Raglan WWTP Optioneering - Short List Design and Costing

Prepared for Watercare Services Ltd
Prepared by Beca Limited

5 February 2021

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Revision History

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3	Shaun le Grange / Claire Scrimgeour	Updated draft with additional options	11 December 2020
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Document Acceptance

Action	Name	Signed	Date
Prepared by	Shaun le Grange/Claire Scrimgeour		5 February 2021
Reviewed by	John Crawford		5 February 2021
Approved by	Garrett Hall		5 February 2021
on behalf of	Beca Limited		

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Executive Summary

Background

Watercare Services Limited (Watercare) is in the process of determining the preferred treatment and discharge option for a long term resource consent application for the Raglan Wastewater Treatment Plant (WWTP).

This report assesses alternative options for the Raglan WWTP treatment and discharge to support the selection of the preferred option to include in the long term resource consent application.

Options Development

A “long list” of possible options was identified by Watercare and Beca staff with hapū and stakeholder input. This long list was then assessed to provide a short list of options to be evaluated further within this report, in terms of developing a high-level concept design and costing to inform the preferred option decision making process. Options assessed in this report are summarised below:

Option	Treatment	Discharge
Option M1	Existing treatment process + tertiary membrane	New harbour outfall
Option M2	MBR and UV disinfection	New harbour outfall
Option F1	MBR and UV disinfection	Freshwater diffuse discharge
Option L1	Existing treatment process + tertiary membrane	Combined public land discharge and new harbour outfall
Option L2	Existing treatment process	Private land discharge and storage
Option L3	Existing treatment process + tertiary membrane	Combined private land discharge and new harbour outfall
Option L4	MBR and UV disinfection	Combined public land discharge and new harbour outfall

Growth is expected to continue in Raglan, due to infill and greenfield residential sites including Rangitahi Peninsula and currently zoned residential land. Population projections are based on NIDEA medium household growth forecasts rebased from the 2018 Census. These are based on average occupancy during the summer season (estimated at 2.7 people for each connected property) rather than usual resident population recorded at the census date. Household forecasts are well within the available capacity of current and future residential areas included in the Waikato 2070 Growth and Economic Development Strategy (Waikato District Council, 2020). There is currently little commercial and industrial wastewater production in Raglan and this is not expected to increase. The average daily inflow at the Raglan WWTP is expected to increase from 1,163m3/day in 2020 to 1,957m3/day in 2055.

Option Features

The features of the different options are described below:

Option	Description	Comments
Option M1	The existing ponds would need to be upgraded to treat the increasing flows. A tertiary membrane unit with 3,000m^3 per day capacity will be installed after the ponds. A new 85m outfall would be located near the existing.	The tertiary membrane unit will remove suspended solids and pathogens from the discharge. The new discharge structure will improve distribution of the treated wastewater on the outgoing tide.

Option	Description	Comments
Option M2	The MBR system consists of new screens, flow balancing pond (utilising existing pond) reactor basin, membranes, sludge handling and UV treatment. A new 85m outfall would be located near the existing.	High quality treated wastewater will be produced by the MBR system. The new discharge structure will improve distribution of the treated wastewater on the outgoing tide.
Option F1	The MBR system consists of new screens, flow balancing pond (utilising existing pond) reactor basin, membranes, sludge handling and UV treatment. The treated wastewater would be discharged to the stream within the Raglan WWTP site.	A high quality treated wastewater will be produced by the MBR system. A diffuse discharge would be created alongside riparian and wetland restoration planting with native species.
Option L1	The existing ponds would need to be upgraded to treat the increasing flows. A tertiary membrane unit with 3,000m^3 per day capacity will be installed after the ponds. Conveyance to the three public land areas requires 6.8 km of pipelines. Public land area available is between 38-59 ha. A new 85m outfall would be located near the existing.	The tertiary membrane unit will remove suspended solids and pathogens from the discharge. The new discharge structure will improve distribution of the treated wastewater. Discharge to water is expected to occur for approximately 51% of flow at 2025 and 60% of flow by 2055. This system would be complex to manage.
Option L2	The existing ponds would need to be upgraded to treat the increasing flows. Conveyance to the private land area requires 8.8km of pipeline and two pump stations. Land area required for this option is 145 ha plus extra for buffer areas. Storage of 150,000m^3 would be required at the private land.	There is no discharge to water with this option. The conveyance to the private land has a very high head so a booster pump is required part way along the pipeline route.
Option L3	The existing ponds would need to be upgraded to treat the increasing flows. A tertiary membrane unit with 3,000m^3 per day capacity will be installed after the ponds. Conveyance to the private land area requires 8.8km of pipeline and two pump stations. Land area required for this option is 213 ha plus extra for buffer areas. A new 85m outfall would be located near the existing.	The tertiary membrane unit will remove suspended solids and pathogens from the discharge. The conveyance to the private land has a very high head so a booster pump is required part way along the pipeline route. Discharge to water is expected to occur for approximately 6% of flow at 2025 and 24% of flow by 2055. The new discharge structure will improve distribution of the treated wastewater at the harbour. This system would be complex to manage.
Option L4	The MBR system consists of new screens, flow balancing pond (utilising existing pond) reactor basin, membranes, sludge handling and UV treatment. Conveyance to the three public land areas requires 6.8 km of pipelines. Public land area available is between 38-59 ha. A new 85m outfall would be located near the existing.	High quality treated wastewater will be produced by the MBR system. The new discharge structure will improve distribution of the treated wastewater. Discharge to water is expected to occur for approximately 51% of flow at 2025 and 60% of flow by 2055. This system would be complex to manage.

Cost Summary

The capital, operating costs and net present value for each of the short-listed options is summarised in the table below. All costs are in NZD and exclusive of GST. Net Present Value (NPV) was calculated over a 35 year period. The capital cost estimate has an expected accuracy range of -30% / +50%.

Option	M1	M2	F1	L1	L2	L3	L4
Capex ($1000 NZD)	17,000	30,000	31,000	25,000	59,000	42,000	43,150
Additional Annual Opex ($1000 NZD)	498	1,501	1,497	660	421	771	1,655
NPV ($1000 NZD)	24,200	52,100	52,500	34,600	64,800	53,100	67,100

Multi-criteria analysis will be used to compare the non-cost criteria for each option prior to Watercare selecting a preferred option to develop further.

1 Introduction

1.1 Background

The resource consent for the discharge to the Whāingaroa Harbour (in the coastal marine area) for the Raglan Wastewater Treatment Plant (WWTP) expired in February 2020 and a consent application was submitted prior to that for a short term consent while long term options were being further considered. The discharge is able to continue under section 124 of the Resource Management Act (RMA) until a decision is made on the consent. Over the last few years the WWTP has experienced re-occurring non-compliances with the existing resource consent conditions for the discharge of contaminants, mostly breaching the total suspended solids (TSS) consent parameter.

An options assessment is required to inform Watercare's preferred future plans for the discharge and support a resource consent application to be made under the Resource Management Act (RMA) for the long term wastewater solution. Watercare has engaged Beca Ltd. to undertake this options assessment considering expected flows and loads to the Raglan WWTP for a 35-year design horizon.

A "long list" of possible treatment and discharge options was identified previously. The long list was then assessed using technical, cultural, environmental, public health and engineering criteria to provide a shortlist of options to be evaluated further within this report. Options assessed in this report are detailed below (**Table 1**).

Table 1: Treatment and discharge options

Option	Treatment	Discharge
Option M1	Existing treatment process + tertiary membrane	New harbour outfall
Option M2	MBR and UV disinfection	New harbour outfall
Option F1	MBR and UV disinfection	Freshwater diffuse discharge
Option L1	Existing treatment process + tertiary membrane	Combined public land discharge and new harbour outfall
Option L2	Existing treatment process	Private land discharge and storage
Option L3	Existing treatment process + tertiary membrane	Combined private land discharge and new harbour outfall
Option L4	MBR and UV disinfection	Combined public land discharge and new harbour outfall

This report provides a brief description for each option together with a summary of the advantages, disadvantages, risks and unknowns associated with each option. Concept level comparative capital and operational cost estimates (-30%/+50%) have been made for all options, which are compared via net present value (NPV) analysis. This report provides an update on an earlier draft version of the report published in August 2019.

2 Existing Wastewater Treatment Plant

2.1 Wastewater Treatment Plant Description

Raglan is a small community home to a usually resident population of approximately 4,000 that increases for periods in the summer. The Raglan wastewater reticulation system is a conventional system with 17 pump stations as shown in Figure 1. The small Whānga Coast community has a low-pressure wastewater system which connects to the Raglan wastewater system at the WWTP.

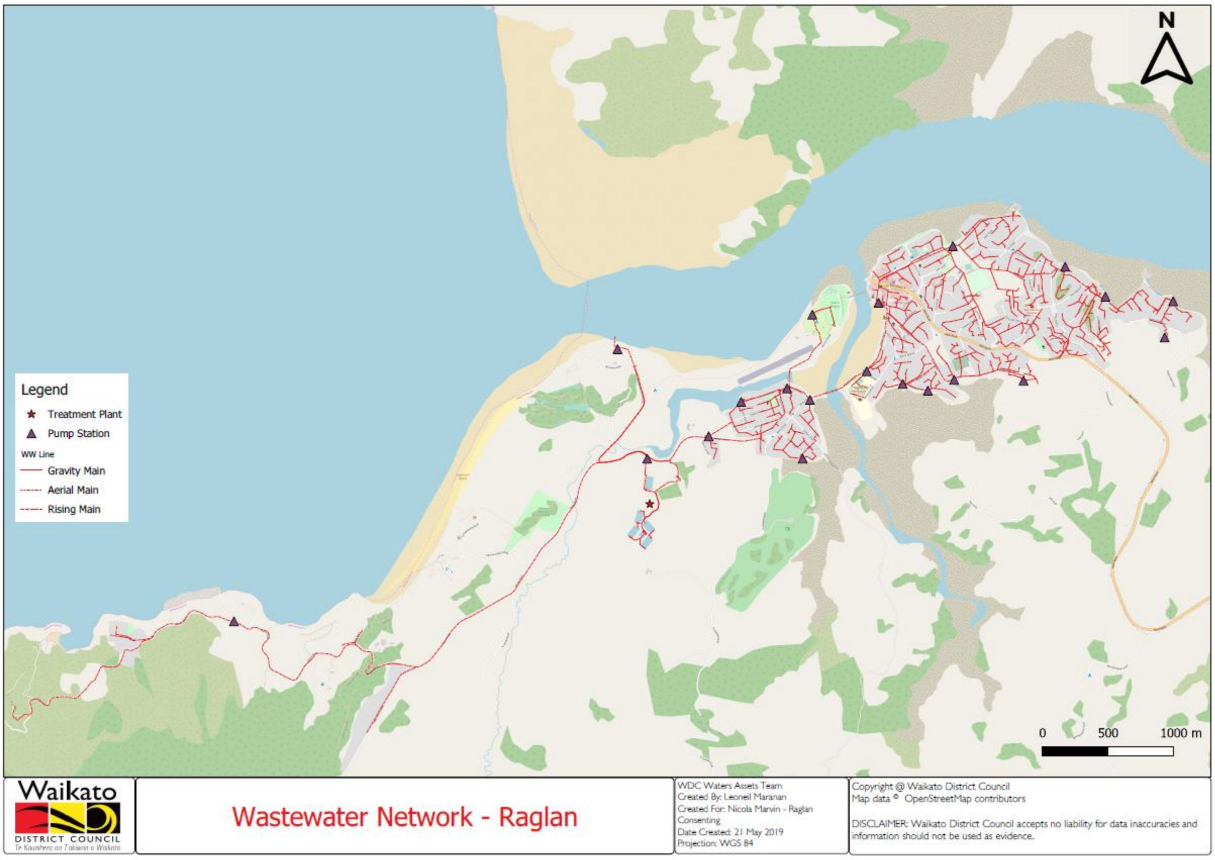

Figure 1: Raglan Wastewater System Schematic

Wastewater is treated at the WWTP, located to the south-west of the Raglan community on Wainui Road. The WWTP is administered and operated by Watercare on behalf of Waikato District Council.

Wastewater is received at the inlet works (screen), from where it is piped to aerated ponds A and D, and then to ponds B and C. The ponds have an aeration system and associated Aquamats installed. The Aquamats provide additional surface area for fixed film biological activity. The pond treated wastewater currently discharges into a day pond for storage prior to discharge on the outgoing tide. If the holding capacity of the day pond is exceeded, flow is transferred to the storage pond. From the day pond, treated wastewater is pumped via an inline UV disinfection system to the mouth of the Whāingaroa (Raglan) Harbour. Two anaerobic ponds exist on site prior to the aerated ponds, however, these are currently unused. The existing process at Raglan WWTP is shown in **Figure 1**.

The current discharge consent allows a discharge of up to 2,600m³ of treated wastewater per day to Whāingaroa Harbour. Discharge is only permitted for a maximum of 5.5 hours per outgoing tide, commencing no earlier than 0.5 hours before high tide and ceasing no later than 1 hour before low tide. Discharge duration may exceed this after extreme weather but not for more than 20 days per year.

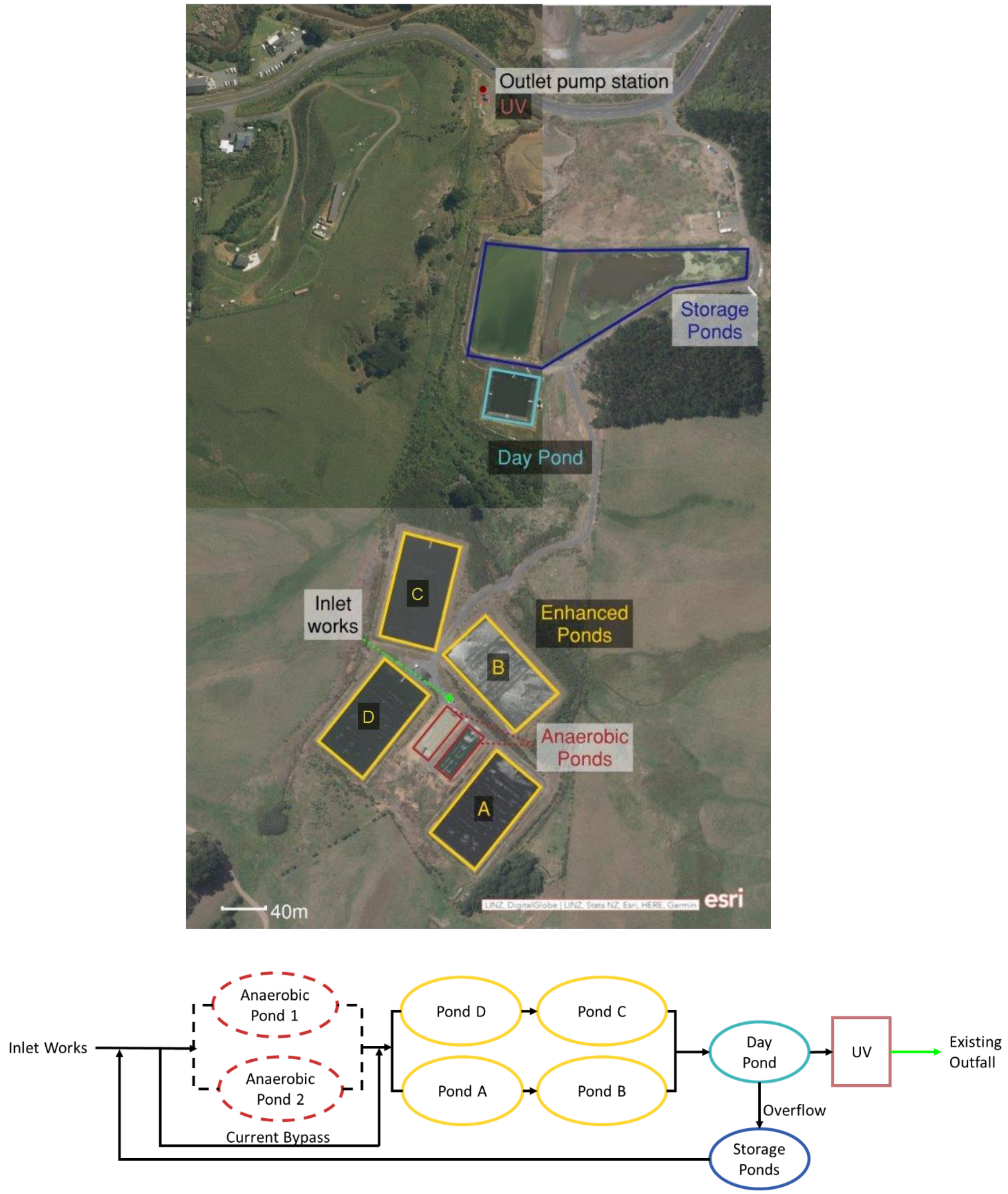

Figure 2: Raglan WWTP process current state

Full compliance with treated wastewater quality consent conditions has not been achieved over recent years, generally due to elevated TSS concentrations in the treated wastewater. To minimise excessive algal growth in the storage pond (several days of retention) prior to the harbour discharge, WDC installed the 'day pond' in 2015.

3 Design Basis – Flows and Loads

3.1 Measured Flow

Daily inflow and outflow data for Raglan WWTP has been provided by Watercare. Once 2,600m^3 of flow has been discharged to the harbour in a 24-hour period (as a result of peak wet weather flows), additional flow is stored either in the day pond or the adjacent storage ponds. Treated wastewater in the storage ponds is pumped back into the influent line when the operators set the pump to run manually. The actual flows coming into the day pond are not measured.

Historical treated wastewater flow rates have been analysed for the period of 2014 to 2020. The average daily flow (ADF), and peak wet weather flows (PWWF) are shown in **Table 2**.

Table 2: Historical Treated Wastewater Discharge Flows 2014-20

Parameter	Discharge Flow (m^3/day)
ADF	1,043
10th Percentile	547
90th Percentile	1,783
PWWF	3,749

The peak discharge flows do not allow for flow that is stored in the storage ponds. The individual outflow data is highly variable, so a weekly rolling average has been calculated **(Figure 3).** There are some gaps in this data set but a small increase in base flows over recent years is evident which is likely to be due to population growth.

The Raglan wastewater model (Mott McDonald 2017) identified high infiltration and inflow rates in some parts of Raglan, particularly in the lower areas near the harbour. Waikato District Council (and now Watercare) has a regular maintenance and renewals programme to manage illegal downpipe connections and target pipe renewals. In recent years storage has been increased at key pump stations and the Raglan pipe network has been inspected by CCTV. The SCADA system has also been upgraded to provide better response to network faults and allow high flows to be better managed.

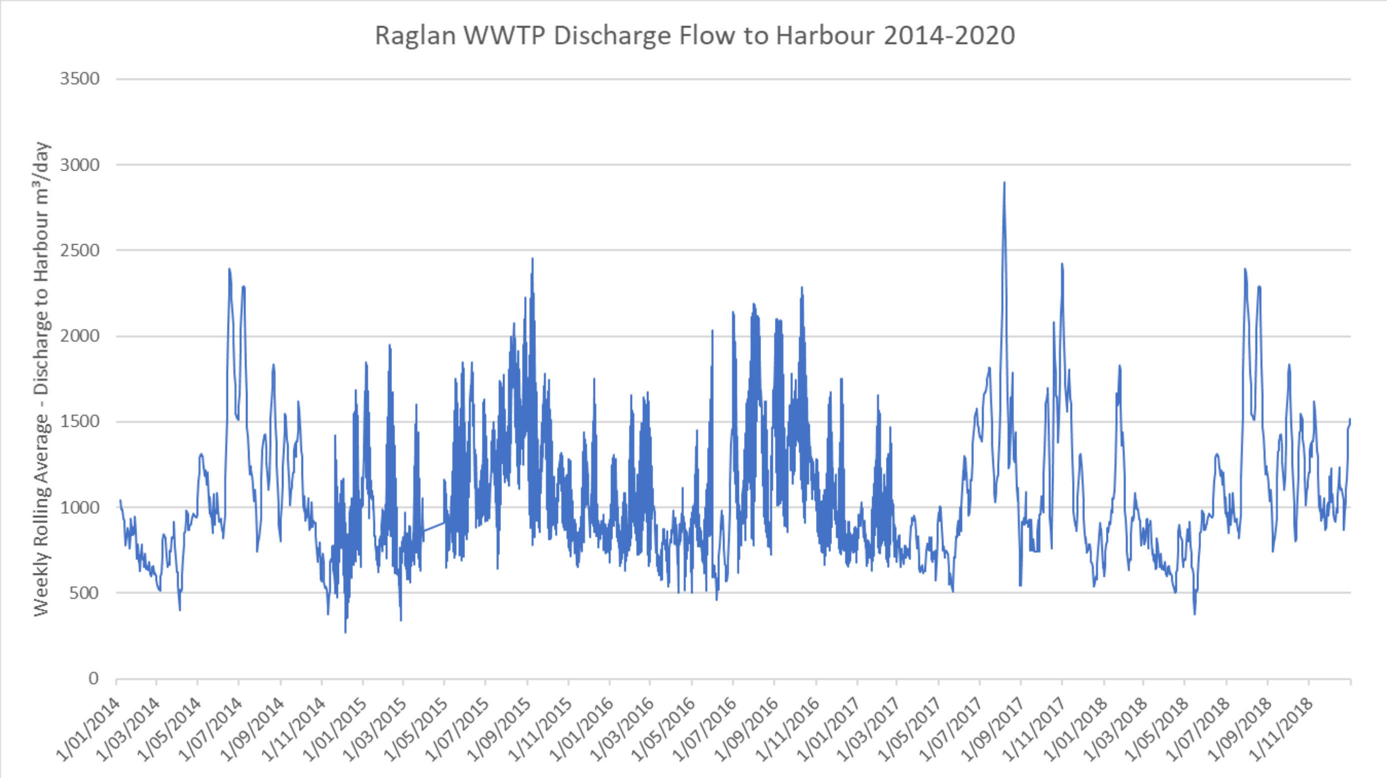

Figure 3: Weekly Rolling Average Outflows at Raglan WWTP

3.2 Treated Wastewater Quality

Treated wastewater quality data from monthly grab samples of final treated wastewater between 2017 and 2019 was reviewed. Table 3 shows the typical quality of the Raglan WWTP treated wastewater downstream of the day pond and UV disinfection system. The pond system is producing peaks of TSS from time to time, and as a result the WWTP discharge does not meet the consent limits.

Table 3: Treated Wastewater Quality 2017-19 (Pond Treated wastewater post UV)

Parameter	Median Consent limit	Median Concentration	5th Percentile	95th Percentile
Carbonaceous biochemical oxygen demand ($cBOD_5$) (mg/L)	10	6	3	21
Total Suspended Solids (TSS) (mg/L)	20	32	12	97
Ammoniacal nitrogen (mg/L)		8	0	19
Total Nitrogen (mg/L)		26	13	35
Total Phosphorus (mg/L)		5	3	7
Faecal coliforms (mg/L)	14	3	1	65

3.3 Design Influent Flow and Load

3.3.1 Design Basis and Assumptions

Growth is expected to continue in Raglan, due to infill and greenfield residential sites including Rangitahi Peninsula and current residential zoned areas. Population projections are based on NIDEA medium household growth forecasts rebased from the 2018 Census1. An estimate of expected connected population and design wastewater inflows are provided in **Table 4** below. These are based on average occupancy during the summer season (estimated at 2.7 people for each connected property) rather than usual resident population recorded at the census date.

Household forecasts are well within the available capacity of current and future residential areas included in the Waikato 2070 Growth and Economic Development Strategy (Waikato District Council, 2020). There is currently little commercial and industrial wastewater production in Raglan and this is not expected to increase. Further growth sensitivity analysis is recommended for the preferred option.

Table 4: Projected Wastewater Flows

Date	Population	Average Daily Inflow (m^3/day)	Peak Wet Weather Inflow (m^3/day)
2018	4,428	1,079	2,949
2020	4,847	1,163	3,175
2025	5,895	1,372	3,741
2030	6,942	1,582	4,307
2050	8,465	1,886	5,129
2055	8,821	1,957	5,321

The seasonal pattern indicated by the daily flow data shows a higher winter base flow expected to be due to wet weather flows and elevated ground water level. There is approximately an 80-100 m^3/day ADWF increase between summer months and the shoulder season, which is assumed to be attributed to the increase in system users over the holiday period. More regular influent sampling would be needed to confirm holiday loads, but these do not appear to be having an undue impact on the WWTP currently.

The base influent flow used was 1,163 m^3/day average daily flow (ADF) for 2020, with an ADF forecast of 1,957 m^3/day by 2055. The raw influent data provided by Waikato District Council is displayed in **Table 5.**

[1] Information provided by Mark Davey, Waikato District Council

Table 5: Raglan influent data 2017-2018

Parameter	Average Concentration (mg/L)
Carbonaceous biochemical oxygen demand ($cBOD_5$) mg/L	204
Total Suspended Solids (TSS) mg/L	235
Ammoniacal nitrogen mg/L	35
Total Nitrogen mg/L	83
Total Phosphorus mg/L	7

The future projected loads were estimated assuming the typical load generation rates per person. This is based on residential growth only and does not make any allowance for significant industrial growth as there is little land suitable or zoned for industrial development. There is a predicted 99% increase in average flows and loads over the 35-year design window. The current and projected 2055 loads are presented in **Table 6**.

Table 6: Raglan current and 35-year projected flow and load data

Parameter	2020	2055
Population	4847	8821
Wastewater flow average (m^3/d)	1163	1957
Wastewater flow design peak (m^3/d)	3175	5321
TSS (kg/day)	436	794
$cBOD_5$ (kg/day)	388	706
TN (kg/day)	68	123
TP (kg/day)	16	28

4 Expected Treated Wastewater Quality

There are several different approaches that can be taken to address the treated wastewater quality and means of discharge for the Raglan WWTP. The six options assessed in this report are described in more detail below.

4.1 Future Pond Performance

An increase of the incoming loads to the WWTP is expected in the future due to growth in the area. The projected flows and loads for a 35 year consenting period are presented in Table 6. The loads are based on the current concentrations (Table 5). If the ponds are retained (Options M1, L1, L2 and L3), loading on them will be increased. The consequent loading rates, assuming that the anaerobic ponds continue to be bypassed, are shown in Table 7 below.

Historical incoming flow and concentration data (2017-2020) suggests that load in summer is higher than in winter (i.e. flows are greater in the winter given inflow and infiltration of stormwater, however, 'load', measured in kg lessens), however, there is insufficient data to predict seasonal loading for the future. Therefore, for the purpose of this report, it is assumed that future loads in summer and winter will be at the same ratio as they are now. It is expected that the loading to the ponds will increase significantly by 2055 (assuming the anaerobic ponds will continue to be bypassed). These loading rates are well above the level that Aquamats are typically designed for and this is likely to result in continued clogging, lower than optimal dissolved oxygen and deteriorating treatment performance.

Table 7: Pond loading rates in 2020 and 2055

Pond	Pond area, ha	Pond loading rate, in Summer kg BOD/ha/d		Pond loading rate, in winter kg BOD/ha/d		HRT, d	
		2020	**2055**	**2020**	**2055**	**2020**	**2050**
Pond A (primary)	0.46	333	518	206	518	6.5	3.5
Pond B	0.46	60	155	54	211	8	4.3
Pond D (primary)	0.46	333	518	206	518	8	4.3
Pond C	0.46	60	155	54	211	7	3.5

A high level process performance assessment was undertaken to predict treated wastewater quality in the ponds for four pond based scenarios (Options M1, L1, L2 and L3), these are presented in the table below. It is noted that the future treated wastewater quality using Aquamats is indicative only and does not account for the significantly reduced Hydraulic Retention Timer (HRT) in the future. Predicted treated wastewater quality is presented in the table below.

Table 8: Predicted Pond Treated Wastewater Quality

Scenario	Year	Flow (m^3/d)	Influent BOD (mg/L)		Treated Wastewater $cBOD_5$ (mg/L	
			Summer	**Winter**	**Summer**	**Winter**
Current - With aquamats	2020	1200	255	158	8	11
Predicted - With aquamats	2055	2335	204	127**	18*	21*
Predicted - Without aquamats in primary pond	2020	1200	255	158	64	77
Predicted - Without aquamats in primary pond	2055	2335	204	127**	51*	62*

*Not accounted for reduced HRT, which will have a substantial impact on treated wastewater quality.

** Estimated based on the current ratio of Summer to Winter loads

Pond performance in winter can be challenging at times with current loads and lower temperatures and it is expected that it will deteriorate worse in the future with increased load to the ponds and reduced HRT. It should be noted that Table 8 indicates the estimated performance for the average flow condition. Performance is expected to be lower for a peak flow condition. Performance for nutrient removal is expected to follow a similar trend to BOD removal as loads increase. TSS removal is likely to continue to be variable.

The above table predicts pond performance including Aquamats in Pond A and D. However, Aquamats are best suited to be installed in secondary ponds (ponds B and C). If the Aquamats were removed from the primary ponds, a significant aeration supply upgrade will be required to bring the pond loading to the secondary ponds down (this is not accounted for in **Table 8**). Significantly, since there is no clarification / RAS device removal ahead of the Aquamats this would also remove the ability to maintain any form of enhanced biomass inventory beyond what is created and held by virtue of the hydraulic retention time of the ponds. Alternatively, the load reduction can be obtained by re-instating the anaerobic ponds. This will require design assessment for the main parameters being:

- Anaerobic pond design depth appears to be minimum (current 3 m). Design range 3-5 m.
- Pond HRT current 1.6 d (@ 1,200 m^3/d) appears to be too short. Highest design HRT was 2.2d. Normal design range 3-6 d. HRT below 3d carries a risk that methane forming organisms are washed out from the system, therefore anaerobic conditions cannot be established.
- Volumetric loading rate (current not checked). Design range 0.1 to 0.3 kg BOD/m^3/d
- Potential for odour generation unless covered or reliable crust formed
- High flow bypass provisions

If pond optimisation is considered as an option long term, the following steps are recommended:

- Sampling program of incoming wastewater
- Sampling program across each process step
- Assessment of anaerobic pond design and upgrade requirements
- Assessment of pond performance improvement options including:
  - Anaerobic ponds are re-established to take full or part of the flow
  - Aquamats are removed from Ponds A and D. Aeration system is installed in Ponds A and D if required for further BOD load and Total Nitrogen reduction. Aquamats remain in Ponds B and C

4.2 Additional Tertiary Membrane

A tertiary membrane system is used in options M1, L1, L2 and L3. A tertiary membrane will improve TSS and pathogen removal predominantly. Post-pond data available from similar plants suggest a considerable reduction in the target parameters is possible, as well as a small reduction in nutrients.

The following median treated wastewater quality is expected from the tertiary membrane, based on the 12-month rolling median value (TSS) and geometric mean (E. coli, FC):

- TSS < 3 g/m^3
- E. coli < 5 cfu/100mL
- Faecal Coliforms < 5 cfu/100mL
- TN <17 g/m^3, ≈36% reduction (based on similar Motueka system). This level of removal seems high based on organic N content of the TSS and if Aquamats are removed TN levels could increase. Further work is required to confirm the level of removal if this option is the preferred option.
- TP <4 g/m^3, ≈29% reduction (based on similar Motueka system)

The expected 90th percentile values for the same parameters are:

- TSS < 6 g/m^3
- E. coli < 10 cfu/100mL
- Faecal Coliforms < 10 cfu /100mL

4.3 Membrane Bioreactor (MBR)

Options M2, F1 and L4 utilise an MBR system for treatment followed by UV disinfection. An MBR will produce a high quality treated wastewater with low nutrient and pathogen concentrations. The expected 90th percentile treated wastewater quality is outlined in Table 9.

Table 9: Expected Treated Wastewater Quality (90th percentile)

Suspended solids (TSS)	Biochemical oxygen demand ($cBOD_5$)	Ammoniacal nitrogen (NH_4-N)	Total nitrogen (TN)	Total phosphorus (TP)	E Coli
<5 mg/L	<5 mg/L	<1 mg/L	<8 mg/L	<1 mg/L*	<10 cfu/100ml

*assumes alum dosing or Bio P configuration.

4.4 Summary

For comparison purposes, Table 10 below presents a comparison of treated wastewater qualities for the various treatment process options presented here. Note these are reported as 90 percentile concentrations.

Table 10: Comparison of Treated Wastewater 90 Percentile Concentrations from Various Treatment Processes

Parameter	Suspended solids (TSS)	Biochemical oxygen demand ($cBOD_5$)	Ammoniacal nitrogen (NH_4-N)	Total nitrogen (TN)	Total phosphorus (TP)	E Coli
Unit	mg/L	mg/L	mg/L	mg/L	mg/L	cfu/100mL
Current Aquamats + UV	84	12	14	26	7	<100
Tertiary Membrane + UV	<5	<10	14	<20	7*	<10
MBR + UV	<5	<5	<1	<8	<1	<10

* Potentially some TP removal with membranes and without alum dosing. With alum dosing could get to TP <1 mg/L.

5 Treatment and Discharge Options

5.1 Option M1 – Additional Tertiary Membrane, New Harbour Outfall

5.1.1 Option Description

Option M1 (**Figure 4**) would see the addition of a tertiary membrane polishing the pond treated wastewater to specifically target a reduction in TSS and pathogen levels.

