual monitoring reports completed by TRC. The report determined that the Stratford WwTP is contributing to periphyton growth, but that reducing the load from the plant may not have an effect on the growth as upstream levels already exceed water quality levels required to reduce growth.

The study on the macroinvertebrates concluded that the discharge appears to be having a relatively benign effect on the macroinvertebrate downstream of the plant.

With regard to the National Standards from the National Objective Framework and the Taranaki Regional Draft Standards, the effluent from the WWTP doesn't meet all in-stream guideline values, but after reasonable mixing all are within the guideline values downstream.

2.2.3 OBJECTIVES OF UPGRADES

The report determined that any upgrades should focus on reducing the effects on periphyton growth and macroinvertebrates. This should be achieved through upgrades that will increase the nitrogen and phosphorus treatment of the plant, reducing the nutrient concentrations in the plant effluent.

3.0 ALTERNATIVE DISPOSAL OPTIONS

The objective of the upgrades is to minimise the effects on the receiving environment through the reduction of nutrient concentrations in the effluent to the Patea River. This objective of decreasing the nutrient loads can be achieved through the use of alternative disposal schemes for the treated effluent. Options considered in this report are:

- Partial Disposal to other receiving environments
- Total discharge to land

[2] Stratford Waste Water Treatment Plant, Ecological Assessment of Effects on the Patea River; *Brian T. Coffey and Associated Limited, 2015.*

- Disposal via a constructed wetland

3.1 BASIS OF DESIGN

This investigation has been undertaken using data previously collected, analysed and used as the basis of other reports including the *Issues and Options* report and the resource consent application. Due to errors in recording the flowrate early in the data supplied, the initial period of the data was disregarded to allow for accurate sizing of the land disposal options. Land disposal systems should be sized based on effluent data as the pond system may allow for buffering of peak flows. Council have not historically recorded this, and therefore no effluent flow data is available.

The raw data appears to have measurement error, continuously recording the maximum readable value of approximately 19,000 m^3/day during the period of October 2009 – August 2010. To ensure that the options investigated are not oversized and to better reflect the cost of each option, the data for this period was removed before analysis began. The remaining data covered a period of approximately 4.5 years, and is presented below on Figure 1 and summarised on Table 1:

