Memorandum

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From	Asaf Rachmani /Andrew Springer
Office	Hamilton Environmental Office
Date	6 June 2017
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Subject	Mangawhai WWTP - Summary Report

1 Background

To date, Opus provided Kaipara District Council with two reports, these are:

- Mangawhai Wastewater Treatment Plant – Capacity Assessment, dated 22nd of December 2016
- Mangawhai Wastewater Treatment Plant – Option Investigation for an Increase Capacity, dated 23rd of March 2017.

Following the delivery of these reports and several communications Opuses had with Kaipara District Council, some further queries for clarification have been raised. This memorandum aims to provide clarification to address the following three questions.

- The existing Mangawhai WWTP and Lincoln Down Farm disposal field capacity.
- The estimated number of connections the WWTP and disposal field can accommodate.
- Mangawhai community Future Growth and what will be needed at WWTP and disposal field.

1.1 Connection Discharge Rate Evaluation

To be able to evaluate the peak and average flow rates produced by a typical household ("connection") within the Mangawhai community, the average flow rates during the time periods mentioned below were divided by the estimated number of connections of 1,991 (number of connection that was provided to Opus by Kaipara District Council). Table 1 presents this evaluation.

- The entire year 2016
- 2016/2017 peak season (24/12/16 to 04/02/17) and
- New Year 2017 (01/01/17)

Table 1 presents this evaluation of the discharge rate per connection.

Table 1: Estimated flow per connection during annual average, peak season and peak flow

Description	Flow at 1991 connections (m^3/d)	Approximate Flow per Connection (l/connection/d)
Annual Average Flow 2016	492	250
2016/2017 Peak Season (24/12/16 to 04/02/17) Average	616	300
New Year 2017 (01/01/17)	1204	600

Previous reports had been developed on an agreed flow rate of 600 l/connection/day to evaluate the treatment capacity of the Mangawhai WWTP. This indicated that there was little or no spare capacity in the WWTP. From the data above 600 l/c/d is only applicable for the short duration maximum occupancy occurring at New Year period, but this level for short duration will not affect consent compliance as this is based on a rolling average period over 6 samples, and 12 weeks.

By considering the flow period aligned to the sampling periods, the worst case if the peak summer 12 weeks. **Based on this, a flow per connection of 300 l/connection/day was selected to evaluate the number of connections.**

2 WWTP Plant Capacity

2.1 Existing Operation

Up until the detailed monitoring during February 2017, it was not clear what the performance of the CASS system was. This uncertainty was because no samples existed for the outlet of the CASS system. As part of the detailed monitoring investigation, two sample taps were installed on the decanter pipes from each CASS basin and grab samples were now able to be taken daily.

The monitoring investigation over the Waitangi weekend showed that at a flow rate of 651 m^3/d, with both CASS Basin in operation, all except the total phosphorous, were above the current consent limits. This suggesting that the CASS plant in its current configuration is likely not to meet the current consent limits during peak days such as Waitangi and Christmas New Year. However, over a longer rolling average period that involves lower loading entering the plant together with the balancing arrangements and the removal performance of the tertiary treatment the Mangawhai WWTP contains, the effluent qualities are still within the current discharge conditions.

2.2 Preliminary Optimised Operation

In regards to Kaipara District Council requirement to optimise the use of the existing infrastructure and defer any significant upgrades to the WWTP, Opus reviewed the existing operation regime and plant items and proposed the following improvements to maximize the load carrying capacity of the plant.

- During normal operation, it is proposed to increase the total cycle length of the CASS system to 6 hours. During high flow, such as during big rain events the total cycle time can be shortened to a 4 or 3-hour cycle to suit the hydraulic conditions. This proposed aeration is applied for both single and parallel basin operation modes.
- To reduce risk associated with short-circuiting and or an increase of contaminants in the effluent caused by continuous recirculation of the RAS, it is recommended to use the RAS pumps to recycle the MLSS from the main CASS reactor into the first cell during the react stage only. The future recycle rate should be sized to 3 to 7 times (this ratio is dependent upon effluent total nitrogen requirements and available carbon) the inflow rate entering the Mangawhai Plant (Other similar plants use up to 10 times but Cell 1 and cell 2 within the CASS basins are proposed to be used as designated anoxic zones (Cell 1 always as an anoxic selector and Cell 2 as an

anoxic/aerobic swing zone in anoxic mode whenever load conditions permit). This will create an appropriate environment for further removal of nitrogen through the denitrification process. If further removal of ammonia was found to be required, cell two could be used as a swing zone allowing aerobic conditions to occur as well.

- Provision of chemical assistance, including aluminum-based coagulant to improve settlement and addition of external carbon source to enhance denitrification.

Based on these operation improvements, the key changes to the treatment process over current CASS system would be:

- Increased denitrification rate by additional anoxic condition, recycle of nitrate and addition of carbon source.
- Increase aeration. The aeration capacity of the plant is increased by 30% as each basin now receives 16 hours of aeration per day rather than 12 hours under a 4-hour cycle regime.
- Provision to increase settle ability of sludge and suppress formation of filamentous bacteria.