This option also entails modifications to Ponds A-D to improve their respective treatment performance in response to growth and is assumed to involve the following:

- Removal of Aquamats in Ponds A-D (this could potentially be staged with ponds A and D removed in the first stage)
- Install new surface aeration system in Ponds A-D
- Reinstating anaerobic ponds with the following to reduce BOD loading to the aerobic ponds:
  - De-sludging of Ponds 1 and 2
  - Lining of Ponds 1 and 2 with PE liner (including under drainage and gas venting system)
  - Covering of Ponds 1 and 2. The covers should be made removable so that an agricultural contractor can be engaged annually to come in and remove accumulated sludge using a reasonably conventional dairy effluent pond desludging system.
  - Modification of the inlet to pass more flow if a 1-2 d HRT is desired
  - Allowance for four inlet points to each pond
  - Consideration of methods (in addition to the above) to remove sludge from Ponds 1 & 2. Simple 'pipe in invert of pond' type concepts do not tend to work because of rat holing of the sludge around a static inlet.

Further investigation and design work is required to confirm the extent of the pond modification required and a provisional sum has been included in the cost estimate.

The higher quality treated wastewater would then be discharged to the new outfall location in the Whāingaroa harbour channel, with a duckbill fitted at the end of the pipe to improve mixing.

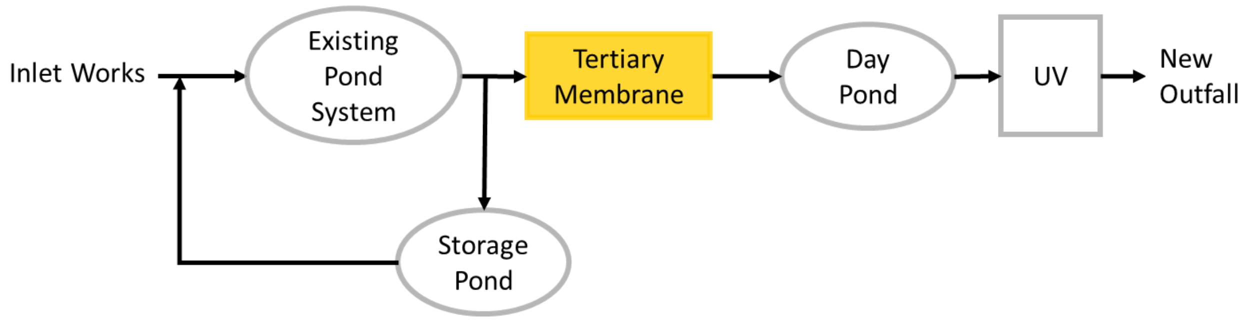

Figure 4: Process flow diagram for Raglan WWTP Option M1

The results of modelling suggest that improvement to dilution performance could also be achieved by shortening the duration of discharge to the peak harbour outflow periods to reduce the potential for the return of treated wastewater to the harbour in certain conditions. To allow this increase in flow rate over a shorter period, and to accommodate an increase in design flows over time, all the harbour outfall pipelines considered have been assumed to be increased to 350mm NB which is consistent with the diameter of the conveyance pipeline from the WWTP.

5.1.2 New Harbour Outfall

Figure 5 below shows the concept design behind the new outfall proposed. It should be noted that the existing pipeline currently has a diameter decrease very close to the existing outlet. The new outfall would tie-in with the existing pipeline before the diameter decrease and would match the upstream pipe diameter. Refer to Appendix A for the concept design drawing for the new outfall.

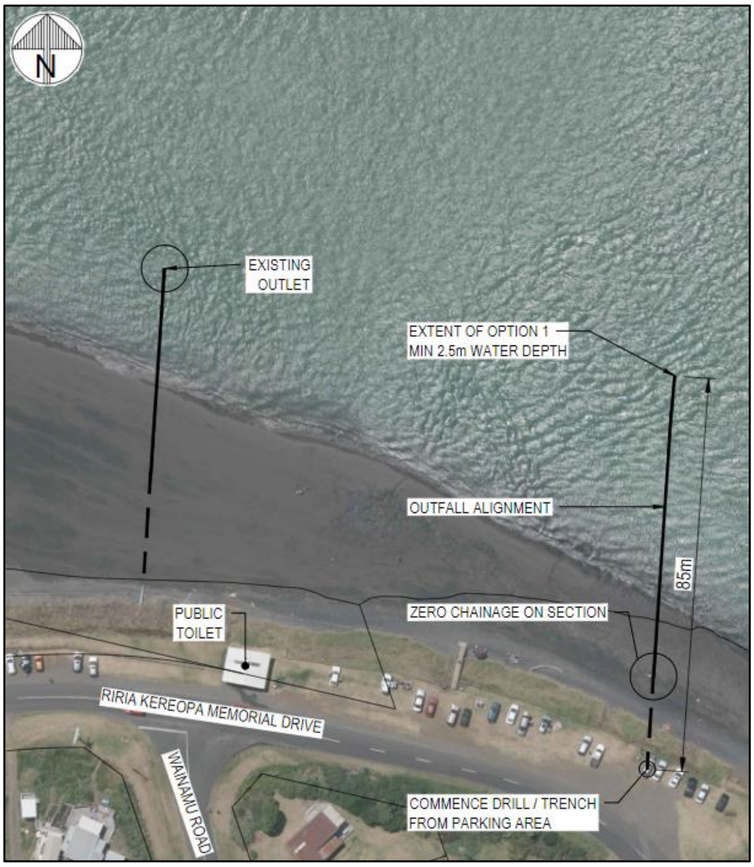

Figure 5: New Harbour Outfall Position

The discharge location shown has been selected such that the pipeline components exposed on the harbour bed would be at least 2.5m below chart datum for navigational purposes. The discharge outlet would be deep enough to provide meaningful improvement in dilution performance compared to the existing outfall while minimising the exposure to tidal currents during construction and providing for practical access for maintenance. Limiting the outfall length also limits the exposure to the apparent migration of channel features which appears to occur in the main channels.

5.1.3 Advantages, Disadvantages and Risks

Introducing a tertiary membrane to the existing system would result in a better-quality treated wastewater being discharged to the harbour. Improvements to the pond system would be required to maintain treatment performance.

The proposed 3000m³/day tertiary membrane would require significant capital investment and increase operating costs, including maintenance, labour, pumping and chemical requirements. With a 3000m³/day capacity for the proposed tertiary membrane it is proposed to store pond treated wastewater in a rebuilt storage pond to minimise flows bypassed during high flow events. The tertiary membrane system capacity can be increased in future by adding additional membrane modules. The reject stream from the tertiary membrane system consists of small flows with higher TSS levels or cleaning chemicals would be returned to the inlet works for treatment through the pond system.

A similar membrane system has been implemented at Maungaturoto, Motueka, Matamata, Dannevirke and Taihape WWTPs as a post pond tertiary treatment step. Should this (or any other tertiary membrane) option progress further, Beca recommends Watercare visit one of these locations to gain an understanding of the operation of this type of system.

The proposed location of the outfall has less construction risk than further out into the channel as it is exposed to lower currents, is more accessible for construction and ongoing inspection, and requires less in the way of temporary works.

5.2 Option M2 – MBR and UV, New Harbour Outfall

5.2.1 Option Description

Option M2 (**Figure 6** and **Figure 7**) will significantly improve the treated wastewater quality by utilising a Membrane Bioreactor (MBR) system in place of the existing pond system and discharge via a new outfall as per option M1. MBR systems do not like wide variations in flow so one of the existing ponds would be utilised for raw wastewater flow buffering. The MBR process components are outlined below.

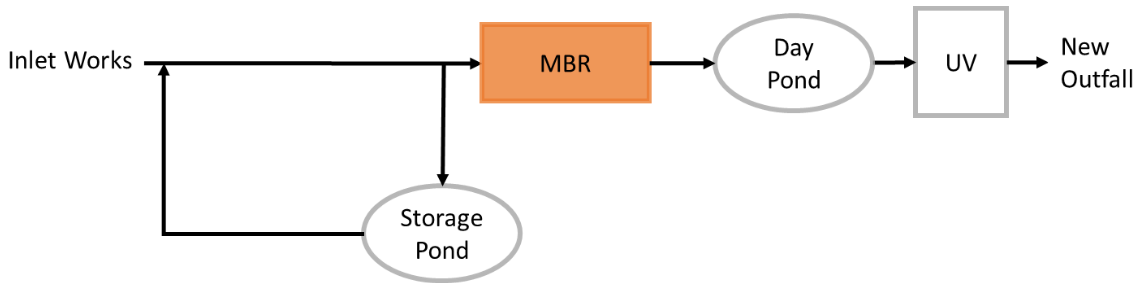

Figure 6: Process flow diagram for Raglan WWTP Option M2

Figure 7: Proposed MBR Layout

An inlet works facility comprising:

- Influent collection chamber
- Coarse (5mm aperture), primary band screen
- Vortex grit separator which includes aeration, grit removal conveyors and scum removal
- Grit classifier
- Fine (1mm aperture), secondary band screen
- Screenings load out conveyors to skip
- Screening washer/compactors if the screens do not include an integral compaction zone
- Scum collection tank including decanting pipework

A reactor and membrane system, comprising:

- Activated sludge reactors (ASRs) configured for nitrogen and phosphorus removal
- Blowers and diffused aeration system, including internal recycle
- Ultrafiltration membrane separation using submerged hollow fibre membranes
- A clean in place (CIP) system required for maintaining the cleanliness of the membranes and preventing irreversible fouling
- Return activated sludge (RAS) and waste activated sludge (WAS) pumping
- Alum (or equivalent) dosing for additional phosphorus removal where necessary

A tertiary UV disinfection system comprising:

- Either an in-channel lamp bank or packaged in pipe UV disinfection system (there may be potential to reuse the existing in pipe system).

A dewatering system consisting of:

- Screw press, capable of dewatering undigested Waste Activated Sludge (WAS) to ≈19%DS
- Polymer make-up systems and feed pumps
- Dewatering day tanks for storing and aerobically stabilising sludge until the dewatering systems operate
- Sludge pumps and piping to feed dewatering
- Sludge loadout conveyors and skips for removal of dewatered sludge from site

5.2.2 Advantages, Disadvantages and Risks

The expected treated wastewater quality for this option would be significantly improved. An MBR process requires much more operator effort and is more sensitive to changes in incoming loads than a pond system. Biosolids are produced daily and consequently must be hauled away several times per week for reuse or landfill disposal.

Outfall issues are the same as for option M1.

5.3 Option F1 – MBR and UV, Freshwater Diffuse Discharge

5.3.1 Option Description

Option F1 (**Figure 8** and **Figure 9**) would discharge 100% of the MBR treated wastewater to the stream adjacent to the WWTP site and as a result no discharge via the outfall would be required. At this stage peak flows would be mitigated pre-MBR using one of the existing ponds and no allowance has been made for buffering after treatment. The components of the MBR system are the same as for option M2. The raw wastewater inflow would need to be buffered prior to the MBR similar to option M2.

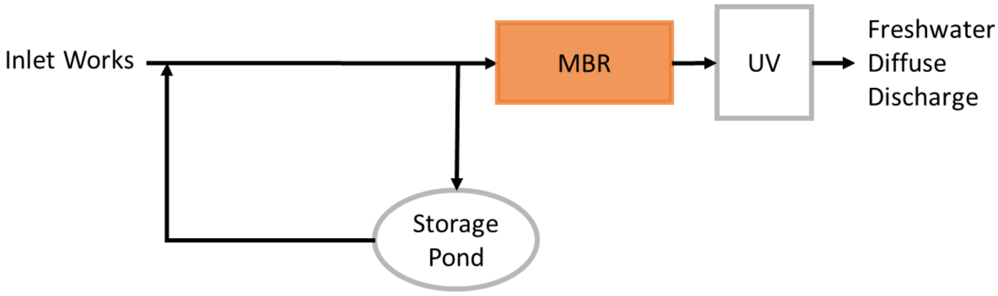

Figure 8: Process flow diagram for Raglan WWTP Option F1

Figure 9: Proposed MBR and Discharge Layout

5.3.2 Advantages, Disadvantages and Risks

Option F1 improves the treated wastewater quality like Option M2 however there is still residual concentrations of ammoniacal nitrogen and phosphorus in the treated wastewater which could impact on waterways.

There are opportunities to restore the nearby streams by riparian planting by implementation of this option.

5.4 Option L1 – Additional Tertiary Membrane, Combined Public Land Discharge and New Harbour Outfall

5.4.1 Option Description

Option L1 (**Figure 10**) introduces discharge to public owned land with the balance discharged via a new harbour outfall. The wastewater would undergo additional treatment via a tertiary membranes as per option M1. The pond system would also need to be upgraded as per option M1.

This non-deficit irrigation option has been based on potential irrigation to three public land areas (see Appendix B for full PDP report):

- Raglan Airstrip
- Golf Course
- Wainui Reserve

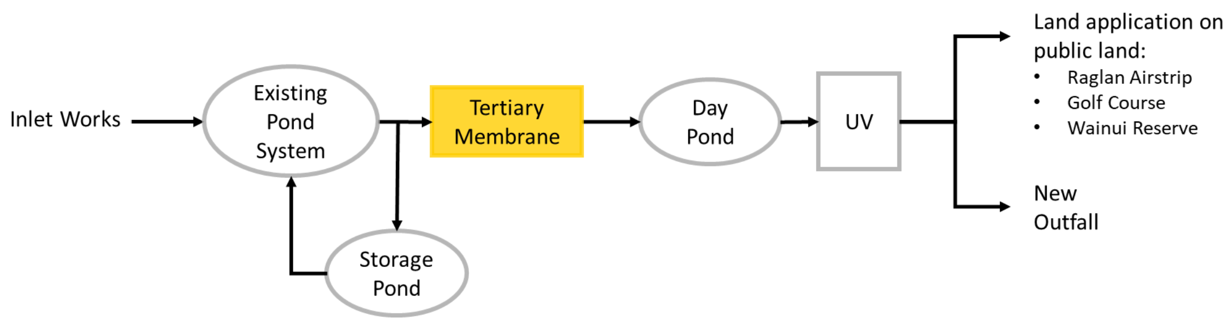

Figure 10: Process flow diagram for Raglan WWTP Option L1

Three possible irrigable areas, a maximum of 59 ha and a minimum of 38 ha, have been outlined for the public spaces. The maximum area reflects the theoretical area that could be irrigated across the three spaces based on the Weighted Attribute Analysis (WAA) usable area and excluding infrastructure such as carparks and the golf clubhouse.

The minimum area is more conservative and incorporates a 50 m buffer inside the parcel boundaries and excludes specific land use on Wainui Reserve which may conflict with the irrigation scheme, such as the Amphitheatre, Sound Splash (annual music festival) and para-gliding. The rough order cost has been based on the maximum irrigable area.

Based on the soil types observed in these areas it has been assumed that irrigation to Wainui Reserve and the Raglan Airstrip can occur year round, while irrigation to the Raglan Golf Course will only occur during the summer months from December – March. It is assumed that Wainui Reserve and the Golf Course would operate on a rotation period of four and three days respectively to allow time for the soils to rest. The maximum irrigation application rate is 8 mm/day.

A storage pond of 1,000 m3 at the Wainui Reserve has been allowed for to buffer irrigation volumes. It is assumed that irrigation to the Golf Course and the Airstrip can occur directly from the WWTP.

The irrigation equipment costing has been based on drip line irrigation. This minimises the risk of potential conflict with public landuse, allowing for the existing land use to be maintained.

It is assumed that non-deficit irrigation will occur at Wainui Reserve and the Raglan Airstrip, and deficit irrigation will occur at the Raglan Golf Course. The WWTP storage pond volume of 25,000 m^3 was utilised in the soil moisture models (SMM).

Because the majority of the treated wastewater would now be discharged to land, there could be adverse effects with the current quality of treated wastewater, so a tertiary membrane would be required to improve treated wastewater quality. This would also reduce any chance of pathogen exposure to workers, public or wildlife. It would also reduce the tendency for soil pore clogging to occur. The treated wastewater quality is expected to be similar to that detailed in Option M1.

A marine discharge will be required when the land discharge sites are unable to accept treated wastewater and storage facilities are full. This contingency discharge would be to the same location as for M1.

Please refer to Appendix B for the full land treatment report completed by PDP.

5.4.2 Irrigation pipeline route

Figure 11 shows high-level indicative pipeline routes from the WWTP to the land discharge sites. The pipelines have the following attributes:

Table 11: Pipe Route Attributes

Designation	Length	Static Head/ Elevation	Pipe Diameter (Pressure Rating)
Raglan Airstrip	1 966m	16m	DN75mm (PN12.5)
Golf Course	2 223m	18m	DN110mm (PN16)
Wainui Reserve	2 563m	58m	DN110mm (PN16)

The following maximum peak flow rates have been assumed in estimating the pump sizes:

Table 12: Peak Flow Rates and Pumps

Designation	Peak Flow Rate	Dynamic Head	Pump Power	Pump Configuration
Raglan Airstrip	2.6 L/s	56m	3 kW	Duty/Standby
Golf Course	5.9 L/s	53m	5.5 kW	Duty/Standby
Wainui Reserve	6.8 L/s	105m	15 kW	Duty/Standby

No consideration of land ownership has been given in determining this pipeline route and, where possible, public roads have been used to inform the routes. A more detailed assessment of the pipe routes to the land discharge areas are required if this is selected as a preferred option.

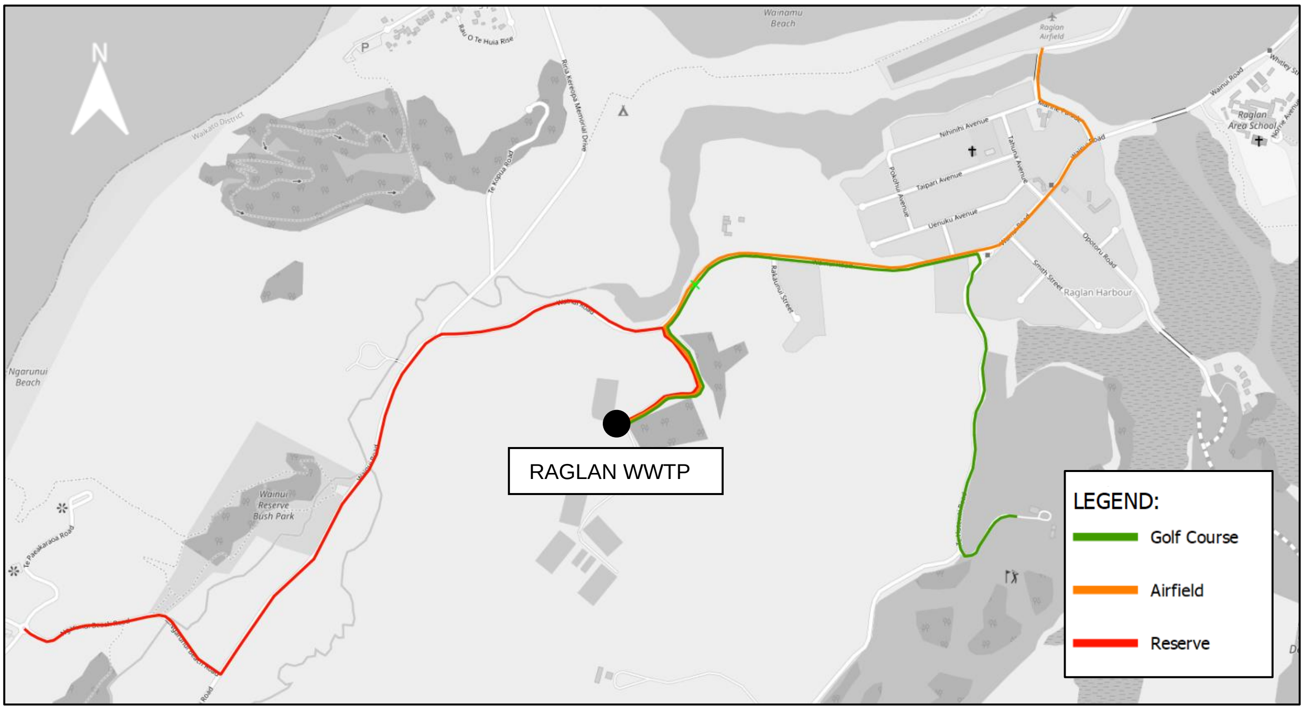

Figure 11: Indicative pipeline routes to public land discharge sites

5.4.3 Advantages, Disadvantages and Risks

Pump stations, rising mains and storage requirements will increase capital costs and operational complexity. This capital investment would increase further with the requirement for a tertiary membrane to reduce TSS and pathogens and pond upgrades to maintain treatment performance. However, this option would reduce the volume of treated wastewater discharged to the Harbour, particularly during dry summer periods.

5.5 Option L2 – Existing Treatment, Private Land Discharge and Storage

5.5.1 Option Description

This option (**Figure 12**) follows a different principle to Option L1 with the following key variances:

- Land discharge would be at an individual site on private land off Te Hutewai Road
- The wastewater would not be subject to any additional treatment processes, however, the ponds would need to be upgraded to maintain current treatment performance
- No discharge via the outfall, instead new storage at the private land would be used to buffer flows.
- Pond upgrades will be required to maintain current treated wastewater quality as per option M1.

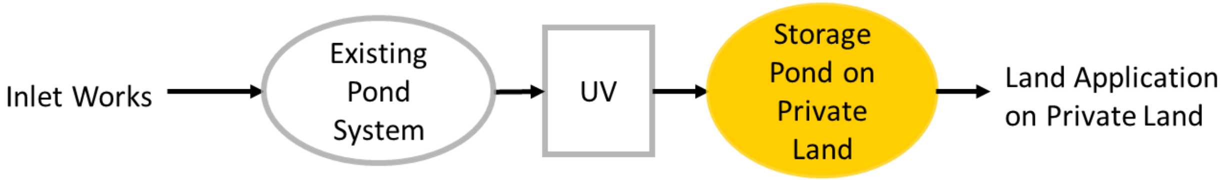

Figure 12: Process flow diagram for Raglan WWTP Option L2

A base irrigation area of 130 ha has been used in the costing based on a soil moisture model run with the 2055 average daily irrigation volume of 1,957 m^3.

To account for the undulating nature of the Raglan area which will require lower irrigation rates in steeper sections the slope adjusted area within the parcels has been used to determine the potential irrigation area. Based on slope adjusted areas for the area approximately 213 ha of irrigable area is required.

A 30% buffer zone factor has been applied. The entire parcel that encompasses the slope adjusted area has been included in the land purchase cost. For the cost assessment, it has been assumed that adjacent parcels (for complete farm operations) require purchase for this option, requiring a total land purchase area of 550 ha.

A rough order cost for a storage dam of 150,000 m^3 is based on the main elements for the structure such as dam embankment, liner, and stormwater diversion. It is assumed that the dam embankment would be a compacted earthen embankment and that there would be suitable material on site for the construction of the embankment, within land parcels selected for irrigation. A liner for the dam has not been included.

Any final dam site selection would require:

- Undertaking site selection process looking at geology and potential geohazard issues such as relic landslides;
- Assessing availability of purchase of land for the dam site and reservoir;
- Assessing any cultural issues;
- Location of disposal area;
- Pipeline routes available to dam site location; and
- Carrying out geotechnical site investigation to determine site and soil suitability.

The irrigation equipment has been costed on solid set irrigation due to the undulating topography in the area. Irrigation costs also include pipeline infrastructure from the main pipeline termination point to the storage pond, pump station and two distribution rising mains to various points across the irrigation area.

The landuse for this costing has been assumed to be mainly irrigated forestry with cut and carry pasture based fodder crops on the flatter areas of terraced ridgelines and valleys.

Please refer Appendix B for the full land treatment report completed by PDP.

5.5.2 Irrigation pipeline route

Figure 13 shows a high-level indicative pipeline route from the WWTP to the land discharge site. The pipeline has the following attributes:

Table 13: Pipe Route Attributes

Designation	Length	Static Head/ Elevation	Pipe Diameter (Pressure Rating)
Private Land (Te Hutewai Road)	8 809m	196m	DN250mm (PN20)

Conveying the treated wastewater to the designated location will require two stages of pumping, i.e. a booster pump station will be required about half way. The following maximum peak flow rate has been assumed in estimating the pump sizes:

Table 14: Peak Flow Rates and Pumps

Designation	Peak Flow Rate	Dynamic Head	Primary Pump Power (@ WWTP)	Booster Pump Power
Private Land (Te Hutewai Road)	25 L/s	181m (Primary) 107m (Booster)	75 kW	45 kW

No consideration of land ownership has been given in determining this pipeline route and public roads have been used to inform the routes. A more detailed assessment of the pipe routes to the land discharge areas are required if this is selected as a preferred option.

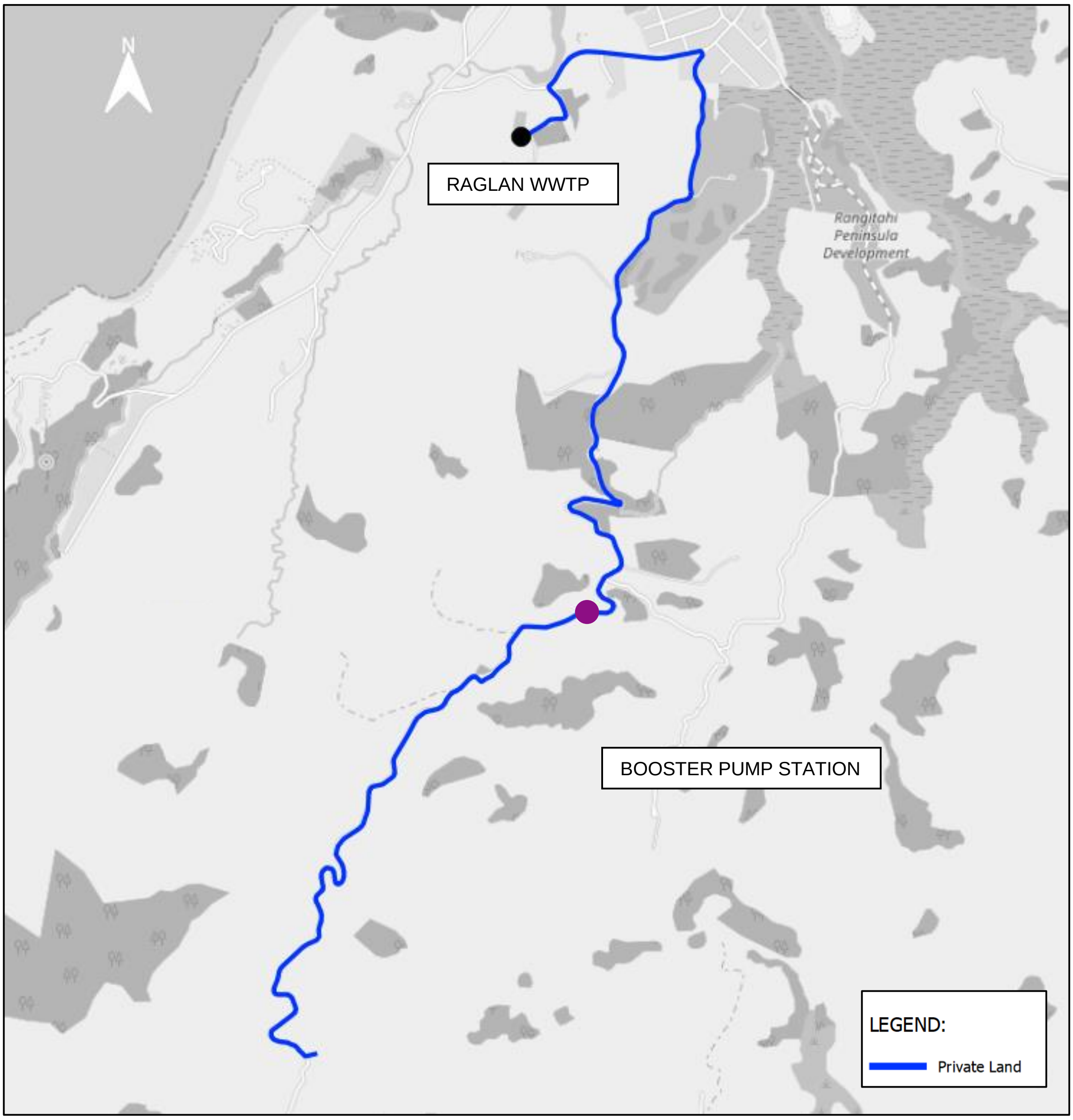

Figure 13: Indicative pipeline route to private land discharge site

5.5.3 Advantages, Disadvantages and Risks

The expected treated wastewater quality for this option would be the same as the current state due to no additional treatment, detailed in **Table 3**.

This option will require significant conveyance and irrigation capital investment with high operational costs for pumping to the very high static head.

Two stage pumping can create hydraulic problems which would need to be addressed in any further design work for this option.

A filter will be required to prevent the irrigation lines for the land treatment from blocking. This will need to be investigated further if this option is preferred but a provisional cost for the filter has been allowed for.

5.6 Option L3 – Additional Tertiary Membrane, Combined Private Land Discharge and New Harbour Outfall

5.6.1 Option Description

This option (Figure 14) is the same as Option L2 except a tertiary membrane system is used to improve treated wastewater TSS and pathogen levels and instead of being stored when soils are not suitable for irrigation, alternative discharge will be via the new harbour outfall.

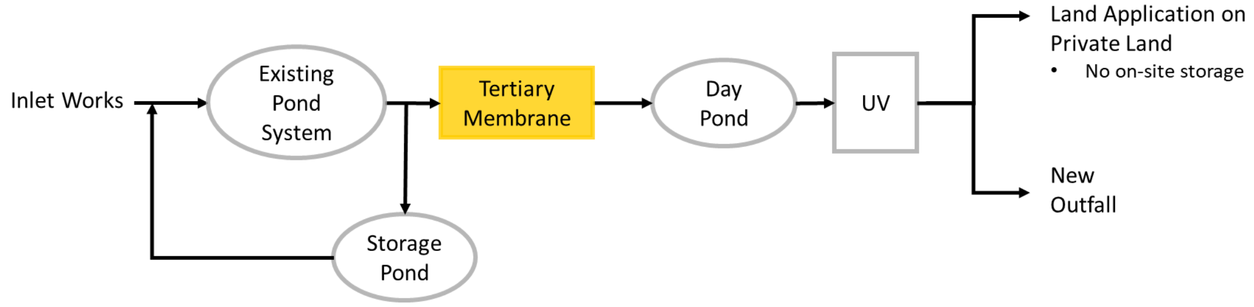

Figure 14: Process flow diagram for Raglan WWTP Option L3

A base irrigation area of 90 ha has been used in the costing based on a soil moisture model run with the 2055 average daily irrigation volume of 1,957 m³.

To account for the undulating nature of the Raglan area which will require lower irrigation rates in steeper sections the slope adjusted area within the parcels has been used to determine the potential irrigation area. Based on slope adjusted areas for the area approximately 145 ha of irrigable area is required.

A 30% buffer zone factor has been applied. The entire parcel that encompasses the slope adjusted area has been included in the land purchase cost. For the costing assessment, it has been assumed that adjacent parcels (for complete farm operations) require purchase for this option, requiring a total land purchase area of 320 ha.

A storage pond of 20,000 m³ capacity located within the irrigation area has been included in the costing to help buffer flows and allow for short term periods where soils exceed saturation or run-off is a risk. This volume is in addition to the 25,000 m³ of storage which is anticipated to be available at the WWTP.

The irrigation equipment has been costed on solid set irrigation due to the undulating topography in the area. Irrigation costs also include pipeline infrastructure from the main pipeline termination point to the storage pond, pump station and two distribution rising mains to various points across the irrigation area.

The land use for this costing has been assumed to be mainly irrigated forestry with cut and carry pasture based fodder crops on the flatter areas of terraced ridgelines and valleys.

This option allows for alternative discharge of the treated wastewater during the wetter winter months.

Please refer Appendix B for the full land treatment report completed by PDP.

5.6.2 Advantages, Disadvantages and Risks

Membrane treatment reduces potential health risks associated with the land discharge as well as lower risks for the period when discharge is to the harbour. Also, worth noting is that recreational water and coastal based activities occur more in the summer period when the land treatment system is more likely to be used.

Based on the expected average discharge to private land of ~470 026m³/year by 2025 and ~542 369 m³/year by 2055, it is anticipated that ~6% of the average annual inflow will discharge via the outfall by 2025 and ~24% by 2055 respectively.

Like all options with a membrane for treatment, there is a greater capital expenditure – coupled with the capital required for purchase of land and the new harbour outfall. Operating expenditure would be higher than option L1 due to the power and labour requirements required for operation of a membrane and pumping to land irrigation. This option would be very complex to operate.

However, as mentioned in Option M1, the ponds will need upgrading to maintain current treatment performance and the new harbour outfall would allow for the treated wastewater to be dispersed more efficiently on the outgoing tide.

5.7 Option L4 – Membrane Bioreactor, Combined Public Land Discharge and New Harbour Outfall

5.7.1 Option Description

Option L4 (**Figure 15**) is similar to option L1 except with MBR treatment in place of tertiary membrane treatment.

This non-deficit irrigation option has been based on potential irrigation to three public land areas (see Appendix B for full PDP report):

- Raglan Airstrip
- Golf Course
- Wainui Reserve

The MBR treatment process is described earlier in this report for options M2 and F1 and the public land irrigation areas and proposed pipeline routes are the same as option L1.