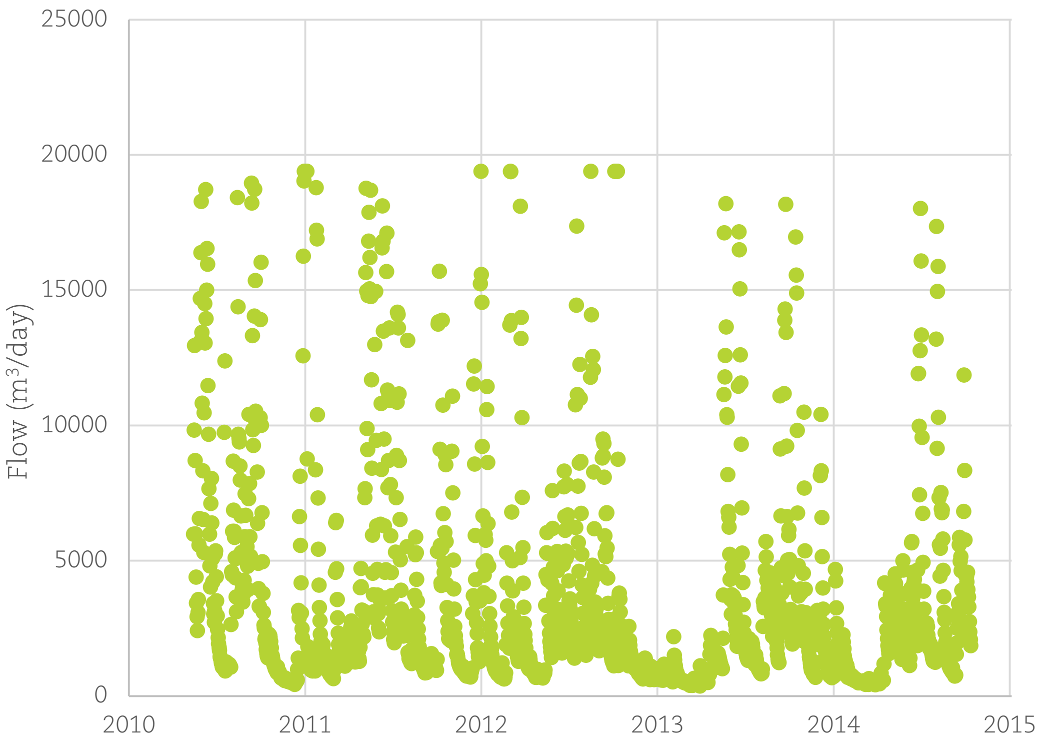

FIGURE 1 : INFLUENT FLOW DATA

TABLE 1: INFLUENT FLOW DATA

PARAMETER	FLOW (m^3)
Minimum	370
Median	2,000
Mean	3,700
90^{th} Percentile	9,700
Maximum	19,400

3.2 TOTAL LAND DISPOSAL

In this option all treated effluent is disposed to land. The most viable form of land disposal is generally via land irrigation, either with above or in ground irrigators.

The suitability of land for disposal is dependent on many factors, including the topography of the land in the proposed disposal area, the permeability of the ground and proximity to water courses.

Disposal to land has potential cultural benefits over discharge to water and may provide additional natural reduction in nutrient loads discharged to the final receiving environment. However, the effluent may still flow subsurface to waterways, and hence investigations into the probability, extent and effects of this will be required once prospective land has been identified.

Effluent could be used for irrigation to land which is cropped however care should be taken with any restrictions on the use of the harvested crops as stock feed.

Under wet weather conditions the land can become too saturated for disposal of the treated effluent. During this time, treated effluent is stored in some form of short term storage. Once the weather permits, irrigation of stored effluent can be resumed.

3.2.1 SCHEME INVESTIGATION

To provide the greatest benefit at a minimum cost, a basic model was produced for the scheme. The following assumptions were used in the model:

- Average ground conditions. With a loading rate of 4mm/day for the disposal field.
- 30% buffer area for the disposal field to allow for separation from water ways and any land unsuitable for disposal which may be present in the land parcel.
- Disposal only when the day's rainfall is <10mm.
- The approximate 4 year period for which data is supplied is representative of all foreseeable flow scenarios.
- The scheme should give consideration to the maximum flows, successive days of maximum flows and be capable of balancing them.
- There should be no overflow from the reservoir.

Using the available flow data and rainfall data (NIWA) over the same period a disposal area of 210ha and a reservoir volume of 300,000 m^3 is required. Assuming a pond of 2.5m depth was created for the reservoir, the total land required would be approximately 290ha (including disposal area, buffer area, and pond area).

A total land disposal scheme with these characteristics could be expected to cost $61m to $92m (-10%/+35%) and have an annual operating cost of $570,000 to $850,000. Operating costs are based on a $/ha for a similar sized scheme, and no assessment of potential revenue has been investigated or incorporated.

In assessing the costs of a land disposal system, it has been assumed that the disposal field will be within 10km of the existing plant. This allows for some indicative costs to be attributed to reticulation pipeline and pumping infrastructure, and land acquisition. Land has been assumed to be $45,000 a hectare. There are risks associated with Council being unable to locate sufficient land within a reasonable distance from the existing treatment plant which may lead to substantial costs in addition to those above.

3.3 PARTIAL LAND DISPOSAL

Due to the high cost of a full land disposal system, a partial land disposal system may be more viable by lowering the total land required and hence cost. In this option a portion of the effluent is discharged to land with the remainder of the flow continuing to be disposed to water. This may lower the total load on the river depending on the location of the disposal field and retention times within the soil profile.

The following assumptions were made:

- Average ground conditions. With a loading rate of 4mm/day for the disposal field.
- 30% buffer area for the disposal field to allow for separation from water ways and any land unsuitable for disposal which may be present in the land parcel.
- A maximum daily flow to the field of 5,000m^3 to allow some contingency above the average flow. This equates to 78^{th} percentile flow.
- Disposal only when the day's rainfall is <10mm.
- When rain prohibits land disposal, all effluent is discharged to the river.
- Storage not allowed for.