While undertaking the recommended preliminary operation, improvements mentioned above, **the sustainable load carrying capacity of the Mangawhai WWTP was found to be in the order of 1,200 m^3/d.**

Based on the flow rate of 1,200 m^3/d and the sewage production rate per connection of 300 l/connection/day **the estimated number of connections that can be introduced into the Mangawhai existing WWTP under this option is 4,000.** This number of connections is approximately doubled than the current reported number of connections of 1,991.

We propose that the optimisation is undertaken in two phases. The first to improve cycles and anoxic zone performance, and then, if required, use of chemical dosing for enhanced settlement and additional carbon. This approach minimises capital expenditure for KDC.

3 WWTP Cost Estimate

Under the optimisation of the plant, the following process items are likely to be required in the upgrade work.

- **Mixing system** for the designated anoxic zones, Cell 1 and Cell 2 within the CASS basins. This would create an appropriate environment for further removal of nitrogen through the denitrification process.
- **RAS pumps and rising main** to increase the recycle ratio and removal of Nitrate capabilities.
- **Blowers,** four new blowers to allow dedicated pairs to be assigned to each CASS basin. This upgrade is a result of higher loading caused by additional loads and the use of a diurnal peak factor of 2.5 to ensure that the peak hour loading is adequately accommodated.
- **Coagulant dosing system (provisional)** to increase settling ability of the sludge and suppress formation of filamentous bacteria. Can potentially be used to increase the react stage duration for better removal of Nitrogen.
- **External carbon source dosing system (provisional)** to enhance the removal of Nitrate.

Table 2 presents the preliminary estimated capital cost of the proposed operational improvements.

Table 2: Operational optimisation cost summary

Item	NZ$, excluding GST
Operational optimisation total capital cost estimate	288,000 – 514,000

Note:

[1] *Breakdown of the cost is shown in Mangawhai Wastewater Treatment Plant – Option Investigation for an Increase Capacity, dated 23rd of March 2017.*

4 WWTP Future Scope

Kaipara District Council (KDC) have identified areas of potential growth that could bring the number of connections to a maximum of approximately 7,000.

As indicated above, despite any operational improvements of the existing CASS plant, the existing plant could not serve the expected full development. To be able to serve an increased number connection of 7,000, a larger scale upgrade would be necessary, such as duplication of the existing CASS system. This work would likely to be in the order of $ 8 M to $12 M and would need to include larger or alternative disposal arrangement.

The addition of a single extra CASS reactor will increase the capacity of the plant by 2000 properties and can be implemented sequentially in line with growth.

5 Lincoln Down Farm – Treated Effluent Irrigation:

5.1 Original Environmental Management Plan

Review of the existing "*Kaipara District Council, Mangawhai EcoCare Project, Environmental Management Plan – Lincoln Downs [Amended Final Report], April 2010*" by RMCG finds a comprehensive discussion and plan on the ability of the receiving Lincoln Downs farm to successfully irrigate the WWTP treated discharge and utilize the storage ponds for buffer and storage.

While the original Lincoln Downs Irrigation Scheme (section 3 of the RMCG report) envisioned future volumes of a scale of 200 ML per year (548 m3/day), the optimized WWTP discharge of 438 ML (1,200 m3/day) could be equally accepted by the irrigation system.

The RMCG Report states in section 3.1.1 that "There are two possible inflows to the dam: - Reclaimed Water and Rain Water. It also states that there are two possible outflows from the dam: Deficit Irrigation; and Runoff irrigation.

We suggest one additional possible outflow from the dam with a discharge to water. If/when future community flows exceed the maximum capacity of the existing WWTP; or additional treatment process tanks are added to the plant, discharge to water would be a cleaner discharge option for the receiving waterway as significant runoff irrigation has accompanying sediment.

5.2 Present Farm Irrigation:

The 2010 original RMCG Report Section 3 summarizes the designed irrigation scheme as follows:

Present Design Inflow to Farm:

- Volume flowing into irrigation dam from WWTP = 175 ML/yr
- Rainfall collected in irrigation dam (exceeding evaporation) = 15 ML/yr +/-
- The active volume of the irrigation dam = 184 ML/y

Present Design Discharge at Farm:

- Present Irrigation Area = 46 hectares
- Deficit Irrigation = average 4 ML/ha x 46 ha = 184 ML/y
- Ultimate area of land available = 65 hectares

The present situation show a balanced system with 184 ML/y from the WWTP and 184 ML/y discharges via sprinkler irrigation at the Lincoln Downs farm.

With the inflow volume of 175 ML/yr from the WWTP to the dam, this breaks down into community connections as follows:

175 ML/y = 175,000 m3/yr / 365 d/yr = 479 m3/d (average) influent to WWTP

479 m3/d / 2,000 present connections = 240 l/d/c (average)

This is consistent with what the community connections, WWTP, and discharge farm experience today.