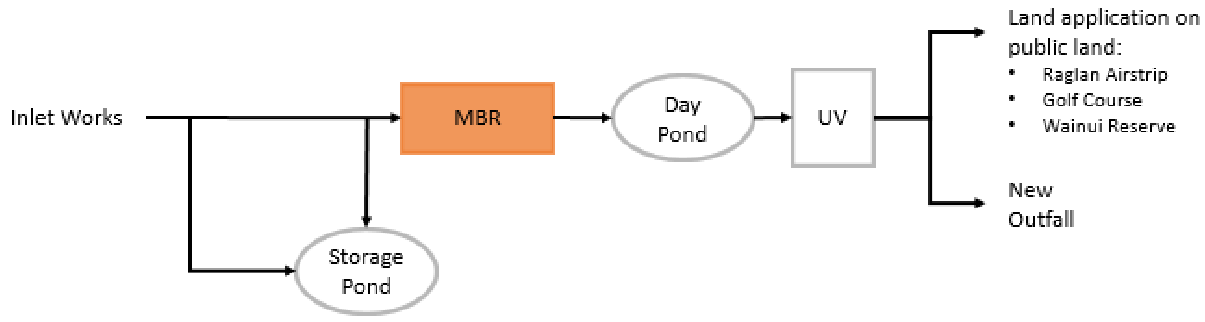

Figure 15: Process flow diagram for Raglan WWTP Option L4

5.7.2 Advantages, Disadvantages and Risks

Pump stations, rising mains and storage requirements will increase capital costs and operational complexity.

An MBR process requires much more operator effort and is more sensitive to changes in incoming loads than a pond system. Biosolids are produced daily and consequently must be hauled away several times per week for reuse or landfill disposal.

Outfall issues are the same as for option M1.

Land discharge issues are the same as for option L1.

6 Cost Estimates

6.1 Comparative Cost Assumptions

A comparative cost exercise was undertaken to establish the order of magnitude capital and operational costs of the various options. We recommend that that these costs are not used for capital appropriation and that a conceptual design of the preferred option be undertaken to confirm the estimated capital and operating costs. All tertiary membrane costs were based on information provided by a supplier, 'Masons'.

These estimates are solely for Watercare's use for the purpose for which they were intended in accordance with the agreed scope of work. They may not be disclosed to any person other than the Client and any use or reliance by any person contrary to the above, to which Beca has not given its prior written consent, is at that person's own risk. The capital and operational cost estimates applicable to the respective land discharge infrastructure were supplied by PDP.

The accuracy of this Conceptual Appraisal is commensurate with the level of design information available and base assumptions made. We have allowed for an estimating tolerance to account for general unknowns in the design and for any discrepancies in the design information prepared to date. The cost estimates are deemed to be Class 5 estimates as per the AACE Cost Estimate Classification System and have an expected accuracy range of -30% / +50%.

The following items have been included in the comparative capital costs:

- Major process items and structures.
- Mechanical and electrical installation.
- Instrumentation and control.
- Site civil works (platform preparation, roading, drainage, fencing etc.).
- Project costs (P+G, contractor margins, design and specification).
- Consultant fees (Design/Engineering)
- A contingency allowance of 30%

The following items have been excluded from the comparative capital costs:

- Client management costs
- Consents and easements
- Legal fees
- Land acquisition or leasing costs
- Client insurances
- Escalation after November 2020
- Goods and Services Tax
- No hard rock or pipe thrusting required/directional drilling
- Any impact of extraordinary global events (such as the current COVID-19 pandemic)

6.2 Comparative Capital Cost Estimates

The comparative capital cost in NZD, excluding GST, for each option is shown in Table 15.

Table 15: Comparative Capital Cost Estimates ($1000 NZD)

Option	M1	M2	F1	L1	L2	L3	L4
Establishment	70	100	100	70	70	70	100
Treatment[1]	9,876	20,813	21,242	9,876	5,000	9,876	20,813
Conveyance	388	355	257	1,894	1,990	2,163	1,894
Contractors P&G/Oversite Overheads and Profit	1,720	145	200	1,970	1,175	2,015	3,795
Sub-total Physical Works	12,054	21,413	21,799	13,810	8,235	14,124	26,602
Consultant Fees Design/Engineering)	1,041	1,886	1,917	1,182	736	1,207	2,363
Sub-total Base Estimate	**13,095**	**23,299**	**23,716**	**14,992**	**8,971**	**15,331**	**28,965**
Contingency Allowance (30%)	3,929	6,990	7,115	4,498	2,691	4,599	8,690
Sub-total Expected Estimate	**17,024**	**30,300**	**30,800**	**19,490**	**11,662**	**19,930**	**37,650**
Land Discharge (PDP)	-	-	-	5,500	47,000	22,000	5,500
Total Expected Estimate	**17,000**	**30,300**	**30,800**	**25,000**	**58,700**	**41,900**	**43,150**

Notes
[1] Provisional allowance of $ 5 000 000 for pond modifications (Options M1, L1, L2 and L3). Further investigations would be required for a more defined cost estimate.

Please refer to Appendix C for a breakdown of the cost estimates.

6.3 Operating Cost Estimates

The estimated annual running costs at 2055 for each option as well as the basis for the costs are shown in Table 16. Estimated operating costs are for the additional treatment/disposal only and do not include any operating costs associated with running the existing operation. Costs are in NZD and exclude GST. Operating costs assume the upgrade is operational in year 1.

Table 16: Annual Operating Cost Estimates at 2055 ($NZD)

Option	M1	M2	F1	L1	L2	L3	L4
Power $	24,000[2]	277,000[3]	277,000	45,000[3]	142,000	165,000[3]	277,000
Chemicals $	5,000	40,000	40,000	5,000	-	5,000	40,000
Additional Labour $	75,000	240,000	240,000	77,000	52,000	79,000	240,000

[2] Excludes pond aeration

Option	M1	M2	F1	L1	L2	L3	L4
Maintenance $	394,000	744,000	740,000	394,000	117,000	394,000	759,000
Monitoring $		200,000	200,000	50,000	50,000	50,000	250,000
Land Treatment (PDP)	-	-	-	89,000	60,000	80,000	89,000
Approx. Annual Total$	**498,000**	**1,501,000**	**1,497,000**	**660,000**	**421,000**	**771,000**	**1,655,000**
Basis:	12 hours labour/wk Maintenance 2% of base capex	10 x UV Lamp replacements /year 880 Tons of screening, grit and sludge /year	10 x UV Lamp replacements /year 880 Tons of screening, grit and sludge /year	20 hours labour/wk + 20 hours/year for pressure mains servicing Maintenance 2% of base capex Additional monitoring needed for land based consent	8 hours labour/wk +20 hours/year for pressure mains servicing Maintenance 1% of base capex Additional monitoring needed for land based consent	20 hours labour/wk + 20 hours/year for pressure mains servicing Maintenance 2% of base capex Additional monitoring needed for land based consent	10 x UV Lamp replacements /year 880 Tons of screening, grit and sludge /year Maintenance 2% of base capex Additional monitoring needed for land based consent

The following assumptions have been used for calculating the operating costs:

- Power cost of $0.2kWh
- Labour cost of $120/hr
- Tertiary Membrane annual chemical costs of $5 000
- MBR annual chemical costs of $40 000
- Maintenance assumed to be 2% of base capex for Options M1, L1 and L3 as they are primarily mechanical/electrical projects
- Maintenance assumed to be 1% of base capex for Option L2 as this option is primarily a civil project
- An allowance of $740 000 has been made for Maintenance on the MBR options (M2, F1 and L4) and covers general maintenance activities, UV lamp replacements, screening, grit and sludge disposal.
- Operational and maintenance cost for the land treatment infrastructure is based information received from PDP.
- Pond de-sludging is excluded from the cost estimates

Monitoring requirements for option M1 is expected to be similar to the existing operation and hence an additional allowance has not been included for these. Options L1-L4 would require a discharge to land consent which is likely to require additional monitoring over the current operation – an allowance of $50,000/annum has been included for this. A monitoring allowance of $200,000/annum has been allowed for the MBR options M2, F1 and L4.

6.4 Net Present Value

The net present value (NPV) for each option is shown in Table 17. This assessment is based on a 35 year period and a discount rate of 6%.

Table 17: NPV Analysis 35 years

Option	M1	M2	F1	L1	L2	L3	L4
Capex ($1000 NZD)	17,000	30,000	31,000	25,000	59,000	42,000	43,150
Additional Annual Opex ($1000 NZD)	498	1,501	1,497	660	421	771	1,655
NPV ($1000 NZD)	24,200	52,100	52,500	34,600	64,800	53,100	67,145

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Appendix A – Outfall Design

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23 November 2020

Attention: Stephen Howard

Dear Stephen

Raglan Wastewater Project – Outfall Options Update

1 Introduction

This note sets out a summary of the advancement of investigations and preliminary conclusions to date in relation to the construction requirements for discharge of treated wastewater to the Raglan Harbour entrance. The option of discharging to the open ocean through a long outfall was also previously considered but concluded as impractical.

Work undertaken in relation to the outfall component of this project now includes:

- Review of existing outfall history and performance
- Review of marine charts and bathymetry data
- Definition of outfall flows and indicative pipe sizes to accommodate existing and future flows, and the option of shorter discharge periods over the tidal cycle to optimise dilution performance
- Physical conditions at the site – bathymetry, tidal currents, wave climate information available from hydrodynamic model
- Establish the relevance of issues related to natural bed changes and currents
- Review preferred outfall alignment
- Consider outfall length requirements in conjunction with discharge modelling
- Develop conceptual options for outfall configuration and descriptions for costing
- Consider construction implications
- Update sketches showing conceptual locations and profiles
- Review of construction options following completion of geophysical investigations to establish likely geotechnical conditions adjacent to the harbour entrance

2 Background

The existing outfall is a DN200 AC pipe that discharges into the southern side of the main entrance channel to Raglan Harbour (Whāingaroa). The discharge location is closer to the shore than the originally installed outfall following the loss of a section of the outer end, presumably due to high current loadings and potentially seabed changes that removed support from the pipeline. The existing curtailed outfall pipeline discharges from the open-ended pipe at a level just below lowest astronomical tide. It is understood that an earlier attempt at outfall installation suffered a similar fate (historic reports indicate that the original outfall installed in 1977 only last for two months), illustrating the issues related to construction in this location and the need to ensure that a new outfall is constructible, secure, and accessible for maintenance.

Options for new outfall installations have been proposed based on a high-level desk top study of information available which includes the components required for calibrated harbour model including bathymetry, tidal and wave information, and further recently completed site-specific geophysical investigation and assessment (ScanTec 12 October 2020). This investigation has been carried out in conjunction with further modelling scenarios carried out by DHI (DHI 16 Nov 2020). This additional work provides more clarity in terms of feasibility of construction methods and refines dilution performance at the proposed outfall discharge location. Preliminary cost estimates will be based on this further investigation work, as well as consideration of the risk that will be perceived by contractors in needing to work in conditions exposed to regular and significant tidal current exposure, and the marine environment.

3 Channel Outfall Discharge Locations and Capacities

Modelling of discharge and dilution performance from locations in the area of the existing outfall in the harbour entrance shows that improvements to the dilution performance of the existing outfall can be achieved by providing an improved diffuser that provides better initial dilution than the current open ended pipe. Extending the pipeline length further into the channel where the water is deeper and the currents greater also provides improvements. However, the additional loads on the outfall from increased currents and the increasing difficulties for construction requires a compromise that provides for practical construction constraints and acceptable dilution performance.

Following the earlier investigations consideration was given to locating a new outfall pipeline approximately 110m to the east of the existing outfall where the construction process and outfall would be confined to road reserve and the coastal marine area. A short section of land line would be required to connect the new outfall to the existing pipeline running from the WWTP to the existing outfall.

The proposed location and alignment are shown on attached Beca drawing 4288629-CK-100, with potential to fine tune the position to minimise construction effects on traffic. The discharge location has been selected such that the pipeline components exposed on the harbour bed will be at least 2.5m below chart datum for navigational purposes. The discharge outlet will be deep enough to provide meaningful improvement in dilution performance compared to the existing outfall while minimising the exposure to tidal currents during construction and providing for practical access for maintenance. Limiting the outfall length also limits the exposure to the apparent migration of channel features which appears to occur in the main channels.

Hydraulic modelling has been carried out by DHI (16 Nov 2020) to identify suitable discharge regimes that help optimise the performance and adequacy of effluent dilution and dispersion from the revised proposed outlet location and concludes that daily flows are best discharged over 4 hours from 1 hour after high tide.

To provide for the existing and predicted future flow rates required to achieve the diurnal volume discharge over this shorter period (i.e. four hours compared to 12 hours), and to accommodate an increase in design flows over time, the outfall pipeline considered is 350 mm NB (400 mm OD PE) to provide adequate flow capacity. This pipe size is consistent with the diameter of the main conveyance pipeline from the WWTP – the existing outfall at 200 mm NB imposes a hydraulic restriction at the end of the conveyance system.

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4 Diffuser Characteristics

The numerical modelling of discharges has considered a single duckbill check valve on the end of the outfall pipeline. The advantage of this type of valve is that they maintain a high exit velocity discharge over the range of design flows to provide good mixing and thus initial dilution at discharge and prevent ingress of seawater and fouling of the pipe with marine growth. The maintenance of relatively high velocity at the discharge point also assists to displace sediment build-up should it occur, by scouring. The outfall would incorporate this component on the end of the 350 NB pipeline at a point that can be secured to the seabed by piling, with the discharge point provided with a degree of resistance from current loading and debris. Access would be required for maintenance or replacement of the check valve.

5 Design Considerations

The exposed nature of the outfall location will require careful consideration of design such that the outfall pipeline will be robust enough to provide secure and low maintenance performance. Site-specific issues in the Raglan Harbour entrance which will require assessment in design include:

- Regular tidal currents of up to 1.8 m/s at the surface. These currents will increase with distance from the shore into the channel.
- Limited to no slack water to allow ease of access during construction, and ongoing inspection. This imposes constraints on construction and inspection times and procedures which need to be tailored to the conditions. A plot of current speed frequency distribution at 1.0 m above the channel bed derived from the hydrodynamic model of Raglan Harbour is shown on the attached drawing
- Exposure to ocean wave penetration into the harbour under certain sea conditions, and wind generated local waves – these will impose loadings to the pipeline in addition to the current forces, and influence construction procedures. The significant wave height record for the 2018 year at the existing diffuser location is plotted on the attached drawing, showing significant wave height (the mean of the highest third of waves) exceeding 1 m.
- Evidence of changes in channel bed bathymetry in response to tidal currents. These include the migration of channel bed features which have the potential to undermine or engulf the exposed section (diffuser). NIWA field investigations undertaken in 1996 which compared bathymetry surveys between 1978 and 1996 suggest that significant changes of up to 3 m in seabed occurred in bed level in the vicinity of the design location of the outfall proposed at that time. This location was further into the channel than currently being considered for the new discharge location, but it is proposed that further investigation and monitoring is required to establish if changes closer to the shore occur, and if so, adjustment to the design can be made to accommodate such changes.
- Geophysical survey has been undertaken to refine the understanding of geotechnical conditions on the proposed outfall alignment. Indications are that the harbour bed at that location comprises an average depth of sand of 11 m overlying bedrock. This investigation has added significantly to the understanding of the site. The indicated sediment depth to rock provides enough clearance to allow horizontal directional drilling (HDD) from onshore and will allow the installation of screw piles or jetted pin piles to provide anchorage at the outer end of a pipeline. Installation of a ballasted PE pipeline into an excavated trench and secured with piles over the outer end could also be achieved although the trench would need to be sheet piled to stay open in the tidal currents.
- The potential operation of the outfall in conjunction with or as a back-up to land disposal requires that the outfall is available and functional at all times despite potentially not having been used for some time. The requirement is for a robust component that provides good utility and access to the point of discharge for maintenance.

Considering these characteristics, the following components are proposed for the initial outfall concept:

- A continuous 350 NB (400 OD) PE pipeline to help provide a robust and corrosion free conveyance
- Pipeline to be either HDD from onshore to the diffuser location or trenched and buried to as close as possible to the diffuser location. The trenched pipeline option to be fitted with clamped-on concrete weight blocks over the full length to assist with installation and in ground stability.
- The single diffuser outlet to be fitted with a rubber duckbill check valve to assist with initial dilution of effluent, to prevent seawater intrusion at low flows, and to provide some scouring capability in the case of variable sand levels.
- The incorporation of a surge chamber on the inshore end of the outfall pipeline may be considered to provide a hydraulic separation between the pumped land line and outfall.
- Consideration of keeping the discharge point relatively close to shore to facilitate access for inspection and maintenance.

6 Construction Requirements

The environmental conditions at the site, in particular tidal currents will make construction challenging and costly in terms of the requirements for temporary works to enable installation. The construction method and procedures will be established by the contractor to achieve the specified requirements. The options available for construction include directional drilling, and installation and of the prefabricated pipeline in a pre-dredged trench. An unrestrained float and sink option with subsequent burial of the pipeline is considered impractical because of tidal current conditions. Geophysical investigations undertaken (Scan Tec October 2020) provides interpretation that the site comprises sand overlying bedrock at an average depth of 11m. This is considered adequate to allow horizontal directional drilling, and the installation of screw or pin piles to secure the outfall to the harbour bed. The Scan Tec report recommends that more detailed geophysical measurements and comparison with existing or future geotechnical data should be undertaken to confirm results presented.

The inferred depths of rock at the surf club site are plotted on the profiles on Drawing 4288629-CK-100 to illustrate the relative positions of harbour bed and underlying rock surface.

It is expected that temporary works required will include:

- Full length temporary trestle for both options to provide above water access to allow machinery to undertake trenching, pile installation, pipe burial, recovery of HDD gear, and construction diver support. The trestle itself will need to be designed to withstand the current conditions, including bed scour that will arise from the current/support pile interaction. The recent geophysical investigations provide information to assist with design of this component.
- The trenched option is likely to require sheet piled protection over the full length of the outfall to allow excavation and maintenance of a trench in the tidal currents and controlled subsequent backfilling once the pipe is installed. The upper beach section of pipeline will require a relatively deep trench such that the pipe achieves an appropriate profile, and as the trench extends into the water, care will be required to minimise exposure of the pipe in the tidal currents until it is installed to grade.

Clearly, in considering these temporary works requirements, the cost of the outfall construction will be directly affected by the design outfall length. To help provide cost effective design the proposed location and outfall length shown on Drawing 4288629-CK-100 are based on achieving a practical minimum length that helps to provide adequate dilution performance and a robust outfall option that has a discharge location that remains accessible for inspection and maintenance.

7 Further Investigations

Ongoing monitoring of bathymetry at the proposed outfall site is recommended to identify potential changes to the bed profile. While the construction options have been established with the intention of accommodating reasonable variations in bed level it is advisable that the magnitude of changes is identified, particularly if a trenched option is preferred. If the outfall option is selected as part of the preferred concept option, then a monitoring programme should be considered in line with the project timeframe. Further investigation is recommended to confirm seabed conditions inferred from the preliminary geophysical survey, and in conjunction with this specialist contractor input should be sought to refine pipeline installation procedures and costs.

Yours sincerely

Ian Goss
Senior Associate - Civil Engineering

on behalf of

Beca Limited

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References

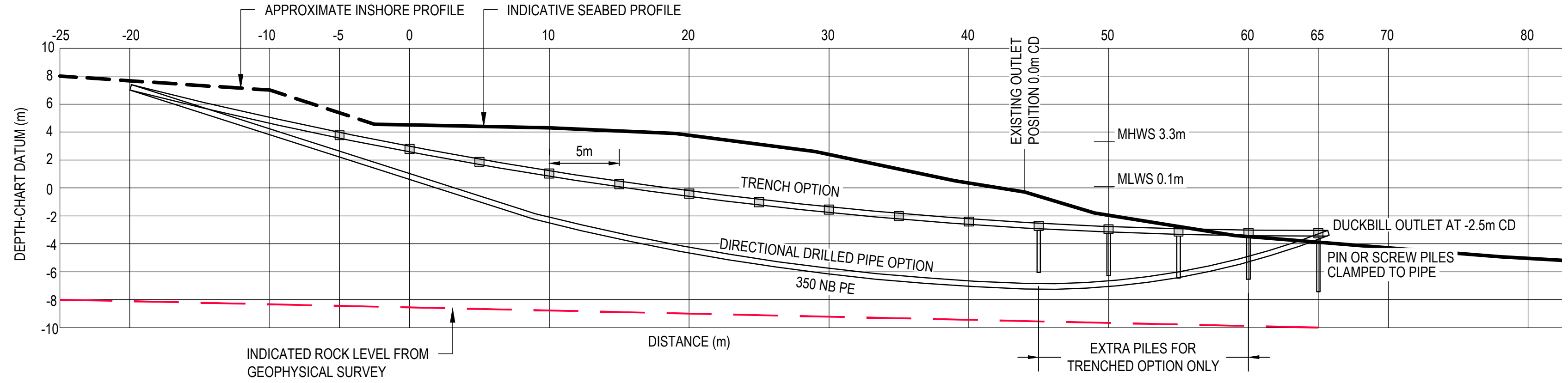
ScanTec WA1015; Technical report for geophysical survey, Raglan Harbour: 12 October 2020

DHI Water & Environment Ltd Ref 448011462/01; Timing optimisation – Raglan Wastewater Treatment Plant; 16 November 2020

Attachment

Beca Drawing 4288629-CK-100 - Preliminary Outfall Discharge Pipe Option

Drawing Plotted: 30 Nov 2020 12:12 pm



INDICATIVE PROFILES ON OUTFALL ALIGNMENT
SCALE 1:500

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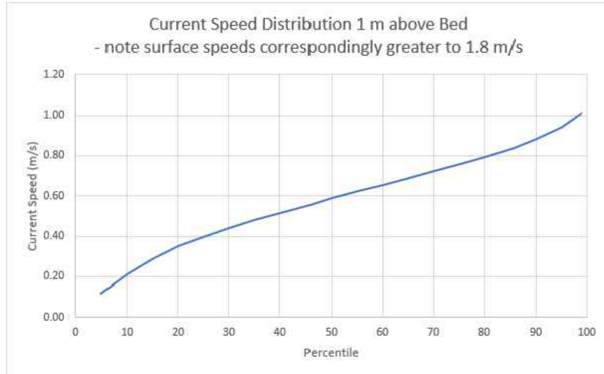
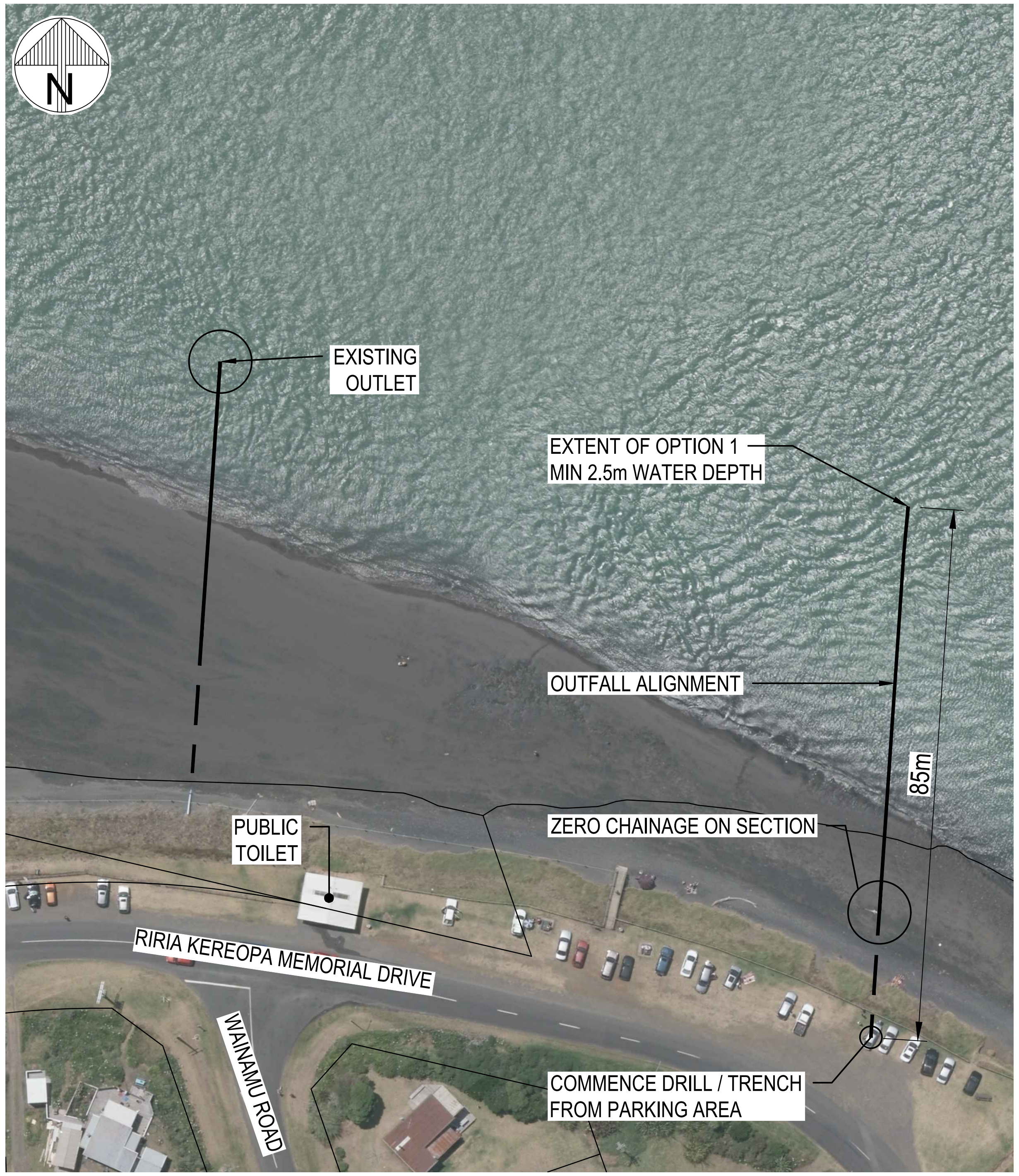
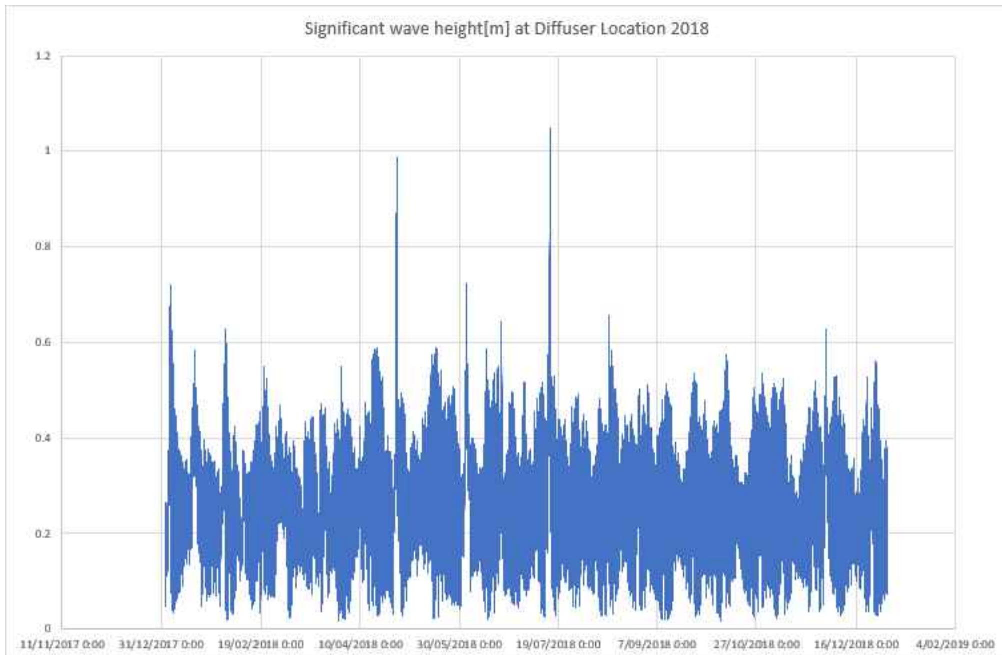


MODELLED CURRENT SPEED DATA AT OUTLET

Note
1 Geophysical data from ScanTec Ltd
2 Modelled data from DHI calibrated harbour model



PLAN
SCALE 1:1000



MODELLED WAVE HEIGHT DATA AT OUTFALL LOCATION

ORIGINAL DRAWING IN COLOUR

PRELIMINARY
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
A	FOR REVIEW	RAS	IG	GH	-

Drawing Originator: Beca

Original Scale (A3): AS SHOWN

Design	IG	11.20
Drawn	RAS	11.20
Dsg Verifier		
Dwg Check	IG	11.20

* Refer to Revision 1 for Original Signature

Approved For Construction*

Date

Client: Watercare

Project: RAGLAN WASTEWATER CONSENT RENEWAL

Title: PRELIMINARY OUTFALL DISCHARGE PIPE OPTION

Discipline: CIVIL- WATER

Drawing No. 4288629-CK-100

Rev. A

Document No. 4288629-CK-100.DWG

DO NOT SCALE

IF IN DOUBT ASK.

B

Appendix B – PDP Land Treatment Report

Raglan Wastewater Treatment Plant Discharge Options – Assessment of Land Irrigation

Prepared for

Watercare Services Limited

January 2021

D R A F T

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Quality Control Sheet

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CLIENT	Watercare Services Limited
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DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

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Reviewed and approved by

SIGNATURE

Daryl Irvine

DRAFT

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Watercare Services Limited and others (not directly contracted by PDP for the work), including Beca Limited and Waikato District Council. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Watercare Services Limited for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

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Executive Summary

The Raglan wastewater treatment plant (WWTP) is owned by Waikato District Council (WDC) and operated by Watercare Services Limited (WSL). Treated wastewater has historically been discharged to the marine environment under a marine discharge consent, which expired in February 2020. Currently, legal operation of the discharge continues as the status quo for treatment and 100% marine outfall discharge under a short term 3 year consent application, lodged early in November 2019 with the Waikato Regional Council (WRC).

A new long term consent is required and changes to the present discharge method are being investigated. The final solution will need to be the Best Practicable Option (BPO) that balances environmental, cultural and financial effects, provided within a 35-year consent (or longest time frame obtainable). To identify a BPO, several options are being explored, which comprise discharge options to land and/or water.

Pattle Delamore Partners Ltd (PDP) has been engaged by WSL, as part of the Technical Adviser team, with Beca Limited as the lead technical adviser, to complete technical assessment works in relation to land treatment options required for the consenting project. Land treatment and Deep Bore Injection (DBI) were both identified by PDP as potential discharge solutions within a long list of discharge options of treated wastewater. DBI was discounted once short listed options were finalised.

<u>Long List Assessment</u>

Four potential land treatment options were investigated, including deficit and non-deficit irrigation, with and without an alternative winter marine disposal option (dual discharge). Soil moisture models, developed for each option, indicate that the following irrigation areas and storage volumes are required for the proposed 35 year consent term:

- Non-deficit, all year round: 90 ha - 190 ha, 150,000 m^3 of storage;
- Non-deficit, dual discharge: 80 ha - 110 ha, 20,000 m^3 of storage;
- Deficit, all year round: 260 ha – 570 ha, 300,000 m^3 – 400,000 m^3 of storage;
- Deficit, dual discharge: 220 ha - 240 ha, 20,000 m^3 of storage.

A weighted attribute, GIS based, assessment (WAA) was conducted to identify potential irrigation areas within a 10 km radius of the Raglan WWTP. The assessment considered usable area, topography, landuse, district plan zoning, distance from the WWTP and land ownership. 40 preferred sites were identified on the south side of Raglan Harbour, with varying irrigable areas. To enable a non-deficit irrigation option, 2 to 4 of the assessed land parcels will theoretically be required. To enable a deficit irrigation option, 4 to 11 of the assessed land parcels would theoretically be required. The two non-deficit schemes progressed to the short listed options due to the smaller land area and storage area requirements.

Short List Assessment

Selected short listed options include:

- Non-deficit irrigation to land – 100% irrigation.
- Non-deficit irrigation to land with an alternative marine discharge.

For the short listed options, theoretical cluster sites have been assessed to identify potential combined irrigation areas that could form part of a complete single location system.

For the non-deficit, 100% irrigation to land, 4 irrigation clusters were identified, within the 10 km radius assessment area, with the optimum location situated south of the treatment plant, near Te Hutewai Rd. There are a number of incised valleys in this location which could provide for large storage dams. Land-uses that could operate under the irrigation system, for the identified cluster sites, would likely include a combination of forestry for steeper slopes and cut and carry pasture based fodder crops for lesser sloped areas, such as ridges and valleys.

For the non-deficit irrigation option with an alternative discharge solution (marine), the required land area is slightly less than the area required for the 100% irrigation option. The reason for this is that the marine discharge will accommodate wastewater volumes during wetter winter months when greater land areas (and storage volumes) are required to avoid oversaturating soils. For the reduced area, 5 theoretical irrigation clusters have been identified. Similar to the 100% irrigation option, the properties along Te Hutewai Rd are likely to be the optimum location (subject to landowner consultation).