The above assumptions would require a disposal field of 165ha including buffer zone. Using the inflow and rain data, river disposal would be reduced to approximately 30% of the year (including days where wet weather prohibits land disposal, and days where the effluent flow exceeds the land disposal capacity). On the days when river disposal is required (high rainfall or excess effluent flow) an average of 5,750m^3/day of effluent would be disposed to the river. Over the course of the year, approximately 50% of the total annual flow would be redirected to land disposal.

In absence of detailed effluent concentrations during periods of high flows, the average concentrations have been assumed. The flow reduction would therefore result in a 50% reduction in loads to the river, as is presented on Figure 2 below. Because no analysis into the effluent concentrations under high flow conditions has been undertaken, average concentrations have been used. As a result the loads on the river presented below may not be representative of those actual observed if such scheme is selected.

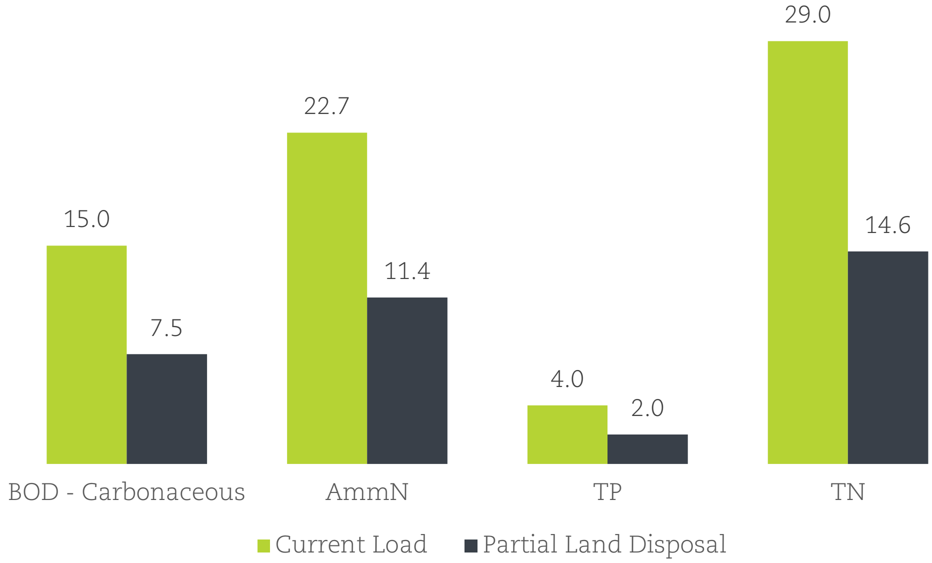

FIGURE 2 : PARTIAL LAND DISPOSAL RIVER LOADS (t/y)

A partial land disposal scheme with these characteristics could be expected to cost $24m to $37m (-10%/+35%) and have an annual operating expenditure of $340,000 to $510,000.

This capital expenditure allows for some reticulation costs and land acquisitions costs, similar to the Total Land Disposal option. Operating costs are based on a $/ha for a similar sized scheme, and no assessment of potential revenue has been investigated or incorporated.

3.4 DISPOSAL TO ADJACENT COUNCIL LAND

An assessment on the feasibility of the adjacent reserve (east of the ponds) and it's suitability for land disposal was undertaken by Earthtec[3] in November 2015. Two disposal options were considered:

- Shallow Drip Lines
- Deep Infiltration trenches

A map presenting the land deemed usable is attached in Appendix 2.

Generally deep infiltration trenches have greater disposal capacity than shallow drip lines. However, it was determined that both options had comparable disposal volumes of 100m^3/day as the deep infiltration trenches were restricted by the geology:

> *The above Darcy calculation indicates that the gravelly sand layers have a hydraulic capacity of about 100m^3/day. The limited capacity is primarily due to the restricted thickness (h=0.6m) of the gravelly sands.*

With the data investigated, disposal to the adjacent reserve could be undertaken 80% of the year (imposing a no disposal with >10mm rainfall). At a maximum 100m^3/day when suitable, the scheme would achieve an estimated reduction of 2% of the total annual flow to the river. This reduction is presented on Figure 3 below.

[3] **RE**: Preliminary Assessment of Ground Disposal Options for Stratford WwTP Effluent; *Earthtec, 2015*

A disposal scheme to the adjacent reserve could be expected to cost $900,000 to $1.3m, and have an annual operating cost of approximately $9,000 to $14,000.