5.3 Optimized Farm Irrigation:

With consideration of the optimization of the WWTP per the Opus Optimization Report, we find that the sustainable discharge volume (existing consent standards) will be 1,200 m3/d.

The optimized designed irrigation scheme would then become as follows:

1,200 m3/d X 365 d/y = 438,000 m3/y = 438 ML/y

Optimized Design Inflow to Farm:

- Volume flowing into irrigation dam from WWTP = 438 ML/yr
- Rainfall collected in irrigation dam (exceeding evaporation) = 15 ML/yr +/-
- The active volume of the irrigation dam = 453 ML/y

Optimized Discharge at Farm:

- Present Irrigation Area = 46 hectares
- Consented Deficit Irrigation = average 5 ML/ha @ 46 ha = 230 ML/y
- Volume of Irrigation dam (holding full) = 175 ML/y
- Active volume of WWTP discharge = 405 ML/y

The optimized situation shows an overflow of the dam of 48 ML/y (453 ML/y – 405 ML/y). This situation when reached would result in the second outflow possibility of the dam – runoff irrigation (Section 3.1.1 RMCG Report)

The original design anticipated that this would occur once in every 10 years. However, at present the WWTP does not experience 1,200 m3/d discharge every day for 365 days. When the WWTP does discharge that quantity and the dam is already full, runoff irrigation would then become necessary.

A look at what the runoff volume of 48 ML/y would produce is relevant here as it is small.

48 ML/y = 48,000 m3/y / 365 d/y = 131 m3/d/farm / 46 ha = 2.9 m3/h/d

2.9 m3/h/d / 1,000 m2/h = .003 m depth = 3mm depth/h/d to runoff

6 Future Options for Farm Discharge

The existing consent allows for 5,000 m3/ha/yr to be discharged to the receiving farm. The assumption is that this volume of treated water matches the uptake of water by pastoral grass crops.

With 46 hectares currently under irrigation we are at a balanced situation until such a time that the influent exceeds the discharge. This tipping point would be estimated to be at approximately 2,625 connections – which equates to 230ML.

- Consented farm discharge in balance with treated volume received at farm.

  5,000 m^3/ha/yr farm influent X 46 hectares = 230,000 m^3/yr = 230 ML

- Pond filling more than emptied.

  At 630 m3/d, the system will start coming out of balance and the pond will fill more than the deficit irrigation discharge over a year's time.

  230 ML = 230,000 m3/yr / 365 d/yr = 630 m3/d (average) influent to WWTP

  630 m3/d / .240 m3/d/c (average) = 2,625 approximated connections – after this point the dam will fill faster during the year than can be emptied over a year's time.

Three potential options exist to address the situation of more WWTP discharge per year that exceed the ability to deficit irrigate the 46 hectares area.

6.1 Options to Increase Discharge Capacity

6.1.1 Increase Area of Discharge:

The 2010 RMCG Report has already envisioned an ultimate discharge area of 65 hectares at the Lincoln Downs Farm. This area would allow for 890 m3/d Annual average of WWTP discharge:

Consented 5,000 m^3/ha/yr farm influent X 65 hectares = 325,000 m^3/yr = 325 ML

325 ML = 325,000 m3/yr / 365 d/yr = 890 m3/d (average) influent to WWTP

890 m3/d / .240 m3/d/c (average) = 3,700 approximated connections – after this point additional discharge locations will need to be found with this scenario.

6.1.2 Discharge of Excess Water to River

The 2010 RMCG Report identifies using runoff irrigation as an option when the deficit irrigation is exceeded. However, runoff irrigation has the detrimental effect of having existing soils at a saturation point and adding more water. This may lead to long term waterlogging which will damage the soil structure (reducing long term application rates), cause die off of vegetation, and increasing risk of soil erosion.

Initial information indicates that a river discharge would require similar quality to that produced from the WWTP, so require no additional treatment upgrade.

It is our experience across New Zealand that the preference is for discharge to land rather than watercourse. However, excessive flows being treated to a high standard and only discharged at high flows to river, and usually linked to rainfall causing high river flow periods may be acceptable.

This option requires minimum infrastructure to be implemented from the pond storage.

If this option is to be considered consultation is required with Northland Regional Council, Iwi and community, following confirmation by modelling of required discharge standards.

6.1.3 Increase Soil Uptake Values:

Examination of the "*Irrigation Reasonable Use Database" (attached)* provides the most up to date estimate of the soils ability to uptake water.

Lincoln Downs Farm when examined as pasture lands, shows an irrigation requirement of 6,384 m3/ha/y. This value is a 28% increase over the currently permitted volume of 5,000 m3/ha/y.

If we accepted this industry data over the original consent, we would increase our ability to receive more treated discharge from the WWTP as follows:

Revised 6,384 m^3/ha/yr farm influent X 46 present hectares
= 293,664 m^3/yr = 294 ML/y

Revised 6,384 m^3/ha/yr farm influent X 65 ultimate hectares
= 414,960 m^3/yr = 415 ML

Acceptance of these new soil values would need to be field verified and then presented to the consenting authority (NRC) for an amendment to the present consent.