The rough order cost for the three short listed land treatment options are:

- Option 1 – Non-deficit 100% to land: $47 M
- Option 2 – Non-deficit with alternative discharge: $22M
- Option 3 – Non-deficit to public land with alternative discharge $5.5M

If these short listed options are to progress further, identified key knowledge gaps and key inputs which need to be incorporated into progressing land treatment as a potential discharge option or part-option, are:

- Legislation and regional planning review to solidify position on any regulatory aspects that may influence any land treatment option.
- Iwi consultation and involvement, particularly to assist in identifying any culturally sensitive areas that should be excluded from further land treatment consideration.

- Initial stakeholder / landowner consultation re: potential interest in either working with WSL collaboratively or land sale/lease possibilities.
- Detailed field investigation to assess general soil types and permeability confirmation at sites where there is landowner interest.
- Initial land treatment concept design with size and application method, including very rough order costing on concept option.

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Appendices

1.0 Introduction

The Raglan wastewater treatment plant (WWTP) is owned by Waikato District Council (WDC) however, in 2019, operation of the plant and management of the treated wastewater disposal was transferred to Watercare Services Limited (WSL). Treated wastewater has historically been discharged to the marine environment under a marine discharge consent, which expired in February 2020. Currently legal operation continues as the status quo for treatment and 100% marine outfall discharge under a short term 3 year consent application lodged early in November 2019 with the Waikato Regional Council (WRC).

A new long-term discharge consent is required and changes to the present discharge method are being investigated alongside re-use options. The final solution will need to be the Best Practicable Option (BPO) that balances environmental, cultural and financial effects, provided within a 35-year consent (or longest time frame obtainable). To identify a BPO, several options are being explored, which comprise discharge options to land and/or water.

Beca (lead technical advisor) and WDC commenced work toward a long-term consent in March 2019, where an alternative agency was engaged to provide land-irrigation technical advice. Investigations conducted for consenting were previously managed by WDC, however, the responsibility for obtaining consents for discharges from the plant have now been transferred to WSL. Work undertaken up to the transfer of responsibilities included several technical, environmental and engineering investigations. A short-list of seven concept options was identified and engagement with the community and mana whenua undertaken.

Upon transition from WDC to WSL a project re-focus occurred which established a WSL preference to engage Pattle Delamore Partners Ltd (PDP) as specialists for the land treatment-based activities, with Beca remaining as the lead technical expert for the consent application preparation. In terms of land-treatment options, work up to the transition of WDC water services to Watercare included a long list options assessment which was refined to focus on one site on Maungatawhiri Rd for land disposal with winter marine discharge. Due to compressed timeframes associated with lodging the new consent applications, the ability for progressing productive engagement with the required property owner was not able to be progressed sufficiently. Upon transition, the intention was to re-new such discussions as part of any short listed disposal methodology. As such, a high-level revisit of the suitability of several sites was needed, which may support any additional discussions with property owners and operators, depending on suitability for discharge.

PDP has been engaged by WSL as part of the Technical Adviser team to complete technical assessment works in relation to land treatment options required for the consenting project. Land treatment has been identified as a potential discharge option. The purpose of this report is to provide a high level review of this discharge applicability within the Raglan area, as a long list option, and to progress towards identifying potential sites for short listed land treatment option assessment.

1.1 Data Sources

Key externally obtained data sources and resources used within this work package are:

- Digital land zoning and designation data (Waikato District Council);
- Digital topographic data (Waikato Regional Council);
- Digital regional soil drainage maps (LINZ and S-MAP);
- Digital regional geological maps (GNS);
- Digital land cover data (LINZ);
- Rainfall and evaporation data (NIWA);
- Registered bore information from Waikato Regional Council including geological/drillers log descriptions; and
- Groundwater and surface water takes, and allocation limits (Waikato Regional Council).

2.0 Land Treatment

Land treatment is the irrigation of wastewater (generally pre-treated/treated) to land, with the purpose of supporting a land use (crop) and with the soil and crop providing further treatment of the wastewater with water and nutrient uptake. Application of dried, dewatered or wet biosolids to land is also captured under land treatment, though is not assessed in this case. Any residuals from land treatment can migrate diffusely to groundwater and/or surface water receptors.

2.1 Land Treatment Scenarios

The following four possible scenarios were initially considered:

- Non-deficit irrigation - 100% to land all year round, at rates exceeding soil moisture demand;
- Non-deficit irrigation with alternative discharge - seasonal irrigation with alternative discharge i.e. marine discharge, during wetter season (late autumn to early spring);
- Deficit irrigation with storage - 100% to land when soil moisture levels require irrigation;
- Deficit irrigation with alternative discharge – seasonal irrigation with alternative discharge i.e. marine discharge, during wetter season.

For a non-deficit irrigation system treated wastewater is irrigated to land all year round, with storage required for periods when soils risk saturation or runoff. This type of system allows for soils to be irrigated above field capacity which is the moisture content held in soils after excess water has drained away. Irrigating soils above field capacity therefore induces downward drainage and leaching of nutrients to groundwater generally occurs.

For a deficit irrigation system, treated wastewater is only irrigated to land when soil moisture levels require additional moisture, up to field capacity, and therefore no downward drainage takes place. This generally occurs during late spring to early autumn when drier conditions benefit from water application. A deficit system requires a large storage capacity during the wetter winter months, or alternatively can be managed with an alternative discharge i.e. marine discharge or discharge to surface water.

In land treatment systems, nutrients in the treated wastewater are captured in the soil, biologically and chemically broken down, and up taken by vegetation stimulating growth and providing further treatment of the applied wastewater. The assimilative capacity of the system is dependent on soil characteristics, plant type and environmental conditions.

2.1.1 Soil Moisture Model

A soil moisture model (SMM) was run to identify approximate irrigable land area requirements and storage volumes for all four scenarios. The SMM models the daily effects on soil moisture under different operating constraints.

The model uses a water mass balance within the void space in the topsoil. The void space is based on the anticipated characteristics of the soil type and is defined by the sum of the wilting point (%),the profile (plant) available water (PAW) (%) (the void space between the wilting point and the field capacity), and the macroporosity (%), which is the void space above field capacity and before saturation.

A daily soil moisture content is determined from the previous days soil moisture plus rainfall and irrigation and less potential evapotranspiration (PET), infiltration to groundwater, runoff and interception.

Figure 1 summarises the soil water storage and the various factors that influence the soil moisture content. Water is stored in the pores of the soil and starts to infiltrate to groundwater once field capacity is reached. The saturation point is when all the pores in the soil are full with water, ponding and runoff start to occur at this point. The wilting point is defined as the amount of water in a soil that a plant requires before it starts to wilt. Below this point evapotranspiration will not occur.

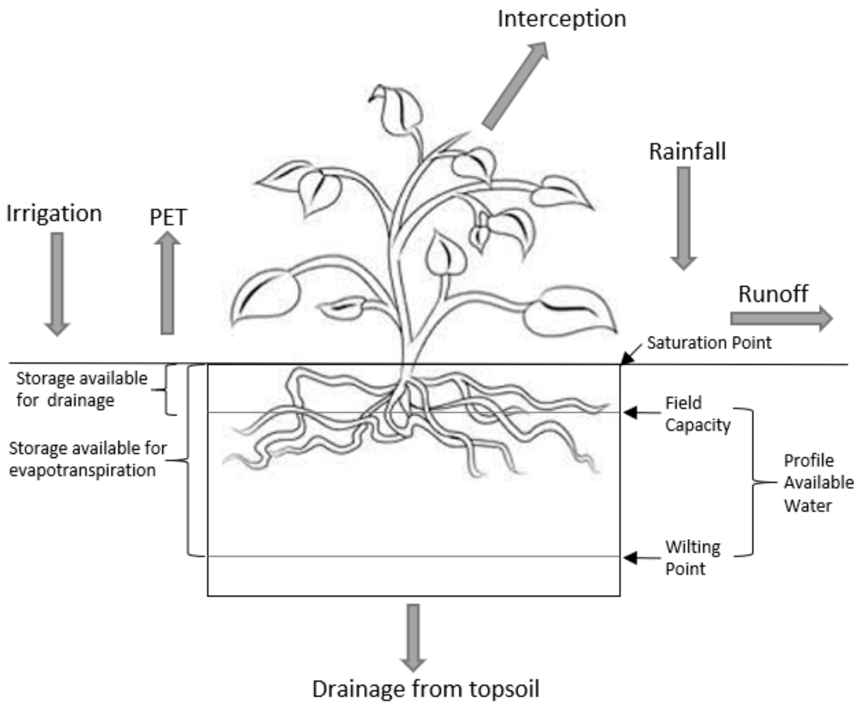

Figure 1: Soil moisture storge schematic

The following assumptions were used in the SMM:

- Rainfall and Potential Evapotranspiration (PET) – daily rainfall and PET data was downloaded from the National Climate Database (2020) for a ten year period (2006 – 2015). The 'Raglan, Karioi' station (agent no 2027) was used as the source of data for rainfall and the 'Hamilton, Ruakura 2 Ews' station (agent no 26117) was used as the source of data for PET. These stations are approximately 2.5 km and 40.5 km from the Raglan WWTP, respectively;
- Daily wastewater volume was the projected average daily flow in the year 2055 (35 years) of 1,957 m^3/d;
- Irrigation does not occur if rainfall exceeds 50 mm/day and the maximum irrigation event is 50 mm;
- Storage is uncovered and affected by evaporation and rainfall;
- The maximum irrigable soil moisture content is:
  - Halfway between field capacity and saturation for a non-deficit system;
  - Field capacity for a deficit system;
- For the non-deficit system and deficit system with alternative discharge, the model assumes 20,000 m^3 (approximately 10 days) of storage;
- Runoff only occurs when soils are at saturation and interception is negligible;
- The soil parameters were based off three dominant moderately drained & well drained soils in the Raglan area.
- To take into account wet soil conditions, the models assume a saturated drainage rate of 10mm/d and an average unsaturated (k_{-40}) drainage rate of 1 mm/d (ranging from 0 mm/d to 2 mm/d).

Based on the soil moisture model assumptions, Table 1 summarises the irrigable land area requirements for each land treatment scenario.

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Table 1: Land Area Requirements for Various Land Treatment Scenarios

Scenario	Land Area (ha)	Storage (m^3)	Annual Irrigation Depth (mm)
Non-Deficit Irrigation	90 - 190	150,000	440 - 800
Non-deficit irrigation with Alternative Discharge	80 - 110	20,000	510 - 770
Deficit Irrigation with Storage	260 – 570	300,000 – 400,000	210 - 320
Deficit Irrigation with Alternative Discharge	220 - 240	20,000	240 - 260

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2.2 Raglan Soil Assessment Summary

PDP undertook field investigations on 21 and 22 July 2020 in Raglan to assess general soil types and permeability in the area to identify potential for wastewater irrigation in Raglan.

A number of sites in the area were visited based on availability and granted permission from property owners. The investigations involved walking over the site, taking soil augers for soil identification, and taking soil cores for permeability testing. PDP engaged Landcare Research soil scientist Malcolm McLeod to assist with the investigations and provide a summary of the soil types present (see Appendix B).

The following locations (see Figure 2) are a mix of public and private land and were used to create an understanding of the general soil types in the Raglan area:

- Wainui Reserve
- Raglan Airstrip
- Raglan Golf Course
- 276 Maungatawhiri Road
- 15 Te Ahiawai Road
- 343 Te Hutewai Road
- Fertiliser Airstrip, Te Hutewai Road

It is noted that testing at the Raglan Airstrip was for knowledge building only as it is understood that the site is reserved for other future uses. Additionally, it is noted that a large section of the Wainui Reserve is designated as Maori Area of Significance and as such is unlikely to be available for land treatment.

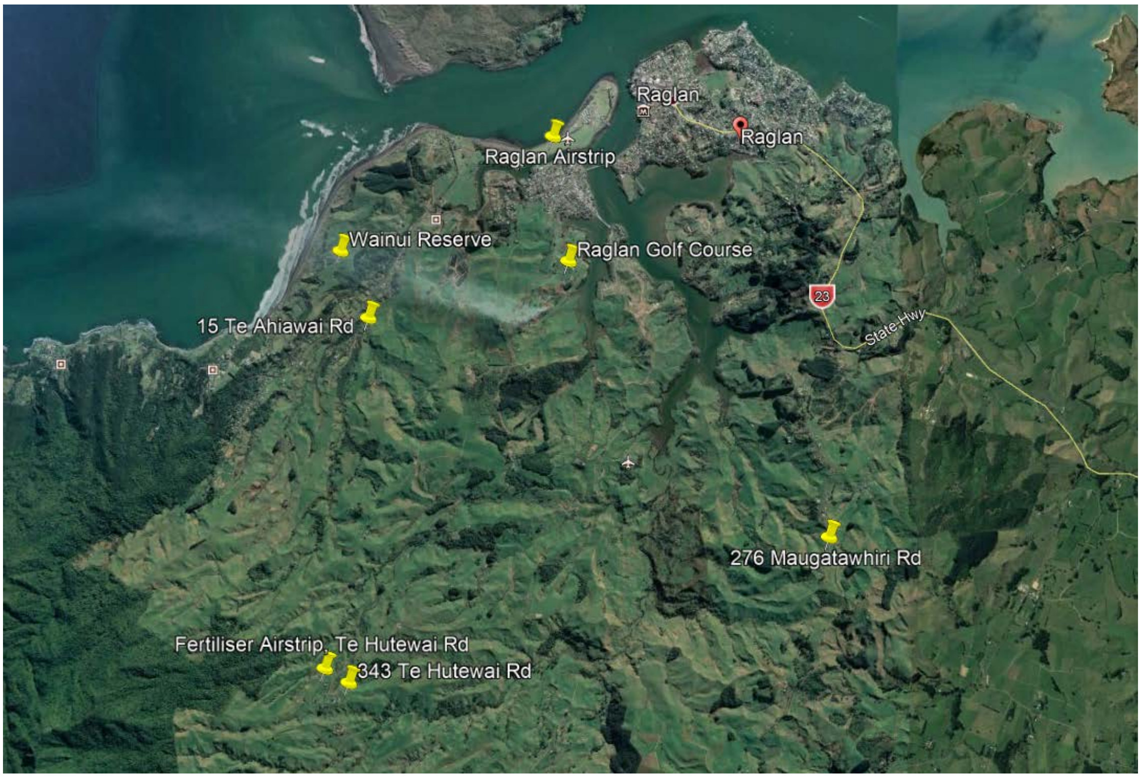

Figure 2: Soil Sampling Locations

The site assessments were undertaken when the soil conditions were wet, following an extended period of rain. This provided an opportunity to observe the performance of the soils under wet conditions which is advantageous as it is important to understanding the soils performance under irrigation to avoid damaging the structure via oversaturation. Soil cores were taken from topsoil and subsoil layers to test for hydraulic conductivities at each assessed site. The purpose of hydraulic conductivity testing is to gain an understanding of the pore size distribution within the soil and the soils ability to transmit water.

In general, there were three main soil types assessed, consisting of:

- Soils with limiting clay layers, in the sites immediately south of Raglan, including the golf course, Wainui Reserve and Te Ahiawai Road,
- Freer draining loamy soils, further south of Raglan (Upper Te Hutewai Rd), and.
- Sandy soils, under the Raglan Airfield.

The soils identified as having limiting clay layers would require high levels of irrigation management to avoid saturated conditions inducing runoff and ponding. Fine manganese concretions and paler colours in these soils indicate wet soil conditions in the upper part of the soil during part of the year. While mapped as 'moderately well drained' on SMAP the soils encountered would

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behave more similar to 'imperfectly drained soils', limiting soakage capacity, due to the lower, limiting clay layer. The areas observed were generally hilly and low permeability in the clayey subsoils could lead to lateral flow within the soil.

Loamy soils were encountered at both sites on Te Hutewai Road and soil colouring indicates there is no rapid changes in permeability, therefore irrigated wastewater would move uniformly to depth. These soils were judged to have medium to high P-retention indicating they would absorb phosphorus from the treated wastewater reducing the chance of run-off.

Sandy soils were encountered at the Raglan Airstrip. Sandy soils have high infiltration rates but are limited in their ability to absorb chemical contaminants entrained in treated wastewater.

The soil types, which are likely to be better for land treatment are the moderately well drained soils that can manage irrigation better during wet periods, but allow sufficient retention of water to adsorb nutrients.

The level of treatment provided by the existing wastewater treatment plant with filtration is sufficient for irrigation of these soils, provided that the application rate is in keeping with the hydraulic capacities of the soils and the nutrient removal capacity of the land use system.

2.2.1 Soil Hydraulic Conductivity

Undisturbed soil cores of the topsoil and subsoil were collected at each location and analysed for saturated hydraulic conductivity (K_{sat}), unsaturated hydraulic conductivity (K_{-40}) and bulk density. Table 2 summaries the results of the sampling.

Table 2: Hydraulic Conductivities in Raglan Area

Site	Topsoil/Subsoil	K_{sat} (mm/h)	K_{-40} (mm/h)	Bulk Density (g/cm³)
Wainui Reserve, site 1	topsoil	29	19	0.85
	subsoil	40	37	1.1
Wainui Reserve, site 2	topsoil	3	1	1.02
	subsoil	5	4	1.13
Raglan Airstrip	topsoil	127	84	1.29
Raglan Golf Course	topsoil	647	117	0.83
	subsoil	693	51	0.94
276 Maungatawhiri Road	topsoil	35	6	0.87
	subsoil	289	108	1.05
15 Te Ahiawai Road	topsoil	63	11	0.97
	subsoil	2	1	1.05
343 Te Hutewai Road, site 1	topsoil	15	8	0.6
	subsoil	289	141	0.66
343 Te Hutewai Road, site 2	topsoil	11	4	0.69
	subsoil	647	262	0.56
Fertiliser Airstrip, Te Hutewai Road	topsoil	231	12	0.63
	subsoil	404	182	0.58

Notes:

1. *Sampling was carried out by PDP staff on 21 – 22 July 2020.*
2. *Laboratory testing carried out by Landcare Research Soil Physics Laboratory.*

Low subsoil saturated and unsaturated hydraulic conductivities at Wainui Reserve and Te Ahiawai Road confirm observations of underlying clay layers with limited permeability. A high saturated hydraulic conductivity was recorded at the Raglan Golf Course, however, this is possibly due to cracks in the sample as the distribution between K_{sat} and K_{-40} is relatively large.

The subsoils at Te Hutewai Road demonstrated higher subsoil saturated hydraulic conductivities and unsaturated hydraulic conductivities indicating soils with increased permeability. The rates are in excess of typical irrigation rates of 5 mm/hr. The distribution between saturated and unsaturated hydraulic conductivity in these soils indicate a good distribution of pore sizes.

The subsoils at Maungatawhiri Road demonstrated a saturated hydraulic conductivity and unsaturated hydraulic conductivity in the lower range encountered at Te Hutewai Road. These soils were judged to have a lower overall permeability on inspection(see Appendix B).

2.3 Land Application Area Scoping Assessment

A custom Weighted Attribute Analysis (WAA) tool was developed by PDP to provide a high-level, wide ranging assessment of potential land treatment sites within the Raglan area. The assessment was designed to be predominantly technical in nature, and therefore deliberately excludes direct assessment of capital and operational costs, as well as social and cultural aspects at this stage.

2.3.1 Physical Extent of Assessment

The physical extent of the assessment area was selected in association with the project team and covers a 10 km radius from the Raglan WWTP in all directions (refer to Figure 3).

The assessment area encompasses a wide range of physical terrain, environmental settings, and land uses within the region. PDP consider the assessment area as comprehensive and representative for the region, and deliberately constructed so as not to exclude potentially favourable portions of the region.

KEY :

- RAGLAN WATEWATER TREATMENT PLANT
- ASSESSMENT AREA

SOURCE:
1. TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA.

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RAGLAN WWTP DISCHARGE OPTIONS

TITLE :
LAND APPLICATION TECHNICAL ASSESSMENT AREA

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0 500 1,000 2,000 3,000
METRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03532200	3	A

A03532200Z002_Site.mxd

Parcel boundaries were overlaid across the assessment area and parcels adjacent to each other with the same Certificate of Title were grouped as one effective parcel. The quantitative assessment was run for every parcel. The aim of this approach was to provide an overall suitability ranking for each parcel of land to enable suitable properties to be identified.

Overall, the assessment is intended to provide high-level assessment of potential land treatment properties in a holistic, quantitative and transparent manner for the entire search area.

2.3.2 Fatal Flaw Assessment

A 'fatal flaw' assessment identified areas within the assessment area that are considered incompatible with land treatment. These are:

- Incompatible land zoning – essentially; urban/residential, commercial, industrial zoned land, and other including living zones, Maioro Mining, Pa, Village and Wetland conservation;
- Land Slope - Slopes greater than 30%.

Areas comprised partly or completely of any of the above, were excluded from further assessment. The remaining land is termed the 'useable land area'.

2.3.3 Weighted Attribute Analysis

The assessment involves use of a WAA on the remaining parcels to quantitatively rank potential suitability for land treatment against a prescribed criterion. The scoring criteria comprises of seven primary aspects:

- Useable Land Area
- Physical Suitability (Slope and Soil Drainage)
- Distance from WWTP
- District Zoning
- Existing Land Use
- Land Ownership

Geospatial data was obtained from data source providers, and automated GIS 'scripts' were developed and utilised to provide consistent data for each parcel. The scripting of the raw data assessment allowed for these very large data set to be handled efficiently i.e. compared to a manual assessment. Geospatial data used as input to the WAA is presented on Figure 4 (land zoning), Figure 5 (land slope), Figure 6 (soil drainage), and Figure 7 (land cover).

The geospatial data was quantitatively evaluated for each criterion at each parcel. The outcome was calculated as a numeric ranking score within a range of 5 (best) to 1 (worst). Each criterion was then weighted based on its perceived importance to land treatment suitability. The WAA Methodology is summarized in Appendix A.

KEY :

- RAGLAN WATEWATER TREATMENT PLANT
- ASSESSMENT AREA
- ASSESSMENT PARCEL

ZONES

- BUSINESS / VILLAGE BUSINESS
- COASTAL
- COUNTRY LIVING
- INDUSTRIAL; LIGHT INDUSTRIAL
- LIVING
- RESIDENTIAL / RURAL-RESIDENTIAL
- PA
- RECREATION
- RURAL

SOURCE:
1. TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA.
2. DISTRICT PLAN INFORMATION DOWNLOADED FROM WRC OPEN DATA PORTAL ON 27/03/2020

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PROJECT : RAGLAN WWTP DISCHARGE OPTIONS

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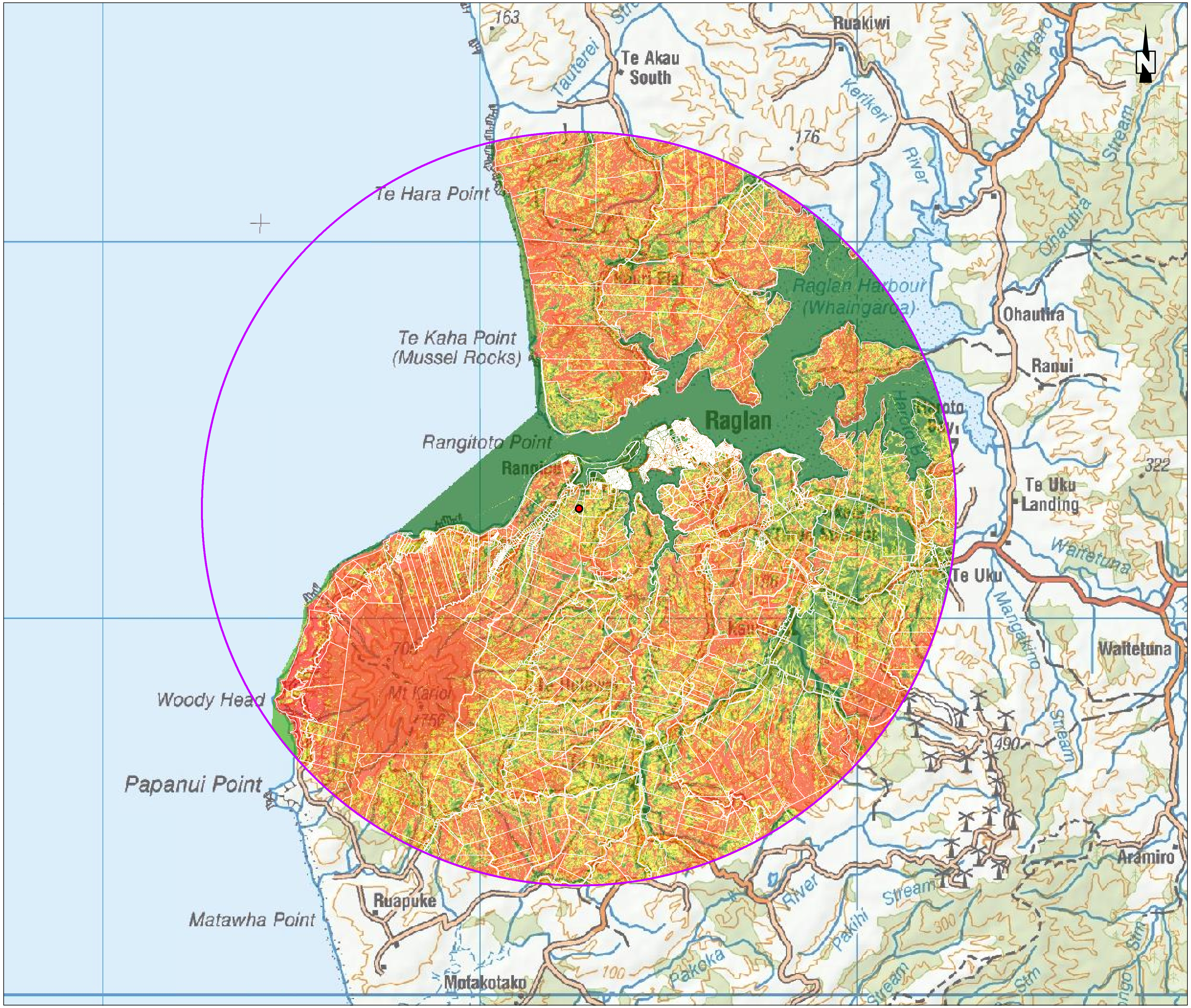
0 500 1,000 2,000 3,000 METRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03532200	4	A

A03532200Z006_DistrictPlan.mxd



KEY :

- RAGLAN WATEWATER TREATMENT PLANT
- ASSESSMENT AREA
- ASSESSMENT PARCEL

PERCENT SLOPE

- 0 - 5%
- 5 - 10%
- 10 - 15%
- 15 - 20%
- 20 - 25%
- 25 - 30%
- >30%

SOURCE:
1. TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA.
2. SLOPES GENERATED FROM DTM PROVIDED BY Waikato REGIONAL COUNCIL 2012.

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PROJECT :

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TITLE :

LAND SLOPE IN ASSESSMENT AREA

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0 500 1,000 2,000 3,000
METRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03532200	5	A

A03532200Z003_Slope.mxd

KEY :

- RAGLAN WATEWATER TREATMENT PLANT
- ASSESSMENT AREA
- ASSESSMENT PARCEL

SOIL DRAINAGE

- POORLY DRAINED
- MODERATELY WELL DRAINED
- WELL DRAINED

SOURCE:
1. TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA.
2. LINZ SOIL DRAINAGE LAYER (AUG 2018) SUPPLIED BY LANDCARE RESEARCH UNDER LANDCARE DATA USE LICENSE LINK: http://lris.scinfo.org.nz/license/landcare-data-use-licence-v1/
DATA REPRODUCED WITH THE PERMISSION OF LANDCARE RESEARCH NEW ZEALAND LIMITED.

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TITLE : SOIL DRAINAGE CHARACTERISTICS IN ASSESSMENT AREA

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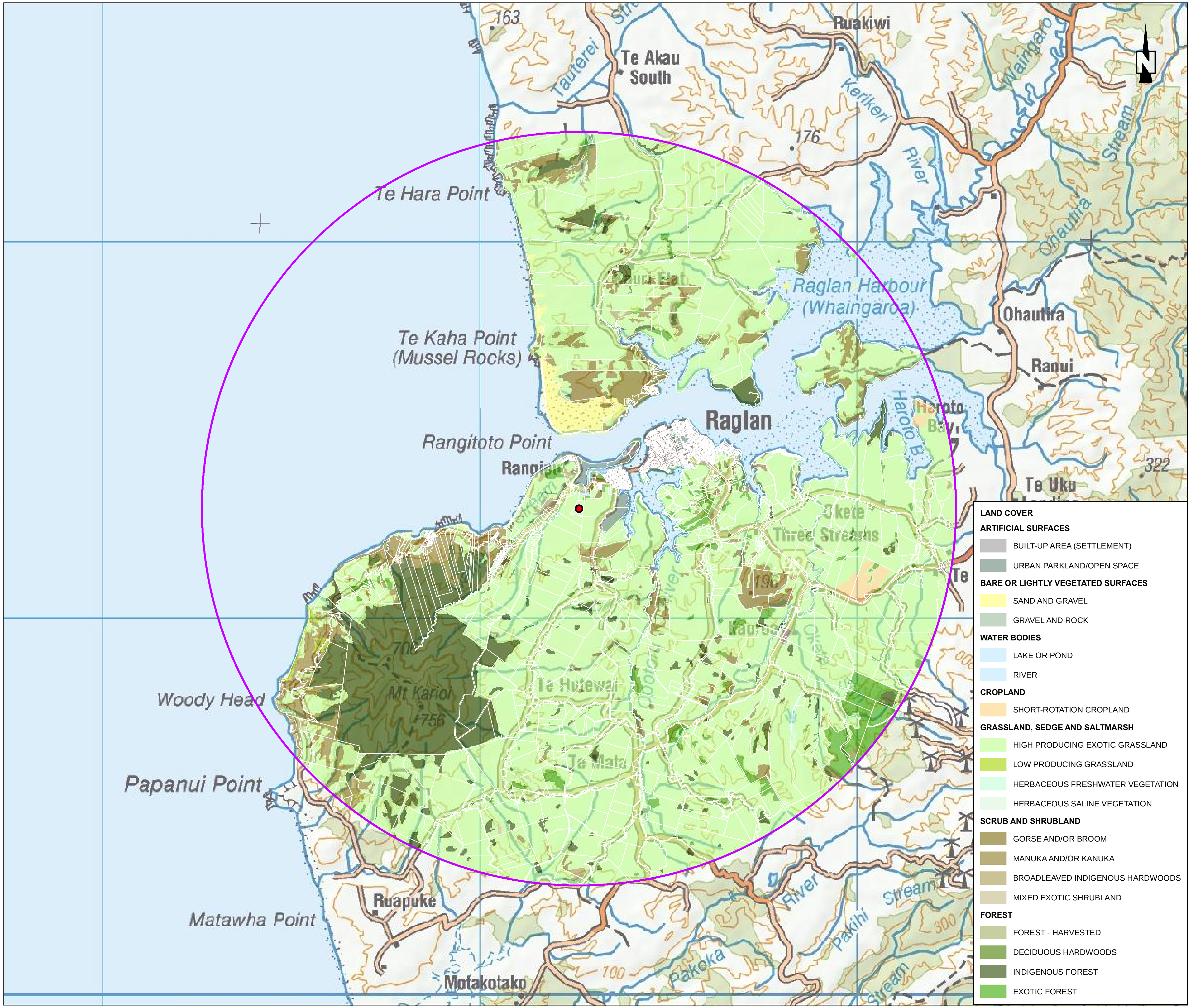
0 500 1,000 2,000 3,000 METRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03532200	6	A

A03532200Z004_Soil.mxd



KEY :

- RAGLAN WATEWATER TREATMENT PLANT
- ASSESSMENT AREA
- ASSESSMENT PARCEL

SOURCE:
1. LAND COVER DATA SUPPLIED BY LANDCARE RESEARCH (LRIS PORTAL), DATED 07/02/2020.
2. TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA.

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TITLE :
LAND COVER IN ASSESSMENT AREA

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SCALE : 1:100,000 (A3)

0 500 1,000 2,000 3,000
METRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03532200	7	A

A03532200Z005_Landcover.mxd

2.4 Land Treatment Assessment Results and Suitable Area Selection

The full results of the land treatment WAA assessment are presented visually based on a scale of suitability in Figure 8.

The WAA was used to identify the top 40 parcels suitable for land treatment in the assessment area (see Figure 9). Areas that are on the northern side of Raglan Harbour were excluded, primarily due to the potential challenges with installing a pipeline across the Raglan Harbour. Areas within the Waikato 2070 Raglan growth nodes were excluded due to projected development in these areas. Areas were also checked for high risk hazards of coastal inundation and coastal erosion. One of the parcels (WAA Rank #11) was flagged to be marginally within a sensitive area to coastal inundation, but was not excluded due to the small area of land that would be potentially impacted.

For the 40 selected parcels, Table 3 summarises the irrigable areas for each parcel which has been determined based on the slope adjusted areas to account for lower irrigation rates over steeper areas. A 30% allowance for non-irrigable areas such as buffer zones from property boundaries, separation from waterways, and separation from dwellings etc, has been made.

For a land treatment option to proceed several parcels will likely be required. For the non-deficit scenarios 2 - 4 parcels are required. For the deficit scenario, which is not a short-listed discharge option, at least 4 to 11 parcels would theoretically be required. Consideration needs to be given to the location of each parcel as it is more practical in terms of infrastructure to have them near or adjoining other sites.