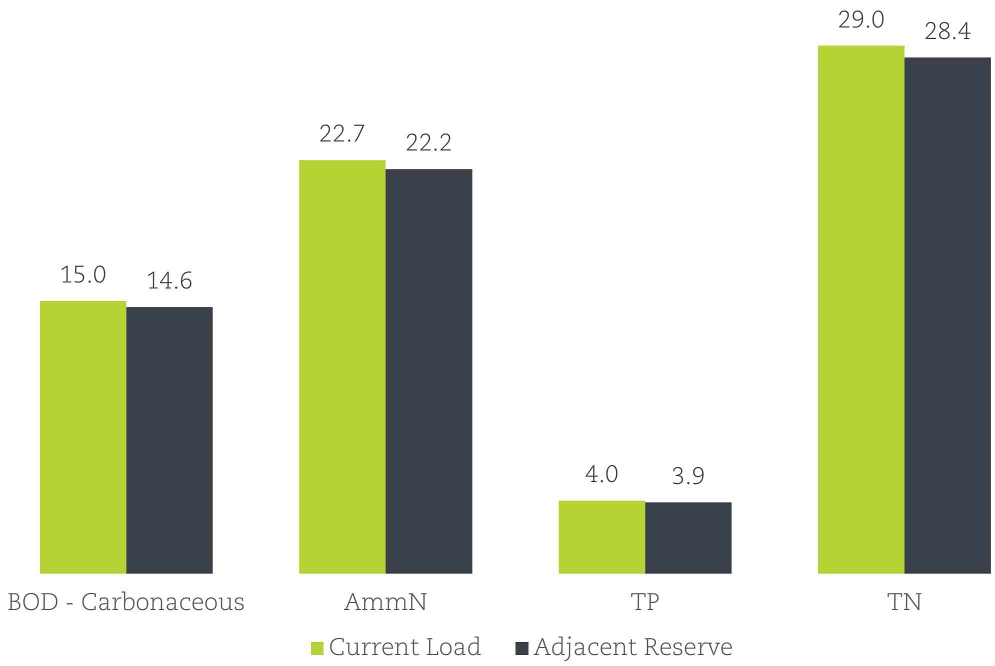

FIGURE 3 : DISPOSAL TO THE ADJACENT RESERVE RIVER LOADS (t/y)

3.5 DISCHARGE TO CONSTRUCTED WETLAND

Under this scheme, a free water surface wetland would be constructed with effluent from Pond 2 flowing to the wetland prior to disposal to the Patea River.

The constructed wetland may provide additional polishing of the treated effluent prior to discharge, and may reduce the nutrient concentration of the effluent.

A high level design has been undertaken assuming that wetlands could be constructed in the adjacent reserve, with polishing and treatment calculations based on industry accepted procedures[4]. This will minimise the capital expenditure of the scheme, but may limit any potential treatment capacity of the system.

It is assumed that two cells would be constructed each with approximately a days' retention time. This allows for 2 days retention time under normal operation while allowing for some treatment should maintenance be required in one of the cells.

Earthworks would be required to create the basins in which the wetland cells would be created. These basins would then be lined and partially filled with topsoil before planting suitable wetland plants.

Calculations on concentrations have been carried out based on first order reductions, with the influent and effluent concentrations presented below on Table 2.

[4] Natural Wastewater Treatment Systems, *Crites, Ronald W.; Middlebrooks, E. Joe; Reed, Sherwood C.*; 2006

TABLE 2: CONSTRUCTED WETLAND POTENTIAL EFFLUENT QUALITY (THEORETICAL)		
	POND 2 EFFLUENT	**WETLANDS EFFLUENT**
BOD_5 – Carbonaceous	11.2	8.4
Ammoniacal Nitrogen	17	13.5
Total Nitrogen	20.2	16.0
Total Phosphorus	3	2.5

It should be noted that these calculations may overstate the treatment of the wetlands. Wetlands are also commonly observed to increase the bacteriological count and turbidity of the effluent due to the presence of birds. However, assuming these concentrations are obtainable, the potential load reductions are presented below on Figure 4.

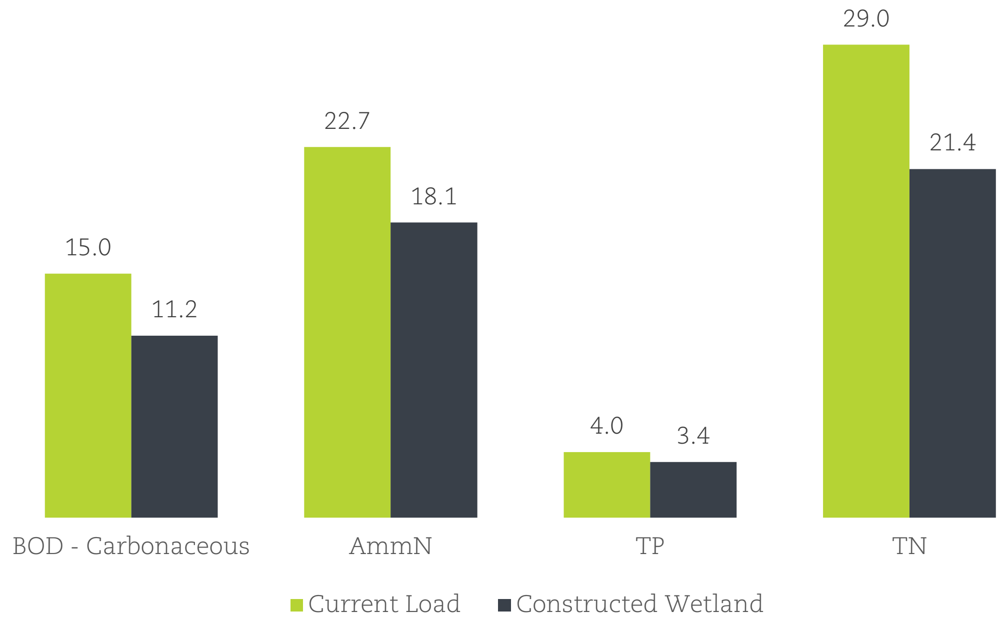

FIGURE 4 : CONSTRUCTED WETLAND LOAD REDUCTIONS

The capital costs of such a scheme is expected to be $2.1m to $3.2m (-10% to +35%) and have an annual operating cost of approximately $22,000 to $34,000. Operating expenditure for the wetland system is based on expected operator time, and an allowance for plant replacement

4.0 SUMMARY OF OPTIONS

Four options were investigated for alternative disposal methods from the Stratford WwTP. A comparison of the costs, their potential for reduction of loads to the river and their cost effectiveness is detailed below.

There is a significant variation in cost between the four options investigated, summarised on Table 3 below. These costs do not include any upgrades to the existing system should they be required in addition to any of these options as part of the renewed resource consent.

TABLE 3: DISPOSAL OPTIONS COST SUMMARY				
	CAPITAL EXPENDITURE		OPERATING EXPENDITURE	
DISPOSAL SCHEME	-10%	+35%	-10%	+35%
Total Land Disposal	$61,100,000	$91,700,000	$570,000	$850,000
Partial Land Disposal	$24,500,000	$36,700,000	$340,000	$510,000
Adjacent Reserve	$880,000	$1,300,000	$9,000	$14,000
Constructed Wetland	$2,200,000	$3,200,000	$23,000	$35,000

Options requiring land acquisition (Total Land Disposal and Partial Land Disposal) are generally the most expensive due the high cost of acquiring the land. Reuse of existing land adjacent to the reserve minimises costs but is restricted in size.

As a result, total land disposal, which requires the greatest land acquisition, is the most expensive option with a capital expenditure of $61m to $92m. This is then followed by partial land disposal requiring lesser land, then Disposal to the Adjacent Reserve and Constructed Wetland which have both assumed no land acquisition is required.

4.2 REDUCTIONS OF LOADS

Of the four options investigated, three use an alternative receiving environment in place of the Patea River. In these options no change in the WwTP effluent concentrations is expected. Instead load reductions are obtained through decreased flows to the river, with the balance being sent to a land disposal scheme.

Land disposal options may provide additional cultural benefits over water discharge options, however detailed investigations are required to confirm the feasibility of any potential land. As there is potential for the effluent to migrate subsurface to nearby waterways, the report should cover this to ensure that the final receiving environment is indeed not the river.

4.3 COST EFFECTIVENESS

Costs presented are largely dependent on the land area required, and hence there is a strong positive correlation between load reductions and cost.