Table 3: Usable Areas of WAA Top 40 Parcels

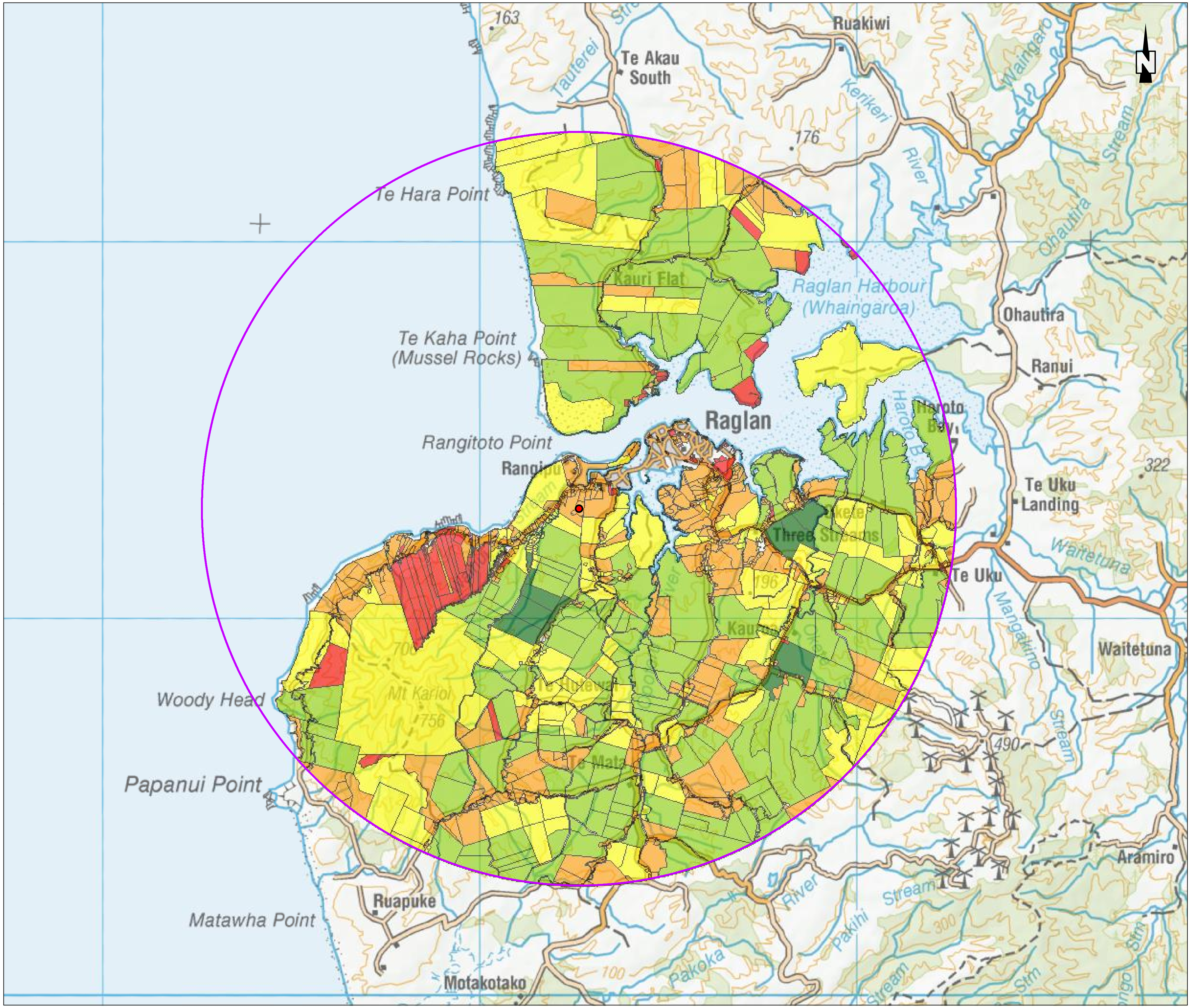
WAA Rank	Number of Parcels	Slope Adjusted Area[1] (ha)	Irrigable Area[2] (ha)
1	2	83	58
2	7	67	47
3	3	77	54
4	2	117	82
5	2	77	54
6	3	91	64
7	8	63	44
8	3	66	46
9	2	38	27
10	6	48	34
11	6	77	54
12	2	103	72
13	4	61	43
14	5	103	72
15	6	72	50
16	5	79	55
17	4	66	46
18	2	62	43
19	7	122	85
20	4	68	48
21	3	66	46
22	8	56	39
23	3	49	34
24	2	45	31
25	2	53	37
26	1	85	60
27	2	71	50

Table 3: Usable Areas of WAA Top 40 Parcels

WAA Rank	Number of Parcels	Slope Adjusted Area[1] (ha)	Irrigable Area[2] (ha)
28	4	71	50
29	3	65	46
30	6	61	43
31	2	27	19
32	9	104	73
33	8	54	38
34	3	58	41
35	5	59	41
36	2	56	39
37	1	78	55
38	1	53	37
39	5	64	45
40	4	41	29

Notes:

1. *Based on the WAA slope weighted areas.*
2. *30% allowance for buffer zones and non-irrigable areas.*



KEY :

- RAGLAN WATEWATER TREATMENT PLANT
- ASSESSMENT AREA

LAND TREATMENT WAA ASSESSMENT RESULTS

- 1-3
- 3-3.5
- 3.5-4
- 4-4.5
- 4.5-5

SOURCE:
1. TOPOGRAPHICAL INFORMATION DERIVED FROM LINZ DATA.

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LAND TREATMENT WAA ASSESSMENT RESULTS

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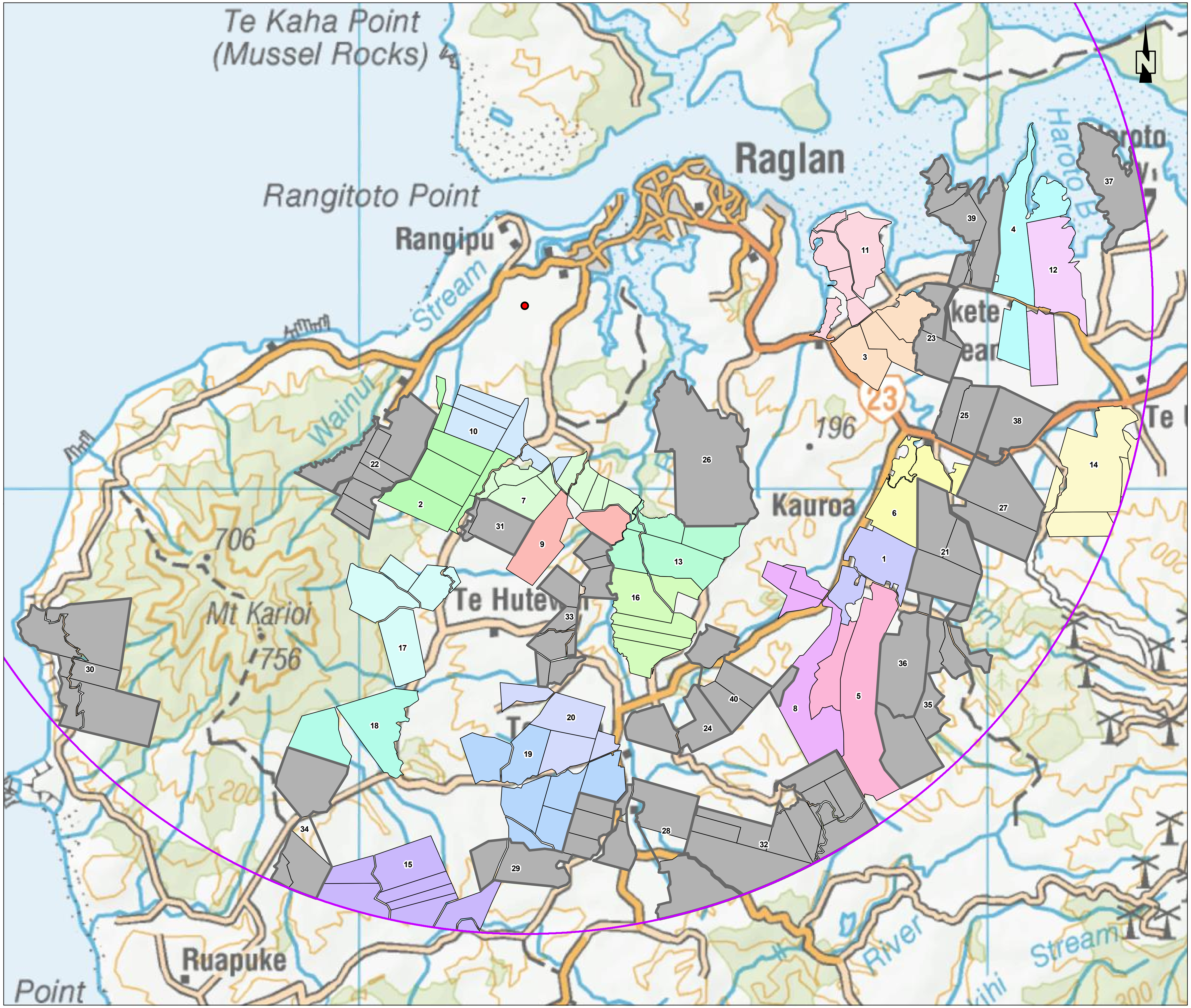
0 500 1,000 2,000 3,000
METRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03532200	8	A

A03532200Z008_Parcel_Ranking.mxd



KEY :

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0 500 1,000 2,000 3,000
METRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03532200	9	A

A03532200Z011_Parcel_Top40.mxd

2.5 Land Treatment Wastewater Quality

Aside from hydraulic limitations, land treatment systems are often limited by nutrient loading rates. Key nutrients for consideration in assessing wastewater irrigation rates include nitrogen, phosphorus and sodium. Whether a system will be hydraulically limited or nutrient loading limited is site specific and dependent on a number of factors including soil characteristics (drainage and soil type), topography and wastewater quality.

Depending on the land use, nitrogen loading for land treatment systems generally range from 150 kg TN/ha/yr for a grazed or forestry system, through to approximately 400 to 500 kg TN/ha/yr for a cut and carry system. Based on grazed or forestry systems, an average nitrogen concentration in the wastewater of approximately 18 g TN/m^3 to 30 g TN/m^3 would be required, for a hydraulic loading rate of approximately 500 mm/yr to 800 mm/yr.

Depending on the land use, the phosphorus loading could typically range between 30 kg TP/ha/yr to 40 kg TP/ha/yr, with an average phosphorus concentration ranging from 4 g/m^3 to 8 g/m^3.

Sodium levels are generally not an issue for municipal wastewater irrigation systems in areas of elevated rainfall and no significant trade waste sources, however, lime addition can be required to manage sodium levels if they increase in the soils over time.

While the required wastewater nutrient levels have been approximated above, for a land treatment system, the allowable nutrient loading rates will need to be assessed against nutrient leaching potential and potential effects on the receiving environment. Given the topography and soil types in the area, requiring large irrigation areas to manage hydraulic loading, it is likely that the hydraulic loading capacity of the soils will be the key limiting factor. However, for higher hydraulic loading rates for non-deficit, all-year round options, nutrient loads could be elevated, potentially requiring landuse changes or additional nitrogen removal at the treatment plant to manage nutrient loads.

D R A F T

3.0 Assessment of Short-Listed Options

From the long list assessment of land treatment and deep bore injection options, the short-listed options selected for further assessment are:

- Non-deficit irrigation to land – 100% irrigation.
- Non-deficit irrigation to land with an alternative discharge solution (marine).

Deficit irrigation options were excluded from further assessment due to the large land areas required and the large number of properties that would be required to be included in a land treatment scheme. Deficit irrigation only occurs when soil moisture conditions require additional irrigation and as such large irrigation areas are required to manage the treated wastewater along with large storage areas for when irrigation cannot occur (particularly for wetter winter months). Due to the large number of parcels that would be required in Raglan for a deficit system it is considered impractical as an option. Therefore, the two non-deficit irrigation systems have been short listed for further consideration.

Deep bore injection was initially included as a short listed option, however it was later excluded from further consideration due to a poor response from consultees during the initial consultation process.

This section provides further assessment of the potential implementation options for the short listed options.

3.1 Non-deficit irrigation - 100% to land all year round

A non-deficit irrigation system with irrigation to land all year round would require a land treatment area in the order of 90 – 190 ha, which would require 2 – 4 parcels to be obtained. For practical purposes parcels in close proximity to each other are desired to minimise infrastructure requirements.

3.1.1 Potential Irrigation Locations

Table 4 summarises several theoretical parcel clusters (A-D) that could be used for the land treatment scheme. These are also displayed visually in Figure 10. Cluster A is closest to the WWTP which would decrease the pumping infrastructure requirements however, more parcels are required due to smaller usable land areas and greater slopes in this area.

The underlying soils of Cluster A are likely to be similar to the freer draining loamy soils observed in this area during the site visit discussed in Section 2.2. As indicated on SMAP, similar soil types may be present at Cluster D. Clusters B and C are indicated to have areas of poorly drained soils which could potentially reduce the allowable irrigation volumes at these sites.

Table 4: 100% Non-Deficit Irrigation Potential Land Treatment Combined Parcels

Cluster	WAA Ranking Numbers	Combined Usable Area
A	2, 7, 9, 10	152
B	1, 5, 6	176
C	4, 12	154
D	19, 20	133

If a non-deficit, year round land treatment option progressed property clusters identified in Table 4 provide optimum scenarios. An advantage of Cluster A would be a single rising main from the treatment plant.

When considering public land for irrigation of wastewater there is insufficient area available within the assessed areas to enable a feasible non-deficit irrigation system on public land alone. Irrigation of the Wainui Reserve is theoretical only as much of the land is designated a Maori Area of Significance and has high public use and therefore could potentially account for only a small fraction of the overall waste stream.

3.1.2 Storage Options

A storage volume in the order of 150,000 m^3 is required for this option, to prevent the need to irrigate during periods of high rainfall and saturated soil conditions. Storage would generally be managed by drawing down storage levels during the drier summer period and then utilising the storage facility during the wetter winter periods. The storage area could be provided by a dam at the irrigation site.

With the undulating nature of the Raglan area many opportunities exist for valleys to be utilised for this purpose. Clusters A, B and D all have incised valleys which may offer the opportunity for conceptual storage.

3.1.3 Land Use and Irrigation type

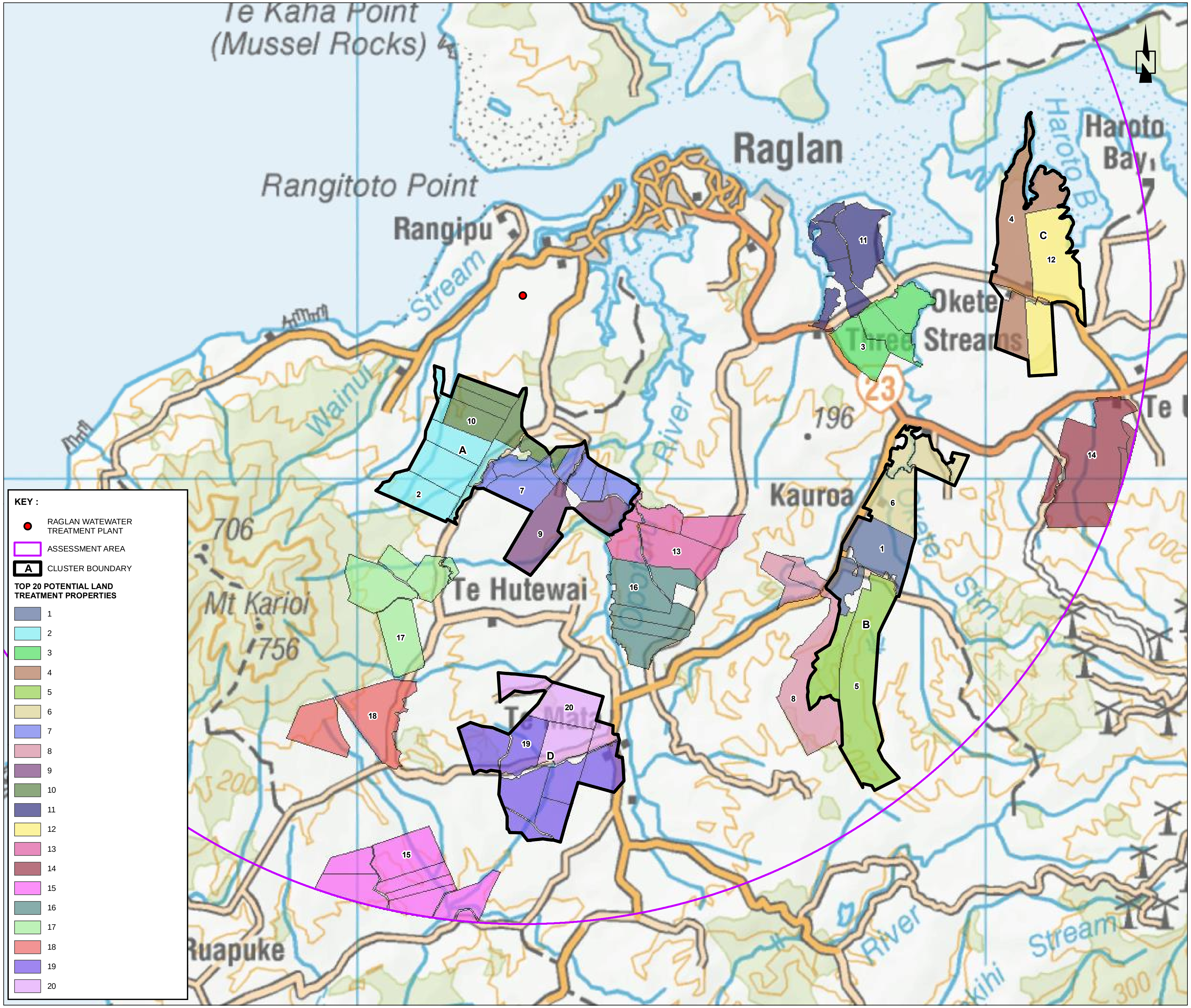
There are a variety of landuse options that could be implemented at the land treatment sites including pastoral grazing, non-consumptive crops, cut and carry, forestry and non-contact consumptive crops. These are discussed in more detail in Raglan Landuse Assessment report no. A03532200R002 (PDP, 2020a). Examples of land treatment schemes that incorporate land use variations include Taupo sewage treatment system (cut and carry) and Cooks Beach sewage treatment system (forestry). The benefits of these systems include additional nutrient uptake for cut and carry systems, and improved hydraulic management and land stabilisation for forestry systems.

Given that the sites identified in Table 4 tend to incorporate predominantly hilly country with some terraced ridges, irrigated forestry is more likely to be an applicable landuse with some opportunities for cut and carry pasture based fodder crops on the flatter areas of terraced ridgelines and valleys.

Due to the topography in the Raglan area the most likely type of irrigation would be solid set.

3.1.4 Additional Considerations

It is noted that with non-deficit irrigation, leaching of treated wastewater does occur and therefore consideration needs to be given to down gradient water takes and receptors in order to avoid contaminating groundwater sources. It is noted that the Raglan water take is to the north-east of Cluster A and therefore particular attention would be required to investigate and monitor groundwater movement from a land treatment system in this area.



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PROJECT :
RAGLAN WWTP DISCHARGE OPTIONS

TITLE :
LAND TREATMENT POTENTIAL PARCEL CLUSTERS

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0 500 1,000 2,000 3,000
METRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03532200	10	A

A03532200Z015_ParcelCluster_New.mxd

3.2 Non-deficit Irrigation with Winter Marine Discharge

A non-deficit irrigation system with alterative marine discharge during the wetter winter months would require a land area in the order of 80 – 110 ha which would require 1 – 3 parcels to be used. Table 5 summarises theoretical clusters (E-I) that could be used for this scenario. Figure 11 details the theoretical cluster locations.

Table 5: 100% Non-Deficit Irrigation Potential Land Treatment Combined Parcels

Cluster	WAA Ranking Numbers	Combined Usable Area
E	2, 7, 9	118
F	1, 6	122
G	4, 12	154
H	19, 20	133
I	3, 11	108

The parcels ranked 4 and 19 under the WAA assessment could potentially be used as single parcels under this scenario, however, their usable areas are at the lower limit of the required area at 82 ha and 85 ha respectively.

3.2.1 Storage Options

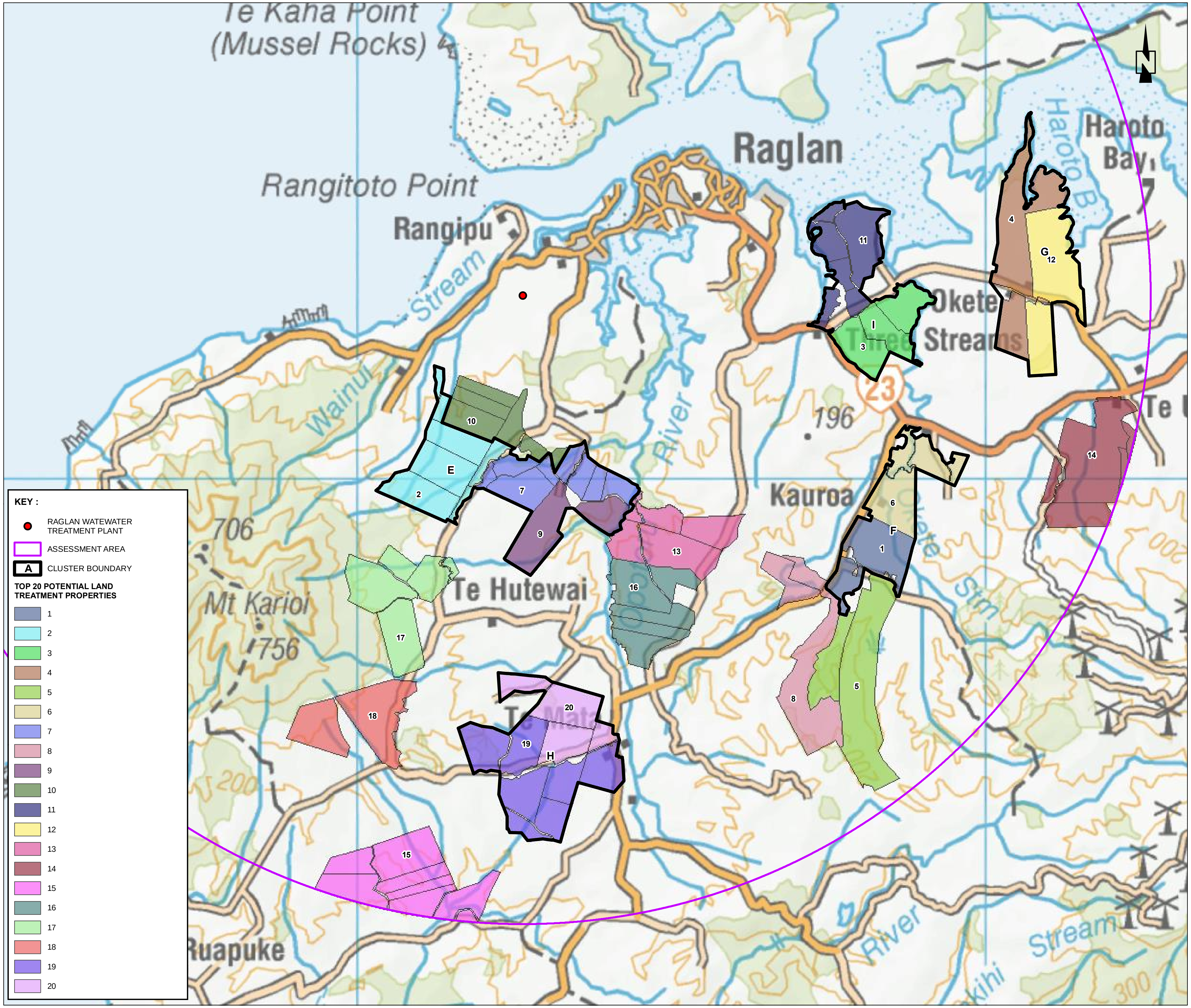
A much smaller storage volume, in the order of 20,000 m^3, would be required for this option, which would generally be used during periods of heavily rainfall in the drier months, and/or when treated wastewater volumes exceed the daily irrigation limits.

Due to the reduced size of the required storage facility, this could be a constructed storage lagoon at the irrigation site, within a suitable area of flat land.

3.2.2 Land Use and Irrigation Type

As with the non-deficit, 100% irrigation to land option, there are a variety of landuse options that could be implemented at the treatment site including pastoral grazing, non-consumptive crops, cut and carry, and forestry.

As the clusters generally incorporate predominantly hilly country with some terraced ridges, irrigated forestry is more likely to be an applicable landuse with some opportunities for cut and carry based cropping on the flatter areas of terraced ridgelines and valleys. For Clusters 2b, 4b and 5b, these sites are located on gentler sloping land and cut and carry maybe a more dominant operation for these sites.



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CLIENT :

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PROJECT :

RAGLAN WWTP DISCHARGE OPTIONS

TITLE :

LAND TREATMENT POTENTIAL LAND CLUSTER FOR ALTERNATIVE DISCHARGE

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0 500 1,000 2,000 3,000
METRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03532200	11	A

A03532200Z016_LandClusterAlternativeDischarge_New.mxd

3.3 Forward Work

Identified key knowledge gaps and key inputs which need to be incorporated into progressing land treatment as a potential discharge option or part-option, are:

- Legislation and regional planning review to solidify position on any regulatory aspects that may influence any land treatment option.
- Iwi consultation and involvement, particularly to assist in identifying any culturally sensitive areas that should be excluded from further land treatment consideration.
- Initial stakeholder / landowner consultation re: potential interest in either working with WSL collaboratively or land sale/lease possibilities.
- Field investigation to assess general soil types and permeability confirmation at sites where there is landowner interest.
- Initial land treatment concept design with size and application method, including very rough order costing on concept option.

D R A F T

4.0 Short Listed Options Costing Assessment

A rough order costing assessment was undertaken for the following three short listed options:

- Non-deficit 100% irrigation to land.
- Non-deficit irrigation to land with an alternative discharge solution.
- Non-deficit irrigation to potentially available public land with an alternative discharge solution.

Irrigation of public land, with an alternative discharge option, has been included in the short-listed option cost assessment, should it be found that only public land is available. Public land irrigation costing assessments have been based on irrigating Wainui Reserve, the Raglan Golf Course and the council owned section of Raglan Airstrip.

Because no private land has been secured at the time of this assessment, costing assessments for irrigation of private land has been based off an arbitrary location based on Clusters A and E (refer to Section 3.0).

4.1 Non-Deficit Irrigation to Land 100% Irrigation

A rough order cost for the non-deficit 100% irrigation to land option has been based on irrigation to private land off Te Hutewai Road (Cluster A).

4.1.1 Land Area

A base irrigation area of 130 ha has been used in the costing based on a soil moisture model run with the 2055 average daily wastewater volume of 1,957 m^3 and hydraulic conductivities of K_{sat} = 10 mm/d and K_{-40} = 1 mm/d.

To account for the undulating nature of the Raglan area, which will require lower irrigation rates in steeper sections, the slope adjusted area within the parcels has determined the potential irrigation area. Based on slope adjusted areas for the area incorporating Cluster A (61% adjustment factor) approximately 213 ha of irrigable area is required.

A 30% buffer zone factor has also been applied to allow for offset distances from boundaries and streams. The entire parcel that encompasses the slope adjusted area has been included in the land purchase cost. For the costing assessment, it has been assumed that adjacent parcels (for complete farm operations) require purchase for this option, requiring a total land purchase area of 550 ha (based on the Cluster A location).

4.1.2 Dam

A rough order cost for a storage dam of 150,000 m^3 is based on the main elements for the structure such as dam embankment, penstock and stormwater diversion. It is assumed that the dam embankment is a compacted earthen embankment and that there is suitable material on site for the construction of the embankment, within land parcels selected for irrigation. A liner for the dam has not been included.

The dam site has been selected based on the proximity to Te Hutewai Road and minimal upstream catchment area. It is assumed that access to the site is possible from Te Hutewai Road. Any final dam site selection would require:

- Undertaking site selection process looking at geology and potential geohazard issues such as relic landslides;
- Assessing availability of purchase of land for the dam site and reservoir;
- Assessing any cultural issues;
- Location of disposal area;
- Pipeline routes available to dam site location; and
- Carrying out geotechnical site investigation to determine site suitability.

A 15% allowance for surveying of selected site, geotechnical investigations, detailed design costs, any required resource consenting and overall project management costs has been included in the cost.

4.1.3 Irrigation Type and Landuse

The irrigation equipment has been costed based on solid-set irrigation due to the undulating topography in the area. Irrigation costs also include pipeline infrastructure from the main pipeline termination point to the storage dam, pump station and three distribution rising mains to various points across the irrigation area.

The landuse for this costing has been assumed to be conversion to irrigated forestry on steeper land (15% to 30% slope) with cut and carry pasture (hay or silage) on the flatter areas of terraced ridgelines and valleys (<15% slope).

4.1.4 Rough Order Cost Estimate

Table 6 summarises the cost estimate for the non-deficit 100% irrigation to land option.

Table 6: Non-deficit Irrigation to Land 100% Irrigation Cost

Item	Capital Cost	Cost
1.0	**Wastewater Treatment**	**To be costed separately**
2.0	**Conveyance**	**To be costed separately**
3.0	**Irrigation System**	**$9,000,000**
	Irrigation Equipment and Distribution[1]	$7,820,000
	Pump Stations	$480,000
	Landuse Establishment	$270,000
	Electrical and Control	$430,000
4.0	**Storage Dam**	**$5,980,000**
A	**Sub Total**	**$14,980,000**
B	Preliminary and General[2]	$1,200,000
C	Offsite Overheads[2]	$1,200,000
D	**Total Construction (A+B+C)**	**$17,380,000**
E	Professional Services[3]	$2,610,000
F	Irrigation site investigations and consenting	$690,000
G	Dam Site Investigation, Consenting Costs[4]	$900,000
H	Unscheduled Items[5]	$3,480,000
I	Contingency[6]	$5,210,000
J	Land Purchase[7]	$16,500,000
K	**Total CAPEX (D+E+F+G+H+I)**	**$46,800,000**
L	**Total Annual OPEX**	**$60,000**

Notes:

1. *Including internal distribution rising mains.*
2. *8% of capital cost.*
3. *15% of total construction.*
4. *Includes geotechnical investigations for detailed design for dam construction.*
5. *20% of total construction.*
6. *30% of total construction.*
7. *Land purchase price based on $30k per hectare.*

4.2 Non-Deficit Irrigation to Land with Alternative Discharge

A rough order cost for the non-deficit irrigation to land with alternative discharge option has been based on irrigation to private land off Te Hutewai Road (Cluster E).

4.2.1 Land Area

A base irrigation area of 90 ha has been used in the costing based on a soil moisture model run with the 2055 average daily irrigation volume of 1,957 m^3 and hydraulic conductivities of K_{sat} = 10 mm/d and K_{-40} = 1 mm/d.

To account for the undulating nature of the Raglan area which will require lower irrigation rates in steeper sections the slope adjusted area within the parcels has been used to determine the potential irrigation area. Based on slope adjusted areas for the area incorporating Cluster E (62% adjustment factor) approximately 145 ha of irrigable area is required.

A 30% buffer zone factor has been applied. The entire parcel that encompasses the slope adjusted area has been included in the land purchase cost. For the costing assessment, it has been assumed that adjacent parcels (for complete farm operations) require purchase for this option, requiring a total land purchase area of 320 ha (based on the Cluster E location).

4.2.2 Storage Pond

A storage pond of 20,000 m^3 capacity, located within the irrigation area has been included in the costing to help buffer flows and allow for short term periods where soils exceed saturation or run-off is a risk. This volume is in addition to the 25,000 m^3 of storage which is anticipated to be available at the WWTP.

4.2.3 Irrigation Type and Landuse

The irrigation equipment has been costed on solid set irrigation due to the undulating topography in the area. Irrigation costs also include pipeline infrastructure from the main pipeline termination point to the storage pond, pump station and two distribution rising mains to various points across the irrigation area.

The landuse for this costing has been assumed to be mainly irrigated forestry with cut and carry pasture based fodder crops on the flatter areas of terraced ridgelines and valleys.

4.2.4 Expected Alternative Discharge

This option allows for alternative discharge (marine) of the treated wastewater during the wetter winter months. The average monthly irrigation volumes and average monthly volumes to alternative discharge based on the average daily flow of 1,372 m^3 and 1,957 m^3 for 2025 and 2055 respectively, are summarised in Table 7.

Table 7: Average Wastewater Alternative Discharge and Irrigation Volumes

Month	2025		2055	
	Alternative Discharge Volume (m^3)	Irrigation Volume (m^3)	Alternative Discharge Volume (m^3)	Irrigation Volume (m^3)
January	0	51,356	0	67,202
February	0	48,220	0	61,557
March	0	50,286	0	62,456
April	0	45,121	1,470	48,089
May	327	26,549	31,140	26,549
June	17,669	21,961	37,849	21,961
July	20,256	19,372	38,263	19,372
August	16,808	25,453	34,165	25,453
September	4,912	37,915	19,912	37,915
October	516	54,667	8,280	56,072
November	0	45,682	535	60,087
December	0	52,457	0	66,056

Notes:

1. *Discharge volumes based on soil moisture model with hydraulic conductivities of Ksat = 10 mm/d and K_{-40} = 1 mm/d and an irrigation area of 90 ha.*

4.2.5 Rough Order Cost Estimate

The rough order cost estimate for the non-deficit irrigation to land with alternative discharge option is summarised in Table 8.