20 year NPV's are presented below in Table 4 to allow consideration to be given to both capital and operating costs when evaluating against the potential load reduction. The following assumptions have been used in calculating the NPV:

- 3% annual inflation
- 6% discount rate

TABLE 4: 20 YEAR NPV OF OPTIONS	
OPTION	20 YEAR NPV
Total Land Disposal	$77,500,000
Partial Land Disposal	$32,500,000
Disposal to the Adjacent Reserve	$1,150,000
Constructed Wetland	$2,800,000

Figure 5 and Figure 6 below present a comparison between cost and annual nutrient load on the river for the options investigated.

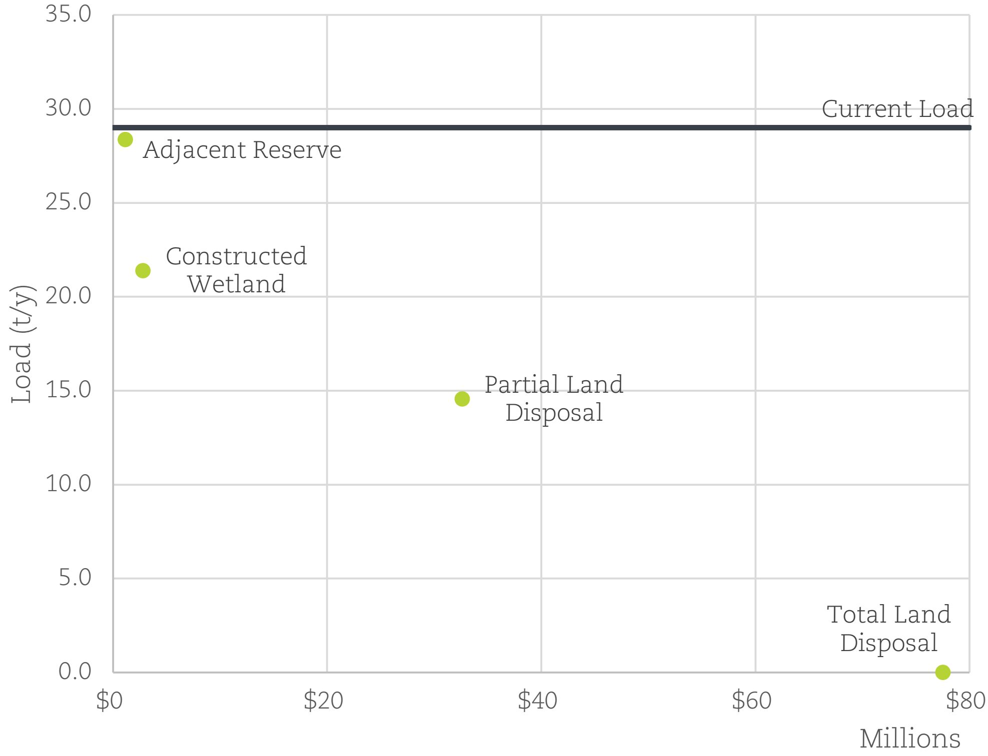

FIGURE 5 : TOTAL NITROGEN LOAD SUMMARY ON PATEA RIVER

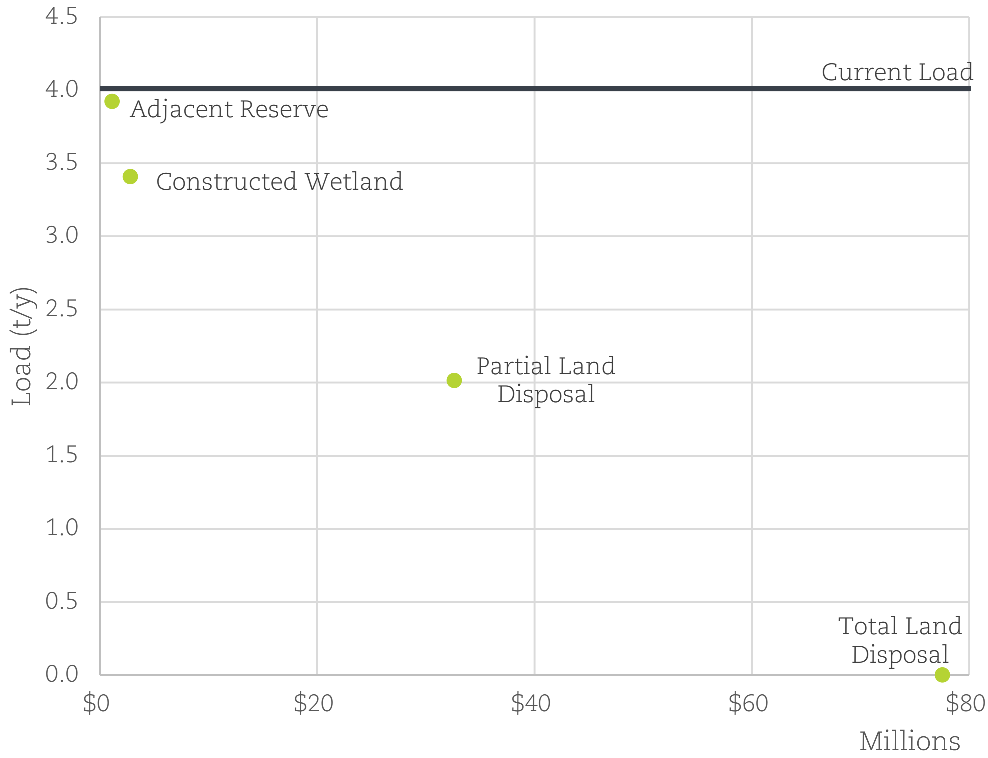

FIGURE 6 : TOTAL PHOSPHORUS LOAD SUMMARY ON PATEA RIVER

While the Total Land Disposal Option may provide the greatest reduction of loads, potentially removing them altogether, it is the most expensive option. In addition to this further detailed studies are also required to assess the risk that treated effluent may flow subsurface to waterways. Due to the high cost, it is unlikely that this option is the best use of any available funds.

Partial Land Disposal minimises the total land required for disposal but still results on some load to the river. Again there is a risk that the effluent continues to flow to the waterways below ground.

Disposal to the Adjacent Reserve and Constructed Wetland have smaller NPVs than the other options, and provide similar total phosphorus load reductions. However Constructed Wetland may provide additional reduction of total nitrogen when compared to Disposal to the Adjacent Reserve. This reduction is achieved through potential additional treatment from the wetland foliage instead of flow minimisation.

5.0 CONCLUSIONS