Table 8: Non-deficit Irrigation to Land with Alternative Discharge Concept Cost

Item	Capital Cost	Cost
1.0	**Wastewater Treatment**	**To be costed separately**
2.0	**Conveyance**	**To be costed separately**
3.0	**Alternative Discharge**	**To be costed separately**
4.0	**Irrigation System**	**$5,820,000**
	Irrigation Equipment[1]	$5,030,000
	Pump Station	$330,000
	Landuse Establishment	$180,000
	Electrical and Control	$280,000
5.0	**Storage Lagoon**	**$900,000**
A	**Sub Total**	**$6,720,000**
B	Preliminary and General[2]	$540,000
C	Offsite Overheads[2]	$540,000
D	**Total Construction (A+B+C)**	**$7,260,000**
E	Professional Services[3]	$1,090,000
F	Irrigation Site Investigation, Consenting Costs	$440,000
G	Unscheduled Items[4]	$1,450,000
H	Contingency[5]	$2,180,000
I	Land Purchase	$9,630,000
J	**Total CAPEX (D+E+F+G+H+I)**	**$22,100,000**
K	**Total Annual OPEX**	**$80,200**

Notes:
1. *Including internal distribution rising mains.*
2. *8% of capital cost.*
3. *15% of total construction.*
4. *20% of total construction.*
5. *Land purchase price based on $30k per hectare.*

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4.3 Non-Deficit Irrigation to Public Land – with Alternative Discharge

A rough order cost for the non-deficit irrigation to public land option has been based on potential irrigation to three public land areas, Wainui Reserve, the Raglan Golf Course and the Raglan Airstrip. Costing for the alternative discharge has been excluded.

4.3.1 Land Area

Two possible irrigable areas, a maximum of 59 ha and a minimum of 38 ha, have been outlined for the public spaces and are summarised in Figure 12 and Figure 13. The maximum area reflects the theoretical area that could be irrigated across the three spaces based on the WAA usable area and excluding infrastructure such as carparks and the golf clubhouse. The minimum area is more conservative and incorporates a 50 m buffer inside the parcel boundaries and excludes specific land use on Wainui Reserve which may conflict with the irrigation scheme, such as the Amphitheatre, Sound Splash (annual music festival) and para-gliding. The rough order cost has been based on the maximum irrigable area. It should be noted that theoretical irrigation area of the Wainui Reserve has included a large area designated as Maori Area of Significance which would significantly decrease the irrigatable area if excluded.

Based on the soil types observed in these areas it has been assumed that irrigation to Wainui Reserve and the Raglan Airstrip can occur year round, while irrigation to the Raglan Golf Course will only occur during the summer months from December – March.

It is assumed that Wainui Reserve and the Golf Course would operate on a rotation period of four and three days respectively to allow time for the soils to rest. The maximum irrigation capacity is 8 mm/day.

4.3.2 Storage

A storage pond of 1,000 m^3 at Wainui Reserve has been allowed for to buffer irrigation volumes. It is assumed that irrigation to the Golf Course and the Airstrip can occur directly from the WWTP.

4.3.3 Irrigation Type

The irrigation equipment costing has been based on drip line irrigation. This minimises the risk of potential conflict with public land use, allowing for the existing land use to be maintained.

4.3.4 Expected Irrigation Volumes

The average monthly irrigation volumes to public land based on the maximum area at each location are summarised in Table 9. It is assumed that non-deficit irrigation will occur at Wainui Reserve and the Raglan Airstrip, and deficit irrigation will occur at the Raglan Golf Course. The WWTP storage pond volume of 25,000 m^3 was utilised in the SMM's.

Table 9: Public Land Monthly Irrigation Volumes

Month	Wainui Reserve	Golf Course	Airstrip
January	14,875	15,197	6,962
February	14,078	11,852	6,354
March	15,062	10,627	6,732
April	14,597	0	6,366
May	9,673	0	6,718
June	7,803	0	6,544
July	6,888	0	5,435
August	9,050	0	6,103
September	13,481	0	6,089
October	18,310	0	7,096
November	12,965	0	5,983
December	15,890	15,801	6,735

Notes:

1. *All units in m^3/month.*
2. *irrigation of Wainui Reserve and Airstrip based on non-deficit irrigation.*
3. *Irrigation of golf course based on deficit irrigation.*

4.3.5 Rough Order Cost Estimate

The cost for the irrigation to public land with alternative discharge is summarised in Table 10.

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Table 10: Irrigation to Public Land with Alternative Discharge Concept Cost

Item	Capital Cost	Cost
1.0	**Wastewater Treatment**	**To be costed separately**
2.0	**Conveyance**	**To be costed separately**
3.0	**Alternative Discharge**	**To be costed separately**
4.0	**Irrigation System**	**$2,750,000**
4.01	Irrigation Equipment[1]	$2,570,000
4.02	Pump	$50,000
4.03	Electrical and Control	$130,000
A	**Sub Total**	**$2,750,000**
B	Preliminary and General[2]	$220,000
C	Offsite Overheads[2]	$220,000
D	**Total Construction (A+B+C)**	**$3,190,000**
E	Professional Services[3]	$480,000
F	Irrigation site investigations and consenting	$210,000
G	Unscheduled Items[4]	$640,000
H	Contingency[5]	$960,000
I	**Total CAPEX (D+E+F+G)**	**$5,500,000**
K	**Total Annual OPEX**	**$98,000**

Notes:

1. *Including internal distribution rising mains and storage pond.*
2. *8% of capital cost.*
3. *15% of total construction.*
4. *20% of total construction.*
5. *30% of total construction.*

D R A F T

KEY :

- RAGLAN WATEWATER TREATMENT PLANT
- ASSESSMENT AREA
- IRRIGATABLE AREA

SOURCE:
1. AERIAL PHOTO FLOWN (2016-19)DERIVED FROM LINZ.

NO.	REVISION	DATE	APP.
A	ISSUE FOR DISCUSSION	13/01/2021	

CLIENT :

Watercare
An Auckland Council Organisation

PROJECT :

RAGLAN WWTP DISCHARGE OPTIONS

TITLE :

PUBLIC LAND POTENTIAL LAND TREATMENT AREAS

pdp solutions for your environment

PATTLE DELAMORE PARTNERS LTD

Auckland Tauranga Wellington Christchurch

SCALE : 1:12,500 (A3)

0 100 200 400 600
METRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03532200	12	A

A03532200Z012_IrrigatableArea.mxd

KEY :

RAGLAN WATEWATER TREATMENT PLANT

ASSESSMENT AREA

PUBLIC LAND POTENTIAL LAND TREATMENT AREAS BUFFERED

SOURCE:
1. AERIAL PHOTO FLOWN (2016-19)DERIVED FROM LINZ.

NO.	REVISION	DATE	APP.
A	ISSUE		

FOR DISCUSSION
13/01/2021

CLIENT :

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pdp solutions for your environment

PATTLE DELAMORE PARTNERS LTD
Auckland Tauranga Wellington Christchurch

SCALE : 1:12,500 (A3)

0 75 150 300 450
METRES

PROJECT NO. :	FIGURE NO. :	REVISION :
A03532200	13	A

A03532200Z013_Public&PotentialLandTreatmentAreas .mxd

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4.4 Sizing and Costing Assumptions

The following assumptions have been made for the rough order costings:

- Irrigation areas have been based on the anticipated average daily flows (ADF) for 2055, at 1,957 m^3/d (as provided by Beca Limited);
- Peak flows are balanced within the WWTP and storage facilities. Where flows exceed the ADF, it is assumed that additional flows are either discharged to the long term storage dam (100% irrigation to land option) or discharged via the alternative discharge method;
- Pumping hours are based on 24 hour pumping per day with storage at site to enable 12 hours of irrigation per day. Public land is based on 6 hours pumping per day;
- Irrigation onto private land is considered to be on well to moderately well drained soils, with a saturated permeability of 10 mm/d and a field capacity drainage rate of 1 mm/d;
- Irrigation to public land (with the exception of the air strip) is considered to be on imperfectly drained soils, with a saturated permeability of 10 mm/d and a field capacity drainage rate 1 mm/d. For the air strip the soil is considered to be well drained (sand) with a saturated permeability of 10 mm/d and a field capacity drainage rate 2 mm/d;
- Irrigation of private land is based on solid set irrigation at a rough order capital cost of $20k/ha and public land irrigation is based on drip line irrigation at $30k/ha. Rates per ha allowance is higher than industry standard to account for the steep topography and irregular shaped irrigation areas;
- Landuse set-up costs have been included for forestry only with the assumption that cut and carry operations on the flatter sections are pre-existing;
- Parcels of adjacent land can be purchased for the land treatment options, i.e. distribution piping to separated sections has not been accounted for in the costing;
- Land cost has been assumed to be $30k/ha;
- Foreign currency exchange fluctuations, $NZD inflation and GST have been excluded.

5.0 Conclusions and Recommendations

Land treatment (irrigation to land) has been investigated, at a high level, as an alternative option for disposal of treated wastewater from the Raglan wastewater treatment plant (WWTP).

5.1 Long List Assessments

Four potential irrigation options were investigated, including deficit and non-deficit irrigation, with and without alternative winter disposal options (dual discharge). Soil moisture models developed for each option indicate that the following irrigation areas and storage are required:

- Non-deficit, all year round: 90 ha – 190 ha, 150,000 m^3 of storage;
- Non-deficit, dual discharge: 80 ha – 110 ha, 20,000 m^3 of storage;
- Deficit, all year round: 260 ha-570 ha, 300,000 m^3 – 400,000 m^3 of storage;
- Deficit, dual discharge: 220 ha-240 ha, 20,000 m^3 of storage.

A weighted attribute, GIS based, assessment (WAA) was conducted to identify potential irrigation areas within a 10 km radius of the Raglan WWTP. The assessment took into account available area, topography, landuse, district plan zoning, land ownership type and distance from the WWTP. 40 preferred sites were selected on the south side of Raglan Harbour, with varying irrigable areas. To enable a non-deficit irrigation option, 2 to 4 parcels will be required, while 4 to 11 parcels will be required for a deficit option.

The two non-deficit schemes, irrigation to land all year round and part-year irrigation with alternative marine discharge, have been chosen to progress to short listed options due to the smaller land area and storage area requirements.

5.2 Short List Assessment

For the short listed, non-deficit wastewater irrigation options, potential cluster sites have been assessed to identify potential combined irrigation areas that could form part of a complete single location system.

For the non-deficit, 100% irrigation to land, 4 irrigation clusters were identified within the 10km radius assessment area, the optimum location is situated south of the treatment plant, near Te Hutewai Rd. There are a number of incised valleys in this location which could provide for large storage dams. Land-uses that could operate under the irrigation system, for the identified Cluster sites, would likely include a combination of forestry for steeper slopes and cut and carry pasture based fodder crops for lesser sloped areas such as ridges and valleys.

For the non-deficit irrigation option with an alternative discharge solution, the required land area is slightly less than the 100% irrigation option. For the reduced area, 5 potential irrigation clusters have been identified. Similar to the 100% irrigation option, the properties along Te Hutewai Rd are likely to be a preferred location.

The rough order cost for the three short listed land treatment options are:

- Option 1 – Non-deficit 100% to land: $47 M
- Option 2 – Non-deficit with alternative discharge: $22M
- Option 3 – Non-deficit to public land with alternative discharge: $5.5M

If these short-listed options are to progress further, identified key knowledge gaps and key inputs which need to be incorporated into progressing land treatment as a potential discharge option or part-option, are:

- Legislation and regional planning review to solidify position on any regulatory aspects that may influence any land treatment option.
- Iwi consultation and involvement, particularly to assist in identifying any culturally sensitive areas that should be excluded from further land treatment consideration.
- Initial stakeholder / landowner consultation re: potential interest in either working with WSL collaboratively or land sale/lease possibilities.
- Field investigation to assess general soil types and permeability confirmation at sites where there is landowner interest.
- Initial land treatment concept design with size and application method, including very rough order costing on concept option.

6.0 Glossary

DBI	Deep bore injection
Deficit Irrigation:	Irrigation to bring soil moisture up to field capacity only, to minimise drainage from the soil
Dual discharge:	Irrigation to land during drier periods with alternative discharge during wetter, winter months, generally from May to September
Field Capacity:	Soil moisture content where water stops draining from the soil
Non-Deficit Irrigation:	Irrigation at rates beyond the soil field capacity
PAW, Profile available water:	Net difference in porosity between field capacity and wilting point
WDC	Waikato District Council
WRC	Waikato Regional Council
WSL	Watercare Services Limited
WWTP	Wastewater treatment plant

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Appendix A: WAA Methodology

The Raglan land treatment weighted attribute analysis (WAA) has been conducted utilising the following criteria and method.

Parcels of land with identical Certificates of Title that are adjacent to each other have been assessed as a single parcel.

Useable Land Area

The 'useable land area' for each parcel was assessed against the area required for irrigation assuming a daily average discharge of 1,957 m^3/day and an application rate of 0.5 m/yr.

Each parcel rated 1 – 5 based on Table A1 below. This distribution was used to determine the ranking for the useable land criteria. A higher rank was given to parcels with larger usable areas as the practicality of a land treatment system on one area is greater i.e. it is expected to be simpler to obtain one big parcel than several smaller ones as less land owners would require negotiation (if leased) or purchasing land required for the scheme.

Table A1: Useable Land Area Ranking

Rank	1	2	3	4	5
Useable Area/Required Irrigation Area	0 – 20%	20 – 30%	30 – 40%	40 – 70%	70 – 100%

Land Suitability – Slope

Land slope is a key contributor to the suitability and efficiency of land for land treatment. GIS scripts were used to delineate the usable area into polygons of 0 – 5% slope, 5 – 10% slope, 10 – 15% slope, 15 – 20% slope, 20 – 25% slope and 25 – 30% slope. Slopes greater than 30% have been excluded from usable areas. These polygons were intersected with the parcel, and the cumulative areas of each polygon, within each parcel, was used to inform the score for this criterion. The effect of slope on land treatment performance was analysed using an 'effective area' approach. The effective area was generated by applying reduction ratios to the total useable area, using the reduction ratios described in Table A2 below.

The effective area was then divided by the usable area within the grid to determine the effective area as a percentage. Each parcel rated 1 – 5 based on Table A3 below.

Table A2: Effective Area Reductions for Slope

Slope	Ratio / Factor	Area Reduction Basis
0 – 5%	100%	Optimal slope – no reduction
5 -10%	90%	Area of 5 – 10% slope factored at 90%
10 – 15%	80%	Area of 10 – 15% slope factored at 80%
15 – 20%	70%	Area of 15 – 20% slope factored at 70%
20 – 25%	30%	Area of 20 – 25% slope factored at 30%
25 – 30%	20%	Area of 25 – 30% slope factored at 20%

Table A3: Slope and Soil Ranking

Rank	1	2	3	4	5
Effective Area	0 – 20%	20 – 40%	40 – 60%	60 – 80%	80 – 100%

Land Suitability – Soil Drainage

Polygons of different soil drainage types were intersected against the usable area and the parcels. For each parcel, areas were produced that corresponded to each soil drainage type.

The effect of soil drainage on land treatment performance was also analysed using an 'effective area' reduction. The effective area was generated by applying reduction ratios to poorer draining soil types, as described in Table A4, below. Moderately well drained soils were given a reduction rating of 60% after visual soil analysis during site visits (21 – 22 July 2020) indicated that these soils are likely to behave like imperfectly drained soils. The effective area was then divided by the usable area within the grid to determine the effective area as a percentage. Each parcel rated 1 – 5 based on Table A3.

Table A4: Effective Area Reductions for Soil Drainage

Soil Drainage	Ratio / Factor	Area Reduction Basis
Bare rock	0%	Unsuitable
Very poorly drained	20%	Area of very poorly drained soil worth 20% of well-drained soil
Poorly drained	40%	Area of poorly drained soil worth 40% of well-drained soil
Imperfectly drained	60%	Area of imperfectly drained soil worth 60% of well-drained soil
Moderately well drained	60%	Area of moderately well drained soil worth 60% of well-drained soil – site visits indicated soils more aligned with imperfectly drained soil
Well drained	100%	Optimal soil drainage type – no reduction

Distance from WWTP

The distance between the centroid of each parcel and the Raglan WWTP treatment plant was evaluated using GIS scripts. The greater the distance between the WWTP and the potential land treatment scheme will likely correlate with greater transmission complexity i.e. greater pipeline length, increased pumping requirements and associated complexity in planning, design, construction and operation.

Each parcel rated 1 – 5 based on Table A5 below, which was based on the possible distance from the WWTP to the furthest extremity of the assessment area divided evenly into five divisions. This distribution was used to determine the ranking for the distance criterion.

Table A5: Distance Ranking

Rank	1	2	3	4	5
Distance	0 – 2,000 m	2,000 – 4,000 m	4,000 – 6,000 m	6,000 – 8,000 m	>8,000 m

District Zone

Polygons of different district zones were intersected against the parcels. For each parcel, areas were produced that corresponded to each district zone.

The effect of district zone on land treatment performance was also analysed using an 'effective area' reduction. The effective area was generated by applying reductions ratios as described in Table A6 below. The effective area was then divided by the usable area within the grid to determine the effective area as a percentage. Each parcel rated 1 – 5 based on Table A7.

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Table A6: Effective Area Reductions for District Zone

Zone	Ratio / Factor	Area Reduction Basis
Coastal	80%	Area may interfere with recreation
Recreational	50%	Area will likely require displacement of recreation
Rural	100%	Suitable area – no reduction

Table A7: District Zone Ranking

Rank	1	2	3	4	5
Effective Landuse Area	0 – 20%	20 – 40%	40 – 60%	60 – 80%	80 – 100%

Existing Landuse

It is deemed preferable that a potential land treatment scheme could be implemented onto land without the need to greatly alter or displace the existing land use activities. Land cover data obtained from Landcare Research categorises landuse within the assessment area into 19 types. PDP has categorised these landuse types into six categories and applied an 'area reduction' factor to less desirable existing land uses, as described in Table A8 below.

Table A8: Area Reductions Applied based on Landuses

Ratio / Factor	Grouping of Landcare Research Landuse Type	Explanation
0%	Built-up Area (settlement), Herbaceous Freshwater Vegetation, Herbaceous Saline Vegetation, Lake or Pond, River, Indigenous Forest	Unsuitable (and majority already excluded during the useable land area criterion)
20%	Gravel or Rock, Sand or Gravel	Major redevelopment of land required for to provide viability
50 %	Broadleaved Indigenous Hardwoods	Reduced ratio due to limitations with installing irrigation plant.
60%	Urban Parkland/Open Space	Redevelopment of existing land likely required and displacement of recreation likely.
80%	Manuka and/or Kanuka, Short-rotation Cropland	Crop – Landuse is largely compatible but may displacement food production. Land use largely compatible, but not deemed as desirable as faster growing exotic species.
100%	High Producing Exotic Grassland, Low Producing Grassland, Deciduous Hardwoods, Exotic Forest, Forest – Harvested, Gorse and/or Broom, Mixed Exotic Shrubland	Landuse is largely compatible and unlikely to displace other activities.

The effective area was then divided by the usable area within the grid to determine the effective area as a percentage. Each grid cell was rated 1 – 5 based on Table A9 below. This distribution was used to determine the ranking for the landuse criteria as the suitability of land for land treatment will increase linearly with effective landuse areas.

TableA9: Landuse Ranking

Rank	1	2	3	4	5
Effective Landuse Area	0 – 20%	20 – 40%	40 – 60%	60 – 80%	80 – 100%

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Land Ownership

Land ownership was assessed for each parcel and the effect on land treatment performance was analysed by applying reductions ratios as described in Table A10 below. Each parcel rated 1 – 5 based on Table A11.

Table A10: Reductions for Land Ownership

Land Ownership	Ratio / Factor	Area Reduction Basis
Public	100%	Suitable area – no land negotiations required
Maori	30%	Sensitive area – likely to have cultural sensitivities, land cannot be purchased only leased
Private	70%	Negotiations required to obtain land. WDC has preference for public land.

Table A11: Land Ownership Ranking

Rank	1	2	3	4	5
Effective Land Ownership Area	0 – 20%	20 – 40%	40 – 60%	60 – 80%	80 – 100%

Criterion Weightings & Final Suitability

The individual criterions used in this analysis are deemed to carry different levels of importance. To account for this, weightings were applied to criterion within the WAA, and this was used to calculate the overall score for each parcel. The criteria weightings and overall WAA score are summarised in Table A12 and Table A13. A greater weighting has been placed on the usable area within a property as this is a key requirement for limiting the number or parcels required for a land treatment option. A sensitivity analysis, with more even weightings, identified that sites with little usable area began to score more highly, which is counter to the objective of the assessment.

The overall WAA score was used to identify the top 20 parcels suitable for land treatment.

Table A12: WAA Criteria and Weightings

Criteria	Weighting
Useable Land	23%
Slope	18%
Drainage	14%
Distance to WWTP	9%
District Zone	14%
Existing Land Use	14%
Land Ownership	9%

Notes:

1. *At this stage of the assessment, capital and operational costs have not been incorporated. This is apart from the recognition that distance between the land treatment area and the treatment plant will relate to capital and operational costs.*

Table A13: Land Treatment Overall Suitability Scoring System

Suitability Score	Overall WAA Score[1, 2]	Colour Code
Low Suitability	<2.50	Red
Low-Moderate Suitability	≥2.50 to <3.00	Orange
Moderate Suitability	≥3.00 to <3.50	Yellow
Moderate-High Suitability	≥3.50 to <4.00	Light Green
High Suitability	≥4.00	Dark Green

Notes:

1. *Score for each criterion is calculated by: 'Criterion Weighting' x 'Criterion Score'.*
2. *The 'overall WAA score' is the sum of each criterion score; with 5 being the maximum possible (highest marks for every criterion), and 1 being the lowest score possible (lowest marks for every criterion).*

Table A14: Land Treatment Weighted Attribute Analysis Scoring System

Criteria	Criteria Weighting	Explanation	Comparative Rating (Criterion Score)				
			1 (Worst)	2	3	4	5 (Best)
Useable Land	23%	Physical area assessed against approximate irrigation area required. Greater usable area scored better as less landowners would be negotiated with / displaced by the scheme, and purchasing land required for the scheme is expected to be simpler if dealing with less landowners.	< 20	20 - 30	30 - 40	40 - 70	> 70
Suitability of Land - Slope	18%	Area weighted assessment of slope. Increased land suitability scored higher as these areas will allow for increased irrigation loading with less runoff and as such, less land area for an equivalent volume scheme.	Low (Steep Slopes)	M-Low	Med	M-High	High (Flatter Slopes)
Suitability of Land - Soil	14%	Area weighted assessment of soil drainage. Increased land suitability scored higher as these areas will allow for increased irrigation loading and as such, less land area for an equivalent volume scheme.	Low (Poorly Drained)	M-Low	Med	M-High	High (Well Drained)
Distance [1]	9%	Distance between each grid unit and the wastewater treatment plant (km). Locations closer to the WWTP scored higher as these would require a shorter transmission pipeline and likely less road and river crossings, and less elevation changes.	> 8,000	6,000 – 8,000	4,000 – 6,000	2,000 – 4,000	< 2,000
District Zone	14%	A weighted assessment based on district plan zoning. Higher score for Rural area as minimal displacement likely.	< 20	20 - 40	40 - 60	60 – 80	> 80
Existing Land Use	14%	Suitability of existing land use for land treatment in terms of the need for redevelopment and the displacement of other activities. Higher suitability scored greater as less land redevelopment would be required as a part of the scheme development, and productive land is less likely to be displaced.	Low	M-Low	Med	M-High	High
Land Ownership	9%	Weighted assessment based on land ownership. Higher score for public land as easier to obtain.	< 20	20 - 40	40 - 60	60 – 80	> 80

Notes:

1. *At this stage of the assessment, capital and operational costs have not been incorporated. This is apart from the recognition that distance between the land treatment area and the treatment plant will relate to capital and operational costs.*

DRAFT

Appendix B: Landcare Research Soil Assessment Report

Manaaki Whenua
Landcare Research

Review of selected soils near the Raglan Wastewater Treatment Plant

Prepared for: Pattle Delamore Partners

August 2020

Review of selected soils near the Raglan Wastewater Treatment Plant

Contract Report: LC3830

Malcolm McLeod

Manaaki Whenua – Landcare Research

Reviewed by:	*Approved for release by:*
Scott Fraser Soil Scientist Manaaki Whenua – Landcare Research	Chris Phillips Portfolio Leader – Managing Land & Water Manaaki Whenua – Landcare Research

Contents

Summary

Project and Client

- Pattle Delamore Partners staff sought advice from Manaaki Whenua – Landcare Research on assessment of usefulness of selected soils for treated wastewater irrigation.

Objective

- Assist Pattle Delamore Partners staff with identification of soil properties pertinent to irrigation of treated wastewater.

Methods

- At selected sites confirm soil properties pertinent to treated wastewater irrigation by way of hand-auguring and reference to existing soil maps of Bruce (1978) and Smap online.

Results

- Seven sites were inspected with soil properties pertinent to treated wastewater irrigation and discussed onsite. Most sites had clayey soils that would require high levels of irrigation management, but one site had loamy soils more suited to wastewater irrigation.

Conclusions

- From a soil perspective alone, soils at Site 2, Te Hutewai Road, have the most potential for land application of treated wastewater because of their useful permeability and ability to absorb phosphorus within the soil. Sandy soils at Site 4 have useful infiltration but limited ability to renovate treated wastewater because of their sandy nature. Clayey soils at other sites would need high levels of irrigation management to avoid inducing waterlogged conditions.

1 Introduction

A general overview of some soils near Raglan was undertaken with Pattle Delamore Partners (PDP) staff to determine their usefulness for irrigation of treated municipal wastewater. Soil restrictions which may influence the choice of the soil for irrigation with treated wastewater was noted. The site visit took place on 21 and 22 July 2020.

The sites for investigation were selected by PDP staff in conjunction with others.

2 Background

Soils in the area have been mapped by Bruce (1978) and this "legacy" soil information interpreted for entry into Smap online.

3 Objectives

The objective of this fieldwork and report is to assist PDP staff with identification of soil properties pertinent to irrigation of treated wastewater.

4 Methods

At seven sites, selected by PDP staff, a brief auger description was made to determine the main soil features pertinent to irrigation of treated wastewater. The relationship to soils mapped by Bruce (1978) and Smap was also established. Sites were located using a hand-held Global Positioning System device (Garmin GPSMAP 64s). Location is given in decimal degrees of latitude and longitude using WGS84 geodetic datum. The approximate location of the sites is shown in Figure 1.

Figure 1. Approximate location of the sites (1–7) visited.

5 Results

Site 1. Raglan golf course. Location -37.814771 174.861012

Bruce (1978) mapped these soils as Raglan soils developed in the upper bed of Hamilton Ash overlying beds of the same formation. Bruce (1978) notes that surface drainage is rapid but internal drainage is impeded by the very firm clay subsoil and the soil is only moderately well drained. Because of its heavy texture the soil is prone to compaction and structural deterioration under stocking in winter.

Smap records the map unit as 100% Opita_2a.1, a Typic Orthic Granular Soil (Hewitt 2010). Soil depth is >1 m with no slowly permeable layer (<4 mm/h) and permeability of the slowest layer within 1 m is between 4 and 72 mm/h. Bypass flow, whereby water and entrained nutrients/contaminants move to depth rapidly with restricted amelioration, is reported as high.

Site visit: Auger observations confirmed Orthic Granular Soils developed in Hamilton Ash beds and soils having a firm subsoil. It is likely the subsoil has slower permeability than the topsoil. Lateral flow within the soil, on sloping ground, should be considered. Fine manganese concretions and paler colours in the uppermost subsoil confirm wet soil conditions in the upper part of the soil during part of the year. The site sampled for hydraulic conductivity was moderately well drained but observations surrounding the sampling site showed imperfect drainage.

Figure 2a. Auger profile of the soil at Site 1, Raglan golf course, to 50-cm soil depth.

Figure 2b. landscape at Site 1.

Site 2. Te Hutewai Road. Location -37.852775 174.841553

Bruce (1978) mapped these soils as Kauroa soils developed in moderately weathered volcanic ash or Mairoa ash beds and classified as yellow-brown loams. Although not recorded, yellow-brown loams have high P-retention thus any applied phosphorus is tightly bound by the clay mineral allophane. The soils were described as friable. Furthermore, Bruce (1978) considered that the friable consistence and ready drainage enabled the soil to withstand trampling and also maintain moisture levels such that it does not dry out in summer or become compacted with soil structure deterioration in winter. Bruce (1978) suggested Kauroa soils to be one of the most productive soils in the Raglan district.

Smap records the map unit as 60% Kapu_3a.1 a Typic Orthic Brown Soil and 40% Otorohanga_12d.2 a Typic Orthic Allophanic Soil. The main difference in this vicinity between a Brown Soil and an Allophanic Soil is that the Allophanic Soil must have P-retention >85%. Brown Soils can grade into Allophanic Soils as P-retention increases. For both Brown and Allophanic Soils, soil depth is >1 m with no slowly permeable layer (<4 mm/h) and permeability of the slowest layer within 1 m is between 4 and 72 mm/h. Bypass flow is reported as medium for the Brown Soil and low for the Allophanic Soil. However, if the Kauroa soil has 30–50% amorphous minerals (on a whole soil basis) as reported by Bruce (1978), bypass flow is likely to be considered low.

Site visit: Auger observations confirmed the soils to be friable and classified as Typic Orthic Brown Soils (Hewitt 2010). The P-retention of the soil at Site 2, judged from a reactive-aluminium field test, indicated that while the soils have medium or high P-retention (Blakemore et al. 1987) it is not high enough for Allophanic Soils. Judging from soil colour, there are no rapid changes in permeability, meaning applied irrigation of wastewater would move uniformly to depth. The soils observed fit the concept of Kauroa soils and those in Smap. The soil is well drained at the sampling site and surrounds.

Figure 3a. Auger profile of the soil at Site 2, Te Hutewai Road, to 70-cm soil depth.

Figure 3b. Landscape at Site 2.

Site 3. Mangatawhiri Road. Location -37.844334 174.886673

In this area Bruce (1978) mapped the soils as Kauroa soils developed in moderately weathered volcanic ash or Mairoa ash beds and classified as yellow-brown loams. However, at this location the soils are clayey and firm. In the general local vicinity, the landscape is hilly rather than rolling and a hill soil association could be delineated using techniques not available to the original soil surveyors. In hilly land (slopes 16–25°) it is difficult to give a single profile description as the soil generally varies with landscape position and nowadays the soil variability would be further described.

Smap records the map unit as 60% Raglan_1a.1 a Typic Orthic Granular Soil (NOT) and 40% Okupata_3a.1 a Typic Oxidic Brown Soil (BXT). The clayey Granular Soils are reported to be moderately well drained and 70–90 cm deep over basalt.

Site visit: An auger observation on a 5° slope shows clayey textures more related to a Granular Soil shown in Smap than the loamy textures associated with a yellow-brown loam mapped by Bruce (1978). The soil had a firm subsoil indicating it is likely the subsoil has slower permeability than the topsoil. Lateral flow within the soil, on sloping ground, should be considered. Fine manganese concretions and paler colours in the uppermost subsoil confirm wet soil conditions during part of the year. The soil at the sampling site was moderately well drained.

At this site, to the south west, we observed an area of rolling land. Soil maps show the soils to be developed in moderately weathered volcanic ash (Mairoa ash beds). From a soil perspective, this land could be useful for irrigation of treated wastewater but would need further investigation to confirm.

Figure 4a. Auger profile of the soil at Site 3, Mangatawhiri Road, to 75-cm soil depth.

Figure 4b. Landscape at Site 3.

Site 4. Airfield. Location -37.852771 174.841505

Bruce (1978) did not map the soils on the airfield but the legend on the soil map suggests sandy soils.

Smap records the map unit as 100% Price_4b.2 with clay over loamy material. Clearly an error has occurred. Likely a soil boundary onto the Bruce (1978) unmapped area has not been included.

Site visit: While this soil is classified as a Typic Truncated Anthropic soil because of earthworks to form the airfield it is likely to have been a Recent Sandy Soil. Without modification the soil should show some colour gradation between topsoil and subsoil. This graduation was not observed in the field. Sandy soils have been used in other parts of New Zealand for land application of treated wastewater. Generally, sandy soils have useful permeability for land application of treated wastewater but because of their sandy nature have limited ability to absorb any chemical contaminants entrained in the treated wastewater. Sandy soils generally have low anion and cation exchange capacity so cannot absorb many applied anions or cations such as phosphorus or sodium. At the observation site the soil was well drained.

Figure 5a. Auger profile of the soil at Site 4, Airfield, to 80-cm soil depth.

Figure 5b. Landscape at Site 4.

Site 5. Te Ahiawa Road. Grid Reference -37.825281 174.843455

Bruce (1978) mapped these soils as Raglan soils plus Okupata hill soils. The Raglan soils are developed in the upper bed of Hamilton Ash overlying beds of the same formation. Bruce (1978) notes that surface drainage is rapid but internal drainage is impeded by the very firm clay subsoil and the soil is only moderately well drained. Because of its heavy texture the soil is prone to compaction and structural deterioration under stocking in winter. Okupata hill soils are developed on flow basalt and large boulders are common on the surface. Bruce (1978) notes that in many places the topsoil contains appreciable amounts of volcanic ash that imparts a silt loam or silty clay loam texture.

Smap records the map unit as 100% Okupata_3a.1 a Typic Oxidic Brown Soil (Hewitt 2010). Soil depth is reported as being well drained with 70–80 cm on rock with no slowly permeable layer (<4 mm/h) and permeability of the slowest layer is between 4 and 72 mm/h. Bypass flow, whereby water and entrained nutrients/contaminants move to depth rapidly with restricted amelioration, is reported as medium.

Site visit: Auger observations confirmed a clay loam topsoil with firm clayey subsoil. Consistent with landscape position, mottles were observed in the upper and middle subsoil indicating some drainage restriction. Lateral flow within the soil, on sloping ground, should be considered. Large surface boulders were observed nearby suggesting the soils are Okupata soils of Bruce (1978) and belonging to the Smap Okupata family but at the auger location site the soils are on rolling rather than hilly land. At this location soil depth exceeded 80 cm, possibly because of the landscape position. To be classified as Typic Oxidic Brown Soils the soils must have friable or very friable failure, meaning that at all moisture contents the soil aggregates crumble under slight stress. This was not the case with the soil being semi-deformable whereby the soil compressed under finger pressure leading to a classification of the soil at the site of Mottled Orthic Brown Soil. At the observation site the soil was imperfectly drained.

Figure 6a. Auger profile of the soil at Site 5, Te Ahiawa Road, to 50-cm soil depth.

Figure 6b. Landscape at Site 5. Note surface boulders in top right of image.

Site 6. Wainui reserve. Location -37.814099 174.834878

In the vicinity, Bruce (1978) mapped these soils as Raglan soils plus Horea soils subdominant in the map unit. Raglan soils are developed in the upper bed of Hamilton Ash overlying beds of the same formation. Bruce (1978) notes that surface drainage is rapid but internal drainage is impeded by the very firm clay subsoil and the soil is only moderately well drained. Because of its heavy texture the soil is prone to compaction and structural deterioration under stocking in winter. Horea soils are developed on weathered sand with some admixture of volcanic ash (Bruce 1978). Soils developed in Hamilton Ash beds are favoured over Horea soils as the soil inspected do not have sandy clay textures (Bruce 1978) in the subsoil.

Smap records the map unit as 60% Opita_2a.1, a Typic Orthic Granular Soil (Hewitt 2010). These soils are deep (>1 m), moderately well-drained soils with no slowly permeable layer (<4 mm/h) and permeability of the slowest layer within 1 m is between 4 and 72 mm/h. Bypass flow, whereby water and entrained nutrients/contaminants move to depth rapidly with restricted amelioration, is reported as high. Price_4b.2 is a Typic Orthic Brown Soil (Hewitt 2010) and covers 40% of the map unit. The Brown Soils cover the Horea soils of Bruce (1978).

Site visit: Site and auger observations suggest the soils are developed in Hamilton Ash bed materials and the soils having a firm subsoil. It is likely the subsoil has slower permeability than the topsoil. Lateral flow within the soil, on sloping ground, should be considered. The site was in a slightly concave landscape position and water could be seen moving through the lower topsoil/uppermost subsoil, consistent with the presence of manganese concretions in the soil. The presence of manganese concretions and paler colours in the uppermost subsoil confirms wet soil conditions during part of the year. Rust-coloured mottles throughout the soil suggest at the site a Mottled Orthic Granular Soil would be a better classification. The parent material for the soil is likely the upper Hamilton Ash beds as the soil inspected does not fit the description for the subdominant map unit of Bruce (1978) or that in Smap. The soil at the site is imperfectly drained.

Figure 7a. Auger profile of the soil at Site 6, Wainui reserve, to 55-cm soil depth.

Figure 7b. Landscape at Site 6.

Site 7. Wainui reserve. Location -37.812040 174.836445

In the vicinity Bruce (1978) mapped these soils as Raglan soils plus Horea soils. Raglan soils are developed in the upper bed of Hamilton Ash overlying beds of the same formation. Bruce (1978) notes that surface drainage is rapid but internal drainage is impeded by the very firm clay subsoil and the soil is only moderately well drained. Because of its heavy texture the soil is prone to compaction and structural deterioration under stocking in winter. Horea soils are developed on weathered sand with some admixture of volcanic ash (Bruce 1978). At this site, soils developed in Hamilton Ash beds are favoured over Horea soils as the soil inspected do not have sandy clay textures (Bruce 1978) in the subsoil.

Smap records the map unit as 60% Opita_2a.1, a Typic Orthic Granular Soil (Hewitt 2010). These soils are deep (>1 m) moderately well drained soils with no slowly permeable layer (<4 mm/h) and permeability of the slowest layer within 1 m is between 4 and 72 mm/h. Bypass flow, whereby water and entrained nutrients/contaminants move to depth rapidly with restricted amelioration, is reported as high. Price_4b.2 is a Typic Orthic Brown Soil (Hewitt 2010) and covers 40% of the map unit. The Brown Soils cover the Horea soils of Bruce (1978).

Site visit: Auger observations confirmed soils developed in Hamilton Ash beds and soils having a firm clayey subsoil. The uppermost subsoil was slightly paler than the lower subsoil, suggesting water movement through the soil is not uniform and permeability in the lower subsoil is slower than in the upper subsoil. Lateral flow within the soil, on sloping ground, should be considered. The soil at the site was moderately well drained.

Figure 8a. Auger profile of the soil at Site 7, Wainui reserve, to 55-cm soil depth.

Figure 8b. Landscape at Site 7.

6 Conclusions

From a soil perspective alone, soils at Site 2, Te Hutewai Road, have the most potential for land application of treated wastewater because of their useful permeability and ability to absorb phosphorus within the soil. Sandy soils at the airfield (Site 4) also have useful permeability to accept treated wastewater but limited ability to absorb chemicals entrained in the treated wastewater. Clayey soils at sites 1, 3, 5, 6, and 7 would need high levels of irrigation management to avoid waterlogged conditions as all the clayey soils were judged (based on their morphology) to have slower permeability in the subsoil compared with the topsoil and could lead to lateral flow within the soil, on sloping ground.

7 References

Blakemore LC, Searle PL, Daly BK 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. 103 p.

Bruce JG 1978. Soils of part Raglan County, South Auckland, New Zealand. New Zealand Soil Bureau Bulletin 41.

Hewitt AE 2010. New Zealand Soil Classification. Landcare Research Science Series No. 1. 3rd edition. Lincoln, New Zealand: Manaaki Whenua Press.

C

Appendix C – Cost Estimate Breakdown

Project:	**Raglan Waste Water Treatment Plant Optioneering**
	Waikato District Council
Document:	**Short List Conceptual Design Cost Estimate**
Version	2
Project No's	4286014/4288629
Date:	14 December 2020 Updated 3/2/21 to create Option L4 which is combination M2 and L1
Author:	Shaun Le Grange/Claire Scrimgeour (verified Rudy Verbeek)

MAIN SUMMARY

1.00 Executive Summary:

1.01 The following Short List Conceptual Design Cost Estimate is for discharge options for Raglan Waste Water Treatment Plant. The figures contained within this report are intended for optioneering purposes only.

2.00 Scope of Work:

2.01 Our brief of the scope of work included in this project typically includes for the following:

M1 **Option M1: Treatment** - Existing treatment process and addition of a tertiary membrane
Option M1: Disposal - Discharge to new outfall and diffuser

M2 **Option M2: Treatment -** MBR and UV treatment
Option M2: Disposal - Discharge to new outfall and diffuser

F1 **Option F1: Treatment -** MBR and UV treatment
Option F1: Disposal - Freshwater diffuse discharge

L1 **Option L1: Treatment** - Additional tertiary treatment after existing ponds and UV Treatment
Option L1: Disposal - Discharge to public land and to new outfall and diffuser

L2 **Option L2: Treatment** - Existing ponds and UV treatment
Option L2: Disposal - Discharge to private land (storage at private land)

L3 **Option L3: Treatment** - Additional tertiary treatment after existing ponds and UV treatment
Option L3: Disposal - Discharge to private land and to new outfall and diffuser

L4 **Option L4: Treatment** - MBR and UV treatment
Option L4: Disposal - Discharge to public land and to new outfall and diffuser

3.00 Summary of Cost:

3.01 Our estimate of cost is as summarised below:

	M1	M2	F1	L1	L2	L3	L4
Item Description	**NZD $**	**NZD $**	**NZD $**	**NZD $**	**NZD $**	**NZD $**	**NZD $**
Establishment	70,000	100,000	100,000	70,000	70,000	70,000	100,000
Treatment	9,876,000	20,813,000	21,242,000	9,876,000	5,000,000	9,876,000	20,812,900
Disposal	388,000	355,000	257,000	1,894,000	1,990,000	2,163,000	1,893,902
Contractors P&G/Offsite Overheads and Profit	1,720,000	145,000	200,000	1,970,000	1,175,000	2,015,000	3,795,052
Sub-total Physical Works	**12,054,000**	**21,413,000**	**21,799,000**	**13,810,000**	**8,235,000**	**14,124,000**	**26,601,854**
Consultant Fees (Design/Engineering)	1,041,000	1,886,000	1,917,000	1,182,000	735,800	1,207,000	2,363,348
Sub-total Base Estimate	**13,095,000**	**23,299,000**	**23,716,000**	**14,992,000**	**8,970,800**	**15,331,000**	**28,965,202**
Contingency Allowance (30%)	3,929,000	6,989,700	7,114,800	4,498,000	2,691,200	4,599,000	8,689,561
Sub-total Expected Estimate	**17,024,000**	**30,300,000**	**30,800,000**	**19,490,000**	**11,662,000**	**19,930,000**	**37,650,000**
Land Discharge (PDP)	-	-	-	5,500,000	47,000,000	22,000,000	5,500,000
Total Expected Estimate	**17,024,000**	**30,300,000**	**30,800,000**	**24,990,000**	**58,662,000**	**41,930,000**	**43,150,000**

4.00 Estimate Approach & Methodology:

4.01 This estimate has been prepared using a combination of high level and detailed estimating principles (i.e. cost per functional area, cost per elemental item, cost resourcing, etc) for the key scope items identified. This estimate has also been priced on local construction industry rates at present date prices.

5.00 Project Risks:

5.01 The following project risks have been identified with the current scheme:

a Conceptual design level information
b Disruption of existing services
a The Ocean Outfall price is based on limited scope of design - methodology of installation and weather mitigation will impact outturn cost
b Design development
a General cost escalation
b Foreign exchange rate fluctuations
a Working around existing services
b Ground and ground water conditions
a Consenting and consent conditions

6.00 Value Management Opportunities:

6.01 The following Value Management Opportunities have been identified with the current scheme:

a N/A

7.00 Estimate Assumptions:

7.01 Our estimate of cost is based on the following working assumptions:

a The accuracy of this Conceptual Appraisal is commensurate with the level of design information available and base assumptions made. We have allowed for an estimating tolerance to account for general unknowns in the design and for any discrepancies in the design information prepared to date. This cost estimate has an estimation accuracy range of -30% / +50% of which is standard Conceptual Appraisal stage.

b All Membrane costs have been taken from the 'Masons' option

c Quantities and descriptions provided are correct

d All pipework unless otherwise stated is assumed to be 0 - 1.5m depth trench

8.00 Estimate Exclusions:

8.01 Our estimate of cost excludes the following:

a Client management costs
b Consents and easements
c Legal fees
d Land acquisition costs
e Client insurances
f Escalation after November 2020
g Goods and Services Tax
h No hard rock or pipe thrusting required/directional drilling for pipework not relating to the ocean outfall

9.00 Reference Documentation:

9.01 Our estimate is based on the following documentation:

a Email: FW: Updated costing sheet with all items included from Hermanus Kruger on the 17/07/2019 "Final Raglan WWTP Cost Estimate - PRE costing professional excel spreadsheet" issued 17/07/2019

b Picton Sewage Upgrade Estimate dated 30 March 2012
Email: FW: Updated costing sheet with all items included from Hermanus

10.00 Disclaimers

10.01

10.02 This report has been prepared by Beca on the specific instructions of our Client. It is solely for our Client's use for the purpose for which it is intended in accordance with the agreed scope of work. Any use or reliance by any person contrary to the above, to which Beca has not given its prior written consent, is at that person's own risk.

10.03 Where another party has supplied information for use in this report, it is assumed to be reliable.

10.04 Beca reserves the right, but not the obligation, to review all calculations included or referred to in this report and, if considered necessary, to revise its opinion in the light of any new or existing information.

10.05 This cost estimate has been developed solely for the purpose of comparing and evaluating options. They cannot be used for budget-setting purposes as common elements between options may have been omitted and/or the works not fully scoped. A functional design should be undertaken if a budget estimate is required.

Project: **Raglan Waste Water Treatment Plant Optioneering**
Waikato District Council

Document: **Short List Conceptual Design Cost Estimate**

2.00 2

4286014/4: 4286014/4288629

Date: 14 December 2020

Author: Shaun Le Grange/Claire Scrimgeour (verified Rudy Verbeek)

Option L4: Treatment - MBR and UV treatment
Option L4: Disposal - Discharge to public land and to new outfall and diffuser

Ref	Estimate Detail Item Description	Calculation	Quantity	Unit	Rate	Sub-Total	Total
	Key Metric Data						
	Tertiary Membrane **Extended Outfall**						
1.00	**Reference Documentation:**						
1.01	Email: FW: Updated costing sheet with all items included from Hermanus Kruger on the 17/07/2019 "Final Raglan WWTP Cost Estimate - PRE costing professional excel spreadsheet" issued 17/07/2019						
1.02	Picton Sewage Upgrade Estimate dated 30 March 2012						
1.03	Email: FW: Updated costing sheet with all items included from Hermanus Kruger on the 17/07/2019						
2.00	**Establishment**						
2.01	**(Excludes Tertiary Membrane Establishment)**						
2.02	Establishment - site set out, service location/relocation, temporary fencing, silt control, site lay down area/facilities, security and plant machinery delivery		1.00	LS	50000	50000	
2.03	Disestablish offsite - remove plant machinery, remove site laydown area/facilities, silt control, temporary fencing and install new fencing.		1.00	LS	20000	20000	
3.00	**Sub Total Establishment**						**70,000**
4.00	**Pond Modifications**						
4.01	Pond modifications, aeration and screens		1.00	PSum	5000000	5000000	
Option L4: Treatmen t - MBR and UV treatment **Option L4: Disposal** - Discharge to public land and to new outfall and diffuser							
5.00	**Road Side Pond Earthworks**						
5.01	De-sludging of ponds		17,280.00	m2	20	345600	
5.02	Raising of Pond Base		3,658.00	m3	45	164610	
5.03	Lining of ponds		17,280.00	m2	20	345600	
6.00	**Tertiary Membrane (Masons)**						
6.01	Roading (40m length - assume 6m wide)		240.00	m2	250	60000	
6.02	Earthworks to site		144.00	m3	50	7200	
6.03	300mm concrete foundation slab (20 x 24m)		480.00	m2	360	172800	
6.04	Building (20x24m)		480.00	m2	2500	1200000	
6.05	Supply process plant to site (3000m3/d - 2 x skids of 2 process train 20m x 24m)		1.00	LS	1850000	1850000	
6.06	Install of plant above (Crane 2 day, 2 men 5 days, plant 5 days)		2.00	No.	20000	40000	
7.00	**Tie-in Works - Tertiary Membrane**						

7.01	Tie in pipework (100mm NB PE Above ground 40m from location + supports + air valve) Iso valve on flanged connection to tank)		1.00	LS	20000	20000	
7.02	Dry-mount P/S (2 x 5.5kW pumps with VSDs)		2.00	No.	20000	40000	
7.03	Valves (2 x non-returns 100mm 2 x isolation valves 100mm)		4.00	No.	750	3000	
7.04	Instruments (1 x FT (100mm) (flow transmitter))		1.00	No.	5000	5000	
7.05	Platform for pumps		1.00	LS	5000	5000	
8.00	**Effluent Tie-in Works - Tertiary Membrane**						
8.01	100mm NB PE below ground from membrane to storage pond (Assumed 1.5m depth)		30.00	m	300	9000	
8.02	E/O last for connections		2.00	No.	1000	2000	
9.00	**Ancillary**						
9.01	Stormwater management (Connection to existing network 2 x manholes + 265 m pipework)		1.00	LS	185000	185000	
9.02	Connection to Potable water		1.00	LS	22500	22500	
9.03	Foul water drainage (slot drains and connection to existing system)		1.00	LS	20000	20000	
9.04	Air compressor + receiver		1.00	LS	Incl.	0	
10.00	**Bulk Chemical Tank**						
10.01	5,000L PE Tank		1.00	No.	4000	4000	
10.02	Concrete bunding, 5000L capacity		1.00	PS	10000	10000	
10.03	Pipework + valving (25mm PVC-schedule 80 30m in trench non-return + iso valve)		1.00	LS	5000	5000	
10.04	Safety shower (Assume 1)		1.00	No.	3000	3000	
10.05	Instruments (3 x FT (flow transmitter) 3x PT (Pressure transmitter))		1.00	LS	30000	30000	
11.00	**Power Supply**						
11.01	100kVA transformer		1.00	LS	60000	60000	
11.02	LV cabling		50.00	m	150	7500	
11.03	HV cabling		265.00	m	300	79500	
11.04	E/O last for cable connections		4.00	No.	5000	20000	
12.00	**Testing and Commissioning**						
12.01	Testing and Commissioning		1.00	LS	100000	100000	
13.00	**Traffic Management**						
13.01	Prepare Contractor's Temporary Traffic Management Plan		1.00	LS	1000	1000	
13.02	Implement Traffic Management Plan - local authority		90.00	days	650	58500	
13.03	Rounding		1.00	LS	190	190	
14.00	**Sub Total Treatment**						**9,876,000**
15.00	**New Discharge section**						
15.01	400NB HDPE SDR20 (assume depth of 0-1.5m)		100.00	m	475	47500	
15.02	E/O for all connections and valves		4.00	No.	20000	80000	
15.03	Rounding		1.00	LS	250	250	
16.00	**Diffuser**						
16.01	Supply and install Diffuser complete with all temporary trenching and piling (Assumed Similar design to Picton Outfall)		1.00	LS	260000	260000	
16.02	Rounding		1.00	LS	250	250	
17.00	**Sub Total Disposal**						**388,000**
18.00	**Main Contractors Preliminary & General / Off-Site Overheads & Profit**						
18.01	Main Contractors Preliminary & General (Construction Management)	10,334,000.20	10,334,000.20	LS	8.00%	826,720	
18.02	Main Contractor Off-Site Overheads & Profit	11,160,720.22	11,160,720.22	LS	8.00%	892,858	
18.03	Rounding		1.00	LS	422	422	

19.00	**Sub Total Contractors P&G/Oversite Overheads and Profit**						**1,720,000**
20.00	**Total Physical Works**						**12,054,000**
20.01	**Consultant Fees (Design/Engineering) / Consents (Cost to Complete)**						**1,041,000**
20.02	Geotechnical Investigation	1.00	1.00	LS	30,000	30,000	
20.03	Further Assessment Work	1.00	1.00	LS	10,000	10,000	
20.04	Investigation Work	1.00	1.00	LS	10,000	10,000	
20.05	Detailed Design	1.00	8%	%	964,320	964,320	
20.06	Procurement & Tender Evaluation	1.00	1.00	LS	10,000	10,000	
20.07	Construction Monitoring & Contract Administration	4.00	4.00	month	3,500	14,000	
20.08	Practical Completion/Producer Statements, etc	1.00	1.00	LS	3,000	3,000	
20.09	Rounding Adjustment	1.00	1.00	LS	-320	-320	
21.00	**Total Base Estimate**						**13,095,000**
22.00	**Contingency**						**3,929,000**
22.01	Construction Contingency	0.00	13,095,000.00	LS	30.00%	3,928,500	
22.02	Rounding Adjustment	1.00	1.00	LS	500	500	
23.00	**Total Expected Estimate**						**17,024,000**

Project: **Raglan Waste Water Treatment Plant Optioneering**
Waikato District Council

Document: **Conceptual Cost Estimate**

2.00 1

4286014/4: 4286014

Date: 09 June 2020

Author: Claire Scrimgeour (verified Rob Newman)

Option L4: Treatment - MBR and UV treatment
Option L4: Disposal - Discharge to public land and to new outfall and diffuser

Ref	Estimate Detail Item Description	Calculation	Quantity	Unit	Rate	Sub-Total	Total
	Key Metric Data						
	MBR Plant 3MLD (Including new inlet works and UV) **Extended Outfall**						
1.00	**Reference Documentation:**						
1.01	John Crawford MBR cost curve January 2020						
1.02	Metro DBC Costing						
2.00	**Establishment**						
2.01	Establishment - site set out, service location/relocation, temporary fencing, silt control, site lay down area/facilities, security and plant machinery delivery		1.00	LS	70,000.00	70,000.00	
2.02	Disestablish offsite - remove plant machinery, remove site laydown area/facilities, silt control, temporary fencing and install new fencing.		1.00	LS	30,000.00	30,000.00	
3.00	**Sub Total Establishment**						**100,000**
4.00	MBR Plant (including screening and UV)		1.00	LS	20,400,000.00	20,400,000.00	
Option L4: Treatment - MBR and UV treatment **Option L4: Disposal** - Discharge to public land and to new outfall and diffuser	**Pump station for pumping buffered influent through MBR**						
#VALUE!	3.5kW pumps		2.00	No.	6,000.00	12,000.00	
#VALUE!	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6,000.00	6,000.00	
#VALUE!	3.5kW VSDs		2.00	LS	2,500.00	5,000.00	
#VALUE!	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25,000.00	25,000.00	
#VALUE!	Pump station slab with shed (total span garage or similar)		1.00	LS	30,000.00	30,000.00	
#VALUE!	Valving and pipework (SS) - 2 x KGVS (150NB), 2 x NRVs, 2 x PRVs		1.00	LS	12,200.00	12,200.00	
#VALUE!	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	15,000.00	15,000.00	
#VALUE!	160 NB PE100 PN10 (Assume in trench 0-1.5m depth))		13.00	m	400.00	5,200.00	
6.00	**Power Supply**						
6.01	500kVA transformer		1.00	LS	75000	75000	
6.02	LV cabling		50.00	m	150	7500	
6.03	HV cabling		265.00	m	300	79500	
6.04	E/O last for cable connections		4.00	No.	5000	20000	
7.00	**Testing and Commissioning**						
7.01	Testing and Commissioning		1.00	LS	100,000.00	100,000.00	
8.00	**Traffic Management (outfall only)**						
8.01	Prepare Contractor's Temporary Traffic Management Plan		1.00	LS	1,000.00	1,000.00	
8.02	Implement Traffic Management Plan - local authority		30.00	days	650.00	19,500.00	

8.03	Rounding		1.00	LS	100	100	
9.00	**Sub Total Treatment**						**20,813,000**
10.00	**New Discharge section**						
10.01	400NB HDPE SDR20 (assume depth of 0-1.5m)		100.00	m	550	55000	
10.02	E/O for all connections and valves		4.00	No.	10000	40000	
11.00	**Diffuser**						
11.01	Supply and install Diffuser complete with all temporary trenching and piling (Assumed Similar design to Picton Outfall)		1.00	LS	260000	260000	
10.03	Rounding		1.00	LS	0	0	
12.00	**Sub Total Disposal**						**355,000**
13.00	**Main Contractors Preliminary & General / Off-Site Overheads & Profit**						
13.01	Main Contractors Preliminary & General (Construction Management)	868,000.20	868,000.20	LS	8.00%	69,440	
13.02	Main Contractor Off-Site Overheads & Profit	937,440.22	937,440.22	LS	8.00%	74,995	
13.03	Rounding		1.00	LS	565	565	
14.00	**Sub Total Contractors P&G/Oversite Overheads and Profit**						**145,000**
15.00	**Total Physical Works**						**21,413,000**
15.01	**Consultant Fees (Design/Engineering) / Consents (Cost to Complete)**						**1,886,000**
15.02	Geotechnical Investigation	1.00	1.00	LS	30,000	30,000	
15.03	Further Assessment Work	1.00	1.00	LS	10,000	10,000	
15.04	Investigation Work	1.00	1.00	LS	10,000	10,000	
15.05	Detailed Design	1.00	8%	%	1,713,040	1,713,040	
15.06	Procurement &Tender Evaluation	1.00	1.00	LS	50,000	50,000	
15.07	Construction Monitoring & Contract Administration	13.00	15.00	month	3,500	52,500	
15.08	Practical Completion/Producer Statements, etc	1.00	1.00	LS	20,000	20,000	
15.09	Rounding Adjustment	1.00	1.00	LS	460	460	
16.00	**Total Base Estimate**						**23,299,000**
17.00	**Contingency**						**6,989,700**
17.01	Construction Contingency	1.00	23,299,000	LS	30.00%	6,989,700	
17.02	Rounding Adjustment		1.00	LS	0	0	
18.00	**Total Expected Estimate**						**30,300,000**

Project: **Raglan Waste Water Treatment Plant Optioneering**
Waikato District Council

Document: **Conceptual Cost Estimate**

2.00 1

4286014/4: 4286014

Date: 09 June 2020

Author: Claire Scrimgeour (verified Rob Newman)

Option L4: Treatment - MBR and UV treatment
Option L4: Disposal - Discharge to public land and to new outfall and diffuser

Ref	Estimate Detail Item Description	Calculation	Quantity	Unit	Rate	Sub-Total	Total
	Key Metric Data						
	MBR Plant 3MLD (Including new inlet works and UV) **Freshwater stream discharge**						
1.00	**Reference Documentation:**						
1.01	John Crawford MBR cost curve January 2020						
1.02	Metro DBC Costing						
2.00	**Establishment**						
2.01	Establishment - site set out, service location/relocation, temporary fencing, silt control, site lay down area/facilities, security and plant machinery delivery		1.00	LS	70000	70000	
2.02	Disestablish offsite - remove plant machinery, remove site laydown area/facilities, silt control, temporary fencing and install new fencing.		1.00	LS	30000	30000	
3.00	**Sub Total Establishment**						**100,000**
4.00	MBR Plant (including screening and UV)		1.00	LS	20,400,000.00	20,400,000.00	
Option L4: Treatment - MBR and UV treatment **Option L4: Disposal** - Discharge to public land and to new outfall and diffuser	**Pump station for pumping buffered influent through MBR**						
#VALUE!	3.5kW pumps		2.00	No.	6000	12000	
#VALUE!	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6000	6000	
#VALUE!	3.5kW VSDs		2.00	LS	2500	5000	
#VALUE!	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25000	25000	
#VALUE!	Pump station slab with shed (total span garage or similar)		1.00	LS	30000	30000	
#VALUE!	Valving and pipework (SS) - 2 x KGVS (150NB), 2 x NRVs, 2 x PRVs		1.00	LS	12200	12200	
#VALUE!	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	15000	15000	
#VALUE!	160 NB PE100 PN10 (Assume in trench 0-1.5m depth))		13.00	m	400	5200	
6.00	**Power Supply**						
6.01	500kVA transformer		1.00	LS	75000	75000	
6.02	LV cabling		50.00	m	150	7500	
6.03	HV cabling		265.00	m	300	79500	
6.04	E/O last for cable connections		4.00	No.	5000	20000	
7.00	**Miscellaneous**						
7.01	Vegetation planting		20,000.00	m2	20	400000	

7.02	Perimeter fence (stock fencing) + 2 gates		830.00	m	35	29050	
8.00	**Testing and Commissioning**						
8.01	Testing and Commissioning		1.00	LS	100000	100000	
9.00	**Traffic Management (outfall only)**						
9.01	Prepare Contractor's Temporary Traffic Management Plan		1.00	LS	1000	1000	
9.02	Implement Traffic Management Plan - local authority		30.00	days	650	19500	
9.03	Rounding		1.00	LS	50	50	
10.00	**Sub Total Treatment**						**21,242,000**
11.00	**Effluent gravity stream discharge site 1**						
11.01	300 NB PE100 PN10 (Assume in trench 0-1.5m depth))		90.00	m	300	27,000	
11.02	Discharge diffuser		1.00	LS	20,000	20,000	
11.03	Rip-rap/gabion discharge structure		60.00	m3	500	30,000	
11.04	1050mm Manhole (assume 1m deep)		3.00	No.	7,000	21,000	
11.05	Stream channel stabilisation		1.00	Psum	50,000	50,000	
12.00	**Effluent gravity stream discharge site 2**						
12.01	300 NB PE100 PN10 (Assume in trench 0-1.5m depth))		150.00	m	300	45,000	
12.02	Discharge diffuser		1.00	LS	20,000	20,000	
12.03	Rip-rap/gabion discharge structure		60.00	m3	500	30,000	
12.04	1050mm Manhole (assume 1m deep)		2.00	No.	7,000	14,000	
12.05	Rounding		1.00	LS	0	0	
13.00	**Sub Total Disposal**						**257,000**
14.00	**Main Contractors Preliminary & General / Off-Site Overheads & Profit**						
14.01	Main Contractors Preliminary & General (Construction Management)	1,199,000.00	1,199,000.00	LS	8.00%	95,920	
14.02	Main Contractor Off-Site Overheads & Profit	1,294,920.00	1,294,920.00	LS	8.00%	103,594	
14.03	Rounding		1.00	LS	486	486	
15.00	**Sub Total Contractors P&G/Oversite Overheads and Profit**						**200,000**
16.00	**Total Physical Works**						**21,799,000**
16.01	**Consultant Fees (Design/Engineering) / Consents (Cost to Complete)**						**1,917,000**
16.02	Geotechnical Investigation	1.00	1.00	LS	30,000	30,000	
16.03	Further Assessment Work	1.00	1.00	LS	10,000	10,000	
16.04	Investigation Work	1.00	1.00	LS	10,000	10,000	
16.05	Detailed Design	1.00	8%	%	1,743,920	1,743,920	
16.06	Procurement &Tender Evaluation	1.00	1.00	LS	50,000	50,000	
16.07	Construction Monitoring & Contract Administration	13.00	15.00	month	3,500	52,500	
16.08	Practical Completion/Producer Statements, etc	1.00	1.00	LS	20,000	20,000	
16.09	Rounding Adjustment	1.00	1.00	LS	580	580	
17.00	**Total Base Estimate**						**23,716,000**
18.00	**Contingency**						**7,114,800**
18.01	Construction Contingency	1.00	23,715,999.60	LS	30.00%	7,114,800	
18.02	Rounding Adjustment		1.00	LS	0	0	
19.00	**Total Expected Estimate**						**30,800,000**

Project: **Raglan Waste Water Treatment Plant Optioneering**
Waikato District Council

Document: **Short List Conceptual Design Cost Estimate**

2.00 2

4286014/4288 4286014/4288629

Date: 14 December 2020

Author: Shaun Le Grange/Claire Scrimgeour (verified Rudy Verbeek)

Option L4: Treatment - MBR and UV treatment
Option L4: Disposal - Discharge to public land and to new outfall and diffuser

Ref	Item Description	Calculation	Quantity	Unit	Rate	Sub-Total	Total
	Estimate Detail						
	Key Metric Data						
	Tertiary Membrane **1970m DN75 HDPE pipe** **2230m DN110 HDPE pipe** **2570m DN160 HDPE pipe** **3 x Pump Stations**						
1.00	**Reference Documentation:**						
1.01	Email: FW: Updated costing sheet with all items included from Hermanus Kruger on the 17/07/2019 "Final Raglan WWTP Cost Estimate - PRE costing professional excel spreadsheet"						
1.02	Picton Sewage Upgrade Estimate dated 30 March 2012						
1.03	Email: FW: Updated costing sheet with all items included from Hermanus Kruger on the 17/07/2019						
2.00	**Establishment**						
2.01	**(Excludes Tertiary Membrane Establishment)**						
2.02	Establishment - site set out, service location/relocation, temporary fencing, silt control, site lay down area/facilities, security and plant machinery delivery		1.00	LS	50000	50000	
2.03	Disestablish offsite - remove plant machinery, remove site laydown area/facilities, silt control, temporary fencing and install new fencing.		1.00	LS	20000	20000	
3.00	**Sub Total Establishment**						**70,000**
4.00	**Pond Modifications**						
4.01	Pond modifications, aeration and screens		1.00	PSum	5000000	5000000	
Option L4: Treatment - MBR and UV treatment **Option L4: Disposal -** Discharge to public land and to new outfall and diffuser							
11.00	**Road Side Pond Earthworks**						
11.01	De-sludging of ponds		17,280.00	m2	20	345600	
11.02	Raising of Pond Base		3,658.00	m3	45	164610	
11.03	Lining of ponds		17,280.00	m2	20	345600	
5.00	**Tertiary Membrane (Masons)**						
5.01	Roading (40m length - assume 6m wide)		240.00	m2	250	60000	
5.02	Earthworks to site		144.00	m3	50	7200	
5.03	300mm concrete foundation slab (20 x 24m)		480.00	m2	360	172800	
5.04	Building (20x24m)		480.00	m2	2500	1200000	
5.05	Supply process plant to site (3000m3/d - 2 x skids of 2 process train 20m x 24m)		1.00	LS	1850000	1850000	
5.06	Install of plant above (Crane 2 day, 2 men 5 days, plant 5 days)		2.00	No.	20000	40000	
6.00	**Tie-in Works - Tertiary Membrane**						
6.01	Tie in pipework (100mm NB PE Above ground 40m from location + supports + air valve) Iso valve on flanged connection to tank)		1.00	LS	20000	20000	
6.02	Dry-mount P/S (2 x 5.5kW pumps with VSDs)		2.00	No.	20000	40000	
6.03	Valves (2 x non-returns 100mm 2 x isolation valves 100mm)		4.00	No.	750	3000	
6.04	Instruments (1 x FT (100mm) (flow transmitter))		1.00	No.	5000	5000	
6.05	Platform for pumps		1.00	LS	5000	5000	
7.00	**Effluent Tie-in Works - Tertiary Membrane**						
7.01	100mm NB PE below ground from membrane to storage pond (Assumed 1.5m depth)		30.00	m	300	9000	
7.02	E/O last for connections		2.00	No.	1000	2000	
8.00	**Ancillary**						