From the options investigated there is a range in the potential reductions and costs between the different options. As 3 out of the 4 options investigated are land disposal based, there is a strong correlation between cost and load reduction. Although the fourth option is not a land disposal option it also falls close to this correlation.

Net Present Value costs of the options varied from $1.15m to $77.5m. Respectively loads maybe reduced proportional to the cost. It should be noted that the final receiving environment for any land disposal system is not known without specific investigations. These should be undertaken to determine any potential land's ability to reduce loads on the river before commitments are made.

Based on the high cost of the options considered in this report, and the limited availability of funding, Stratford District Council are likely to implement treatment upgrades as discussed in the resource consent renewal application.

6.0 LIMITATIONS

6.1 GENERAL

This report is for the use by Stratford District Council only, and should not be used or relied upon by any other person or entity or for any other project.

This report has been prepared for the particular project described to us and its extent is limited to the scope of work agreed between the client and Harrison Grierson Consultants Limited. No responsibility is accepted by Harrison Grierson Consultants Limited or its directors, servants, agents, staff or employees for the accuracy of information provided by third parties and/or the use of any part of this report in any other context or for any other purposes.

6.2 ESTIMATES

Should this report contain estimates for future works or services, physical or consulting, those estimates can only be considered current and will only reflect the extent to which the detail of the project is known to the consultant (feasibility, concept, preliminary, detailed, tender etc) at the time given.

The client is solely responsible for obtaining updated estimates from the consultant as the detail of the project evolves and/or as time elapses.