8.01	Stormwater management (Connection to existing network 2 x manholes + 265 m pipework)		1.00	LS	185000	185000	
8.02	Connection to Potable water		1.00	LS	22500	22500	
8.03	Foul water drainage (slot drains and connection to existing system)		1.00	LS	20000	20000	
8.04	Air compressor + receiver		1.00	LS	Incl.	0	
9.00	**Bulk Chemical Tank**						
9.01	5,000L PE Tank		1.00	No.	4000	4000	
9.02	Concrete bunding, 5000L capacity		1.00	PS	10000	10000	
9.03	Pipework + valving (25mm PVC-schedule 80 30m in trench non-return + iso valve)		1.00	LS	5000	5000	
9.04	Safety shower (Assume 1)		1.00	No.	3000	3000	
9.05	Instruments (3 x FT (flow transmitter) 3x PT (Pressure transmitter))		1.00	LS	30000	30000	
10.00	**Power Supply**						
10.01	100kVA transformer		1.00	LS	60000	60000	
10.02	LV cabling		50.00	m	150	7500	
10.03	HV cabling		265.00	m	300	79500	
10.04	E/O last for cable connections		4.00	No.	5000	20000	
11.00	**Testing and Commissioning**						
11.01	Testing and Commissioning		1.00	LS	100000	100000	
12.00	**Traffic Management**						
12.01	Prepare Contractor's Temporary Traffic Management Plan		1.00	LS	1000	1000	
12.02	Implement Traffic Management Plan - local authority		90.00	days	650	58500	
12.03	Rounding		1.00	LS	190	190	
13.00	**Sub Total Treatment**						**9,876,000**
14.00	**New Discharge section**						
14.01	400NB HDPE SDR20 (assume depth of 0-1.5m)		100.00	m	550	55000	
14.02	E/O for all connections and valves		4.00	No.	10000	40000	
14.03	Rounding		1.00	LS	250	250	
15.00	**Diffuser**						
15.01	Supply and install Diffuser complete with all temporary trenching and piling (Assumed Similar design to Picton Outfall)		1.00	LS	260000	260000	
16.00	**LAND APPLICATION**						
16.01	**Pipeline to Airstrip**						
16.02	DN75 PE100 PN12.5/ SDR13.6 (Open cut trench installation - Rural)		1,970.00	m	100	197000	
16.03	E/O for all connections		2.00	No.	5000	10000	
16.04	Air valves chamber (incl all ancillary items)		7.00	No.	15000	105000	
16.05	Scour valves chamber (incl all ancillary items)		3.00	No.	15000	45000	
17.00	**Pipeline to Wainui Reserve**						
17.01	DN110 PE100 PN16/ SDR11 (Open cut trench installation - Rural)		2,570.00	m	100	257000	
17.02	E/O for all connections		2.00	No.	10000	20000	
17.03	Air valves chamber (incl all ancillary items)		6.00	No.	15000	90000	
17.04	Scour valves chamber (incl all ancillary items)		3.00	No.	15000	45000	
18.00	**Pipeline to Golf Course**						
18.01	DN110 PE100 PN16/ SDR11 (Open cut trench installation - Rural)		2,230.00	m	100	223000	
18.02	E/O for all connections		2.00	No.	10000	20000	
18.03	Air valves chamber (incl all ancillary items)		5.00	No.	15000	75000	
18.04	Scour valves chamber (incl all ancillary items)		4.00	No.	15000	60000	
19.00	**Pump Station for Airstrip Land Application**						
19.01	3kW pumps		2.00	No.	4320	8640	
19.02	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6000	6000	
19.03	3kW VSDs		2.00	LS	2160	4320	
19.04	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25000	25000	
19.05	Pump station slab with shed (total span garage or similar)		1.00	LS	30000	30000	
19.06	Valving and pipework (SS) - 2 x KGVS (40NB), 2 x NRVs, 2 x PRVs		1.00	LS	4067	4067	

19.07	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	5000	5000	
19.08	Manual cleaning steel filter (1500 Micron) - Suction End		1.00	No.	6750	6750	
19.09	Automatic self-cleaning filter (800-10 Micron) - Discharge End		1.00	No.	9100	9100	
19.10	LV cabling		50.00	m	150	7500	
19.11	Hose points and drainage		1.00	LS	10000	10000	
20.00	**Pump Station for Wainui Land Application**						
20.01	15kW pumps		2.00	No.	11475	22950	
20.02	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6000	6000	
20.03	15kW VSDs		2.00	LS	5738	11475	
20.04	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25000	25000	
20.05	Pump station slab with shed (total span garage or similar)		1.00	LS	30000	30000	
20.06	Valving and pipework (SS) - 2 x KGVS (100NB), 2 x NRVs, 2 x PRVs		1.00	LS	12200	12200	
20.07	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	15000	15000	
20.08	Manual cleaning steel filter (1500 Micron) - Suction End		1.00	No.	6750	6750	
20.09	Automatic self-cleaning filter (800-10 Micron) - Discharge End		1.00	No.	9100	9100	
20.10	LV cabling		50.00	m	150	7500	
20.11	Hose points and drainage		1.00	LS	10000	10000	
21.00	**Pump Station for Gold Course Land Application**						
21.01	5.5kW pumps		2.00	No.	5400	10800	
21.02	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6000	6000	
21.03	5.5kW VSDs		2.00	LS	2700	5400	
21.04	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25000	25000	
21.05	Pump station slab with shed (total span garage or similar)		1.00	LS	30000	30000	
21.06	Valving and pipework (SS) - 2 x KGVS (50NB), 2 x NRVs, 2 x PRVs		1.00	LS	4000	4000	
21.07	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	5000	5000	
21.08	Manual cleaning steel filter (1500 Micron) - Suction End		1.00	No.	6750	6750	
21.09	Automatic self-cleaning filter (800-10 Micron) - Discharge End		1.00	No.	9100	9100	
21.10	LV cabling		50.00	m	150	7500	
21.11	Hose points and drainage		1.00	LS	10000	10000	
21.12	Rounding		1.00	LS	-152	-152	
22.00	**Sub Total Disposal**						**1,894,000**
23.00	**Main Contractors Preliminary & General / Off-Site Overheads & Profit**						
23.01	Main Contractors Preliminary & General (Construction Management)	11,840,000.00	11,840,000.00	LS	8.00%	947,200	
23.02	Main Contractor Off-Site Overheads & Profit	12,787,200.00	12,787,200.00	LS	8.00%	1,022,976	
23.03	Rounding		1.00	LS	-176	-176	
24.00	**Sub Total Contractors P&G/Oversite Overheads and Profit**						**1,970,000**
25.00	**Total Physical Works**						**13,810,000**
26.00	**Consultant Fees (Design/Engineering) / Consents (Cost to Complete)**						**1,182,000**
26.01	Geotechnical Investigation	1.00	1.00	LS	30,000	30,000	
26.02	Further Assessment Work	1.00	1.00	LS	10,000	10,000	
26.03	Investigation Work	1.00	1.00	LS	10,000	10,000	
26.04	Detailed Design	1.00	8%	%	1,104,800	1,104,800	
26.05	Procurement &Tender Evaluation	1.00	1.00	LS	10,000	10,000	
26.06	Construction Monitoring & Contract Administration	4.00	4.00	month	3,500	14,000	
26.07	Practical Completion/Producer Statements, etc	1.00	1.00	LS	3,000	3,000	
26.08	Rounding Adjustment	1.00	1.00	LS	200	200	
27.00	**Total Base Estimate**						**14,992,000**
28.00	**Contingency**						**4,498,000**
28.01	Construction Contingency	0.00	14,992,000	LS	30.00%	4,497,600	
28.02	Rounding Adjustment	1.00	1.00	LS	400	400	
29.00	**Total Expected Estimate**						**19,490,000**

Project: **Raglan Waste Water Treatment Plant Optioneering**
Waikato District Council

Document: **Short List Conceptual Design Cost Estimate**

2.00 2

4286014/428E 4286014/4288629

Date: 14 December 2020

Author: Shaun Le Grange/Claire Scrimgeour (verified Rudy Verbeek)

Option L4: Treatment - MBR and UV treatment
Option L4: Disposal - Discharge to public land and to new outfall and diffuser

	Estimate Detail						
Ref	**Item Description**	**Calculation**	**Quantity**	**Unit**	**Rate**	**Sub-Total**	**Total**
	Key Metric Data						
	8800m DN250 HDPE pipe **Pump Station and Booster Station**						
1.00	**Reference Documentation:**						
1.01	Email: FW: Updated costing sheet with all items included from Hermanus Kruger on the 17/07/2019 "Final Raglan WWTP Cost Estimate - PRE costing professional excel spreadsheet"						
1.02	Picton Sewage Upgrade Estimate dated 30 March 2012						
1.03	Email: FW: Updated costing sheet with all items included from Hermanus Kruger on the 17/07/2019						
2.00	**Establishment**						
2.01	**(Excludes Tertiary Membrane Establishment)**						
2.02	Establishment - site set out, service location/relocation, temporary fencing, silt control, site lay down area/facilities, security and plant machinery delivery		1.00	LS	50000	50000	
2.03	Disestablish offsite - remove plant machinery, remove site laydown area/facilities, silt control, temporary fencing and install new fencing.		1.00	LS	20000	20000	
3.00	**Sub Total Establishment**						**70,000**
4.00	**Pond Modifications**						
4.01	Pond modifications, aeration and screens		1.00	PSum	5000000	5000000	
Option L4: Treatment -							
5.00	**Sub Total Treatment**						**5,000,000**
6.00	**LAND APPLICATION**						
6.01	**Pipeline to Private Land**						
6.02	DN250 PE100 PN20/ SDR9 (Open cut trench installation - Rural)		1,970.00	m	250	492500	
6.03	E/O for all connections		2.00	No.	10000	20000	
6.04	Air valves chamber (incl all ancillary items)		20.00	No.	15000	300000	
6.05	Scour valves chamber (incl all ancillary items)		6.00	No.	15000	90000	
7.00	**Pump Station to Booster Pump Station**						
7.01	75kW pumps		2.00	No.	64800	129600	
7.02	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6000	6000	
7.03	75kW VSDs		2.00	LS	20000	40000	
7.04	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25000	25000	
7.05	Pump station slab with shed (total span garage or similar)		1.00	LS	26250	26250	
7.06	Valving and pipework (SS) - 2 x KGVS (150NB), 2 x NRVs, 2 x PRVs		1.00	LS	12200	12200	
7.07	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	15000	15000	
7.08	LV cabling		50.00	m	150	7500	
7.09	Manual cleaning steel filter (1500 Micron)		1.00	No.	6750	6750	
7.10	Hose points and drainage		1.00	LS	10000	10000	
8.00	**Power Supply**						
8.01	100kVA transformer		1.00	LS	60000	60000	
8.02	LV cabling		50.00	m	150	7500	
8.03	HV cabling		265.00	m	300	79500	
8.04	E/O last for cable connections		4.00	No.	5000	20000	

9.00	**Booster Pump Station**						
9.01	45kW pumps		2.00	No.	31050	62100	
9.02	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6000	6000	
9.03	45kW VSDs		2.00	LS	15000	30000	
9.04	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25000	25000	
9.05	Pump station slab with shed (total span garage or similar)		1.00	LS	30000	30000	
9.06	30 000L Tank (Incl pipe work)		1.00	LS	15000	15000	
9.07	Pump station - excavations		54.00	m3	50	2700	
9.08	Valving and pipework (SS) - 2 x KGVS (150NB), 2 x NRVs, 2 x PRVs		1.00	LS	12200	12200	
9.09	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	15000	15000	
9.10	Manual cleaning steel filter (1500 Micron)		1.00	No.	6750	6750	
9.11	Hose points and drainage		1.00	LS	10000	10000	
10.00	**Power Supply**						
10.01	100kVA transformer		1.00	LS	60000	60000	
10.02	LV cabling		50.00	m	150	7500	
10.03	HV cabling		600.00	m	300	180000	
10.04	E/O last for cable connections		4.00	No.	5000	20000	
11.00	**Testing and Commissioning**						
11.01	Testing and Commissioning		1.00	LS	100000	100000	
12.00	**Traffic Management**						
12.01	Prepare Contractor's Temporary Traffic Management Plan		1.00	LS	1000	1000	
12.02	Implement Traffic Management Plan - local authority		90.00	days	650	58500	
12.03	Rounding		1.00	LS	450	450	
13.00	**Sub Total Disposal**						**1,990,000**
14.00	**Main Contractors Preliminary & General / Off-Site Overheads & Profit**						
14.01	Main Contractors Preliminary & General (Construction Management)	7,060,000	7,060,000	LS	8.00%	564,800	
14.02	Main Contractor Off-Site Overheads & Profit	7,624,800	7,624,800	LS	8.00%	609,984	
14.03	Rounding		1.00	LS	216	216	
15.00	**Sub Total Contractors P&G/Oversite Overheads and Profit**						**1,175,000**
16.00	**Total Physical Works**						**8,235,000**
17.00	**Consultant Fees (Design/Engineering) / Consents (Cost to Complete)**						**735,800**
17.01	Geotechnical Investigation	1.00	1.00	LS	30,000	30,000	
17.02	Further Assessment Work	1.00	1.00	LS	10,000	10,000	
17.03	Investigation Work	1.00	1.00	LS	10,000	10,000	
17.04	Detailed Design	1.00	8%	%	658,800	658,800	
17.05	Procurement &Tender Evaluation	1.00	1.00	LS	10,000	10,000	
17.06	Construction Monitoring & Contract Administration	4.00	4.00	month	3,500	14,000	
17.07	Practical Completion/Producer Statements, etc	1.00	1.00	LS	3,000	3,000	
17.08	Rounding Adjustment	1.00	1.00	LS	0	0	
18.00	**Total Base Estimate**						**8,970,800**
19.00	**Contingency**						**2,691,200**
19.01	Construction Contingency	0.00	8,970,800	LS	30.00%	2,691,240	
19.02	Rounding Adjustment	1.00	1.00	LS	-40	-40	
20.00	**Total Expected Estimate**						**11,662,000**

Project: **Raglan Waste Water Treatment Plant Optioneering**
Waikato District Council

Document: **Short List Conceptual Design Cost Estimate**

2.00 2

4286014/4288 4286014/4288629

Date: 14 December 2020

Author: Shaun Le Grange/Claire Scrimgeour (verified Rudy Verbeek)

Option L4: Treatment - MBR and UV treatment
Option L4: Disposal - Discharge to public land and to new outfall and diffuser

Ref	Item Description	Calculation	Quantity	Unit	Rate	Sub-Total	Total
	Estimate Detail						
	Key Metric Data						
	Tertiary Membrane **8800m DN250 HDPE pipe** **Pump Station and Booster Station**						
1.00	**Reference Documentation:**						
1.01	Email: FW: Updated costing sheet with all items included from Hermanus Kruger on the 17/07/2019 "Final Raglan WWTP Cost Estimate - PRE costing professional excel spreadsheet"						
1.02	Picton Sewage Upgrade Estimate dated 30 March 2012						
1.03	Email: FW: Updated costing sheet with all items included from Hermanus Kruger on the 17/07/2019						
2.00	**Establishment**						
2.01	**(Excludes Tertiary Membrane Establishment)**						
2.02	Establishment - site set out, service location/relocation, temporary fencing, silt control, site lay down area/facilities, security and plant machinery delivery		1.00	LS	50000	50000	
2.03	Disestablish offsite - remove plant machinery, remove site laydown area/facilities, silt control, temporary fencing and install new fencing.		1.00	LS	20000	20000	
3.00	**Sub Total Establishment**						**70,000**
4.00	**Pond Modifications**						
Option L4: Treatment - MBR and UV treatment **Option L4: Disposal -** Discharge to public land and to new outfall and diffuser	Pond modifications, aeration and screens		1.00	PSum	5000000	5000000	
5.00	**Road Side Pond Earthworks**						
5.01	De-sludging of ponds		17,280.00	m2	20	345600	
5.02	Raising of Pond Base		3,658.00	m3	45	164610	
5.03	Lining of ponds		17,280.00	m2	20	345600	
6.00	**Tertiary Membrane (Masons)**						
6.01	Roading (40m length - assume 6m wide)		240.00	m2	250	60000	
6.02	Earthworks to site		144.00	m3	50	7200	
6.03	300mm concrete foundation slab (20 x 24m)		480.00	m2	360	172800	
6.04	Building (20x24m)		480.00	m2	2500	1200000	
6.05	Supply process plant to site (3000m3/d - 2 x skids of 2 process train 20m x 24m)		1.00	LS	1850000	1850000	
6.06	Install of plant above (Crane 2 day, 2 men 5 days, plant 5 days)		2.00	No.	20000	40000	
7.00	**Tie-in Works - Tertiary Membrane**						
7.01	Tie in pipework (100mm NB PE Above ground 40m from location + supports + air valve) Iso valve on flanged connection to tank)		1.00	LS	20000	20000	
7.02	Dry-mount P/S (2 x 5.5kW pumps with VSDs)		2.00	No.	20000	40000	
7.03	Valves (2 x non-returns 100mm 2 x isolation valves 100mm)		4.00	No.	750	3000	
7.04	Instruments (1 x FT (100mm) (flow transmitter))		1.00	No.	5000	5000	
7.05	Platform for pumps		1.00	LS	5000	5000	
8.00	**Effluent Tie-in Works - Tertiary Membrane**						
8.01	100mm NB PE below ground from membrane to storage pond (Assumed 1.5m depth)		30.00	m	300	9000	
8.02	E/O last for connections		2.00	No.	1000	2000	

9.00	**Ancillary**						
9.01	Stormwater management (Connection to existing network 2 x manholes + 265 m pipework)		1.00	LS	185000	185000	
9.02	Connection to Potable water		1.00	LS	22500	22500	
9.03	Foul water drainage (slot drains and connection to existing system)		1.00	LS	20000	20000	
9.04	Air compressor + receiver		1.00	LS	Incl.	0	
10.00	**Bulk Chemical Tank**						
10.01	5,000L PE Tank		1.00	No.	4000	4000	
10.02	Concrete bunding, 5000L capacity		1.00	PS	10000	10000	
10.03	Pipework + valving (25mm PVC-schedule 80 30m in trench non-return + iso valve)		1.00	LS	5000	5000	
10.04	Safety shower (Assume 1)		1.00	No.	3000	3000	
10.05	Instruments (3 x FT (flow transmitter) 3x PT (Pressure transmitter))		1.00	LS	30000	30000	
11.00	**Power Supply**						
11.01	100kVA transformer		1.00	LS	60000	60000	
11.02	LV cabling		50.00	m	150	7500	
11.03	HV cabling		265.00	m	300	79500	
11.04	E/O last for cable connections		4.00	No.	5000	20000	
12.00	**Testing and Commissioning**						
12.01	Testing and Commissioning		1.00	LS	100000	100000	
13.00	**Traffic Management**						
13.01	Prepare Contractor's Temporary Traffic Management Plan		1.00	LS	1000	1000	
13.02	Implement Traffic Management Plan - local authority		90.00	days	650	58500	
13.03	Rounding		1.00	LS	190	190	
14.00	**Sub Total Treatment**						**9,876,000**
15.00	**New Discharge section**						
15.01	400NB HDPE SDR20 (assume depth of 0-1.5m)		290.00	m	550	159500	
15.02	E/O for all connections and valves		4.00	No.	10000	40000	
16.00	**Diffuser**						
16.01	Supply and install Diffuser complete with all temporary trenching and piling (Assumed Similar design to Picton Outfall)		1.00	LS	260000	260000	
17.00	**LAND APPLICATION**						
17.01	**Pipeline to Private Land**						
17.02	DN250 PE100 PN20/ SDR9 (Open cut trench installation - Rural)		1,970.00	m	250	492500	
17.03	E/O for all connections		2.00	No.	10000	20000	
17.04	Air valves chamber (incl all ancillary items)		20.00	No.	15000	300000	
17.05	Scour valves chamber (incl all ancillary items)		6.00	No.	15000	90000	
18.00	**Pump Station to Booster Pump Station**						
18.01	75kW pumps		2.00	No.	64800	129600	
18.02	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6000	6000	
18.03	75kW VSDs		2.00	LS	20000	40000	
18.04	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25000	25000	
18.05	Pump station slab with shed (total span garage or similar)		1.00	LS	26250	26250	
18.06	Valving and pipework (SS) - 2 x KGVS (150NB), 2 x NRVs, 2 x PRVs		1.00	LS	12200	12200	
18.07	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	15000	15000	
18.08	LV cabling		50.00	m	150	7500	
18.09	Manual cleaning steel filter (1500 Micron)		1.00	No.	6750	6750	
18.10	Hose points and drainage		1.00	LS	10000	10000	
19.00	**Booster Pump Station**						
19.01	45kW pumps		2.00	No.	31050	62100	
19.02	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6000	6000	
19.03	45kW VSDs		2.00	LS	15000	30000	
19.04	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25000	25000	
19.05	Pump station slab with shed (total span garage or similar)		1.00	LS	30000	30000	
19.06	30 000L Tank (Incl pipe work)		1.00	LS	15000	15000	

19.07	Pump station - excavations		54.00	m3	50	2700	
19.08	Valving and pipework (SS) - 2 x KGVS (150NB), 2 x NRVs, 2 x PRVs		1.00	LS	12200	12200	
19.09	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	15000	15000	
19.10	Manual cleaning steel filter (1500 Micron)		1.00	No.	6750	6750	
19.11	Hose points and drainage		1.00	LS	10000	10000	
20.00	**Power Supply**						
20.01	100kVA transformer		1.00	LS	100000	100000	
20.02	LV cabling		50.00	m	150	7500	
20.03	HV cabling		600.00	m	300	180000	
20.04	E/O last for cable connections		4.00	No.	5000	20000	
20.05	Rounding		1.00	LS	450	450	
21.00	**Sub Total Disposal**						**2,163,000**
22.00	**Main Contractors Preliminary & General / Off-Site Overheads & Profit**						
22.01	Main Contractors Preliminary & General (Construction Management)	12,109,000	12,109,000	LS	8.00%	968,720	
22.02	Main Contractor Off-Site Overheads & Profit	13,077,720	13,077,720	LS	8.00%	1,046,218	
22.03	Rounding		1.00	LS	62	62	
23.00	**Sub Total Contractors P&G/Oversite Overheads and Profit**						**2,015,000**
24.00	**Total Physical Works**						**14,124,000**
24.01	**Consultant Fees (Design/Engineering) / Consents (Cost to Complete)**						**1,207,000**
24.02	Geotechnical Investigation	1.00	1.00	LS	30,000	30,000	
24.03	Further Assessment Work	1.00	1.00	LS	10,000	10,000	
24.04	Investigation Work	1.00	1.00	LS	10,000	10,000	
24.05	Detailed Design	1.00	8%	%	1,129,920	1,129,920	
24.06	Procurement &Tender Evaluation	1.00	1.00	LS	10,000	10,000	
24.07	Construction Monitoring & Contract Administration	4.00	4.00	month	3,500	14,000	
24.08	Practical Completion/Producer Statements, etc	1.00	1.00	LS	3,000	3,000	
24.09	Rounding Adjustment	1.00	1.00	LS	80	80	
25.00	**Total Base Estimate**						**15,331,000**
26.00	**Contingency**						**4,599,000**
26.01	Construction Contingency	0.00	15,331,000	LS	30.00%	4,599,300	
26.02	Rounding Adjustment	1.00	1.00	LS	-300	-300	
27.00	**Total Expected Estimate**						**19,930,000**

Project: **Raglan Waste Water Treatment Plant Optioneering**
Waikato District Council

Document: **Short List Conceptual Design Cost Estimate**

2.00 2

4286014/4288 4286014/4288629

Date: 14 December 2020

Author: Shaun Le Grange/Claire Scrimgeour (verified Rudy Verbeek)

Option L4: Treatment - MBR and UV treatment
Option L4: Disposal - Discharge to public land and to new outfall and diffuser

	Estimate Detail						
Ref	**Item Description**	**Calculation**	**Quantity**	**Unit**	**Rate**	**Sub-Total**	**Total**
	Key Metric Data						
	MBR Plant 3MLD (Including new inlet works and UV) **Extended Outfall**						
1.00	**Reference Documentation:**						
1.01	John Crawford MBR cost curve January 2020						
1.02	Metro DBC Costing						
1.03							
2.00	**Establishment**						
2.01	Establishment - site set out, service location/relocation, temporary fencing, silt control, site lay down area/facilities, security and plant machinery delivery		1.00	LS	70,000.00	70,000.00	
2.02	Disestablish offsite - remove plant machinery, remove site laydown area/facilities, silt control, temporary fencing and install new fencing.		1.00	LS	30,000.00	30,000.00	
2.03							
	Sub Total Establishment						**100,000**
3.00							
	MBR Plant (including screening and UV)		1.00	LS	20,400,000.00	20,400,000.00	
4.00							
4.01	**Pump station for pumping buffered influent through MBR**						
Option L4: Treatment - MBR and UV treatment **Option L4: Disposal -** Discharge to public land and to new outfall and diffuser	3.5kW pumps		2.00	No.	6,000.00	12,000.00	
11.00	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6,000.00	6,000.00	
11.01	3.5kW VSDs		2.00	LS	2,500.00	5,000.00	
11.02	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25,000.00	25,000.00	
11.03	Pump station slab with shed (total span garage or similar)		1.00	LS	30,000.00	30,000.00	
	Valving and pipework (SS) - 2 x KGVS (150NB), 2 x NRVs, 2 x PRVs		1.00	LS	12,200.00	12,200.00	
5.00	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	15,000.00	15,000.00	
5.01	160 NB PE100 PN10 (Assume in trench 0-1.5m depth))		13.00	m	400.00	5,200.00	
5.02							
5.03	**Power Supply**						
5.04	500kVA transformer		1.00	LS	75000	75000	
5.05	LV cabling		50.00	m	150	7500	
5.06	HV cabling		265.00	m	300	79500	
	E/O last for cable connections		4.00	No.	5000	20000	
6.00							
6.01	**Testing and Commissioning**						
6.02	Testing and Commissioning		1.00	LS	100,000.00	100,000.00	
6.03							
6.04	**Traffic Management (outfall only)**						
6.05	Prepare Contractor's Temporary Traffic Management Plan		1.00	LS	1,000.00	1,000.00	
	Implement Traffic Management Plan - local authority		30.00	days	650.00	19,500.00	
7.00							
7.01							
7.02							
13.00	**Sub Total Treatment**						**20,812,900**
14.00	**New Discharge section**						
14.01	400NB HDPE SDR20 (assume depth of 0-1.5m)		100.00	m	550	55000	
14.02	E/O for all connections and valves		4.00	No.	10000	40000	
15.00	**Diffuser**						
15.01	Supply and install Diffuser complete with all temporary trenching and piling (Assumed Similar design to Picton Outfall)		1.00	LS	260000	260000	
16.00	**LAND APPLICATION**						
16.01	**Pipeline to Airstrip**						

16.02	DN75 PE100 PN12.5/ SDR13.6 (Open cut trench installation - Rural)		1,970.00	m	100	197000	
16.03	E/O for all connections		2.00	No.	5000	10000	
16.04	Air valves chamber (incl all ancillary items)		7.00	No.	15000	105000	
16.05	Scour valves chamber (incl all ancillary items)		3.00	No.	15000	45000	
17.00	**Pipeline to Wainui Reserve**						
17.01	DN110 PE100 PN16/ SDR11 (Open cut trench installation - Rural)		2,570.00	m	100	257000	
17.02	E/O for all connections		2.00	No.	10000	20000	
17.03	Air valves chamber (incl all ancillary items)		6.00	No.	15000	90000	
17.04	Scour valves chamber (incl all ancillary items)		3.00	No.	15000	45000	
18.00	**Pipeline to Golf Course**						
18.01	DN110 PE100 PN16/ SDR11 (Open cut trench installation - Rural)		2,230.00	m	100	223000	
18.02	E/O for all connections		2.00	No.	10000	20000	
18.03	Air valves chamber (incl all ancillary items)		5.00	No.	15000	75000	
18.04	Scour valves chamber (incl all ancillary items)		4.00	No.	15000	60000	
19.00	**Pump Station for Airstrip Land Application**						
19.01	3kW pumps		2.00	No.	4320	8640	
19.02	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6000	6000	
19.03	3kW VSDs		2.00	LS	2160	4320	
19.04	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25000	25000	
19.05	Pump station slab with shed (total span garage or similar)		1.00	LS	30000	30000	
19.06	Valving and pipework (SS) - 2 x KGVS (40NB), 2 x NRVs, 2 x PRVs		1.00	LS	4067	4067	
19.07	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	5000	5000	
19.08	Manual cleaning steel filter (1500 Micron) - Suction End		1.00	No.	6750	6750	
19.09	Automatic self-cleaning filter (800-10 Micron) - Discharge End		1.00	No.	9100	9100	
19.10	LV cabling		50.00	m	150	7500	
19.11	Hose points and drainage		1.00	LS	10000	10000	
20.00	**Pump Station for Wainui Land Application**						
20.01	15kW pumps		2.00	No.	11475	22950	
20.02	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6000	6000	
20.03	15kW VSDs		2.00	LS	5738	11475	
20.04	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25000	25000	
20.05	Pump station slab with shed (total span garage or similar)		1.00	LS	30000	30000	
20.06	Valving and pipework (SS) - 2 x KGVS (100NB), 2 x NRVs, 2 x PRVs		1.00	LS	12200	12200	
20.07	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	15000	15000	
20.08	Manual cleaning steel filter (1500 Micron) - Suction End		1.00	No.	6750	6750	
20.09	Automatic self-cleaning filter (800-10 Micron) - Discharge End		1.00	No.	9100	9100	
20.10	LV cabling		50.00	m	150	7500	
20.11	Hose points and drainage		1.00	LS	10000	10000	
21.00	**Pump Station for Golf Course Land Application**						
21.01	5.5kW pumps		2.00	No.	5400	10800	
21.02	Mech + electrical install to last (2men 5days, plant 5days)		1.00	LS	6000	6000	
21.03	5.5kW VSDs		2.00	LS	2700	5400	
21.04	Mini switchboard for motor starters + PLC (assume micrologix)		1.00	LS	25000	25000	
21.05	Pump station slab with shed (total span garage or similar)		1.00	LS	30000	30000	
21.06	Valving and pipework (SS) - 2 x KGVS (50NB), 2 x NRVs, 2 x PRVs		1.00	LS	4000	4000	
21.07	Flowmeter + 2 x PTS, 2 x Pressure switches		1.00	LS	5000	5000	
21.08	Manual cleaning steel filter (1500 Micron) - Suction End		1.00	No.	6750	6750	
21.09	Automatic self-cleaning filter (800-10 Micron) - Discharge End		1.00	No.	9100	9100	
21.10	LV cabling		50.00	m	150	7500	
21.11	Hose points and drainage		1.00	LS	10000	10000	
22.00	**Sub Total Disposal**						**1,893,902**
23.00	**Main Contractors Preliminary & General / Off-Site Overheads & Profit**						
23.01	Main Contractors Preliminary & General (Construction Management)	22,806,801.87	22,806,801.87	LS	8.00%	1,824,544	
23.02	Main Contractor Off-Site Overheads & Profit	24,631,346.02	24,631,346.02	LS	8.00%	1,970,508	
24.00	**Sub Total Contractors P&G/Oversite Overheads and Profit**						**3,795,052**

25.00							
	Total Physical Works						**26,601,854**

26.00	**Consultant Fees (Design/Engineering) / Consents (Cost to Complete)**						2,363,348	9%
26.01	Geotechnical Investigation	1.00	1.00	LS	60,000	60,000		
26.02	Further Assessment Work	1.00	1.00	LS	20,000	20,000		
26.03	Investigation Work	1.00	1.00	LS	20,000	20,000		
26.04	Detailed Design	1.00	8%	%	2,128,148	2,128,148		
26.05	Procurement &Tender Evaluation	1.00	1.00	LS	60,000	60,000		
26.06	Construction Monitoring & Contract Administration	15.00	15.00	month	3,500	52,500		
26.07	Practical Completion/Producer Statements, etc	1.00	1.00	LS	23,000	23,000		
26.08	Rounding Adjustment	1.00	1.00	LS	-300	-300		
27.00	**Total Base Estimate**						28,965,202	
28.00	**Contingency**						8,689,561	
28.01	Construction Contingency	0.00	28,965,202	LS	30.00%	8,689,561		
28.02	Rounding Adjustment	1.00	1.00	LS	-4,762	-4,762		
29.00	**Total Expected Estimate**						37,650,000	