APPENDICES

APPENDIX 1
ESTIMATES

Concept Cost Estimate

Stratford Wastewater Treatment Plant

Total Land Disposal
Stratford District Council

DATE: 30/03/2016
U:\1014\139079_01\400 Tech\420 Calculations\[Costs.xlsx]Total Land Disposal
HG PROJECT NUMBER: 1014-139079-01

ITEM	DESCRIPTION	UNIT	STY	RATE	AMOUNT
1.0	PRELIMINARY AND GENERAL				$ 4,400,000
2.0	PIPELINE				$ 4,900,000
3.0	TREATED EFFUENT STORAGE				$ 17,500,000
4.0	IRRIGATION				$ 8,800,000
5.0	MISC.				$ 12,900,000
	TOTAL WORKS COST				$ 48,500,000
	ENGINEERING COST	20 %		%	$ 9,700,000
	CONTINGENCY	20 %		%	$ 9,700,000
	TOTAL CAPITAL COST				$ 67,900,000
	TOTAL WORKS COST(-10%)	-10 %		%	$ 61,100,000
	TOTAL WORKS COST(+35%)	+35 %		%	$ 91,700,000

Concept Cost Estimate

Stratford Wastewater Treatment Plant

Partial Land Disposal
Stratford District Council

DATE: 30/03/2016

U:\1014\139079_01\400 Tech\420 Calculations\[Costs.xlsx]Partial Land Disposal

HG PROJECT NUMBER: 1014-139079-01

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
1.0	PRELIMINARY AND GENERAL				$ 1,800,000
2.0	PIPELINE				$ 4,900,000
3.0	TREATED EFFUENT STORAGE				$ -
4.0	IRRIGATION				$ 5,300,000
5.0	MISC.				$ 7,400,000
	TOTAL WORKS COST				$ 19,400,000
	ENGINEERING COST	20 %		%	$ 3,900,000
	CONTINGENCY	20 %		%	$ 3,900,000
	TOTAL CAPITAL COST				$ 27,200,000
	TOTAL WORKS COST(-10%)	-10 %		%	$ 24,500,000
	TOTAL WORKS COST(+35%)	+35 %		%	$ 36,700,000

Concept Cost Estimate

Stratford Wastewater Treatment Plant

Adjacent Reserve
Stratford District Council

DATE: 30/03/2016

U:\1014\139079_01\400 Tech\420 Calculations\[Costs.xlsx]Adjacent Land Disposal

HG PROJECT NUMBER: 1014-139079-01

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
1.0	PRELIMINARY AND GENERAL				$ 60,000
2.0	PIPELINE				$ 430,000
3.0	TREATED EFFUENT STORAGE				$ -
4.0	IRRIGATION				$ 110,000
5.0	MISC.				$ 100,000
	TOTAL WORKS COST				$ 700,000
	ENGINEERING COST	20 %	%		$ 140,000
	CONTINGENCY	20 %	%		$ 140,000
	TOTAL CAPITAL COST				$ 980,000
	TOTAL WORKS COST(-10%)	-10 %	%		$ 880,000
	TOTAL WORKS COST(+35%)	+35 %	%		$ 1,320,000

Concept Cost Estimate

Stratford Wastewater Treatment Plant

Constructed Wetland
Stratford District Council

DATE: 30/03/2016
U:\1014\139079_01\400 Tech\420 Calculations\[Costs.xlsx]Wetland
HG PROJECT NUMBER: 1014-139079-01

ITEM	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
1.0	PRELIMINARY AND GENERAL				$ 160,000
2.0	PIPELINE				$ 80,000
3.0	TREATED EFFUENT STORAGE				$ -
4.0	WETLAND CONSTRUCTION				$ 1,380,000
5.0	MISC.				$ 100,000
	TOTAL WORKS COST				$ 1,720,000
	ENGINEERING COST	20 %	%		$ 340,000
	CONTINGENCY	20 %	%		$ 340,000
	TOTAL CAPITAL COST				$ 2,400,000
	TOTAL WORKS COST(-10%)	-10 %	%		$ 2,160,000
	TOTAL WORKS COST(+35%)	+35 %	%		$ 3,240,000

APPENDIX 2
ADJACENT LAND MAP

EARTHTECH

Earthtech Consulting Ltd.
P.O. Box 721, Pukekohe
Phone: 64 9 238 3669
Email: admin@earthtech.co.nz

STRATFORD WWTP
Preliminary Effluent Disposal Investigation
Harrison Grierson

Available Effluent Disposal Area

DRAWN: P.K	CHECKED: P.K	SCALE (A3):	DRAWING NO.: FIG. 2
		1:1500	VERSION: A
TRACED: C.M	DATE: 27/10/15		REF: 3243