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- report

Mangawhai Ecocare Sizing and Growth Assumptions

report

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Prepared for

Kaipara District Council

By

Beca and EPS Consultants International

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Summary

This report provides a commentary on the sizing and growth assumptions used for design purposes by Earth Tech Engineering Pty Ltd (Earth Tech) on the above project.

The information is provided solely for the information of Kaipara District Council in order to establish an understanding of the capacity of the system to be provided and in particular to understand the risks associated with the sizing of the Reuse Site and its infrastructure as related to future population growth assumptions.

The basis of the design is summarised as follows:

Reticulation:

- Sized in accordance with normal design practice with respect to pipeline sizes and gradients.
- Assumed flow rates are reasonable for a township such as Mangawhai.
- Existing areas - if infill development does not occur, then the proposed works provide capacity for the foreseeable future.
- New subdivisions approved since 2003 - Ecocare design provides capacity for these to be connected to the sewerage system.

Pumping Stations and Rising Mains

- Sized in accordance with normal design practice for predicted future flows.
- Inherently have some additional capacity.
- Capacity could be increased further (if future flows are exceeded) by replacing the pumps.

Water Reclamation Plant

- Initial capacity for 3,000 permanent residents and a maximum summer peak of 8,100 persons for 28 consecutive days.
- Note that the current permanent population is estimated to be 1,650
- This provides sufficient capacity till 2014 if the population growth is 7.8% pa, and sufficient capacity till 2024 if the population growth is 3.5% pa.

Reuse Site

- Initial capacity for 2,200 permanent residents and a maximum summer peak of 5,940 persons for 28 consecutive days.
- Predicted to reach capacity in 2014 if the population growth is 3.5% pa.
- At that time, the capacity can be increased by constructing additional storage volume and additional irrigation area.

The option of targeting to provide capacity to meet nominal 2014 population estimate is considered prudent as this is the major cost driver and if additional flows occur there will be time to manage these either through tracing illegal inflows, modifying the reuse/ irrigation facilities or entering into additional reuse agreements with alternative potential users.

It is recommended that Council accepts the proposal as designed by Earth Tech, adopting the 2014 nominal flows as the basis for the design of the Reuse site and request Earth Tech to formally submit its Resource Consent on this basis and also provide detailed pricing for this option as a Council Modification.

1. Introduction

This report provides a commentary on the sizing and growth assumptions used for design purposes by Earth Tech Engineering Pty Ltd (Earth Tech) on the above project.

The Project Deed provides for Earth Tech to take responsibility for the design and flow assumptions inherent in the development of the original scheme. Given the growth that has occurred in recent years and the associated inclusion of additional areas to be serviced immediately by the scheme, Council will request a Council Modification to include these areas and the impact on the size and cost of the system.

Earth Tech is to provide detailed costs for this Council Modification to enable Council to accept the proposed Council Modification.

The information is provided solely for the information of Kaipara District Council in order to establish an understanding of the capacity of the system to be provided and in particular to understand the risks associated with the sizing of the Reuse Site and its infrastructure as related to future population growth assumptions.

2. Reticulation and Pump Station Design

New subdivisions approved since July 2003 and within the Ecocare Drainage District, have in general been required to install sewerage infrastructure to enable connection to the Ecocare scheme once it has been constructed.

Areas developed prior to 2003 (referred to as "existing" areas) will be serviced with infrastructure designed, installed and operated for 15 years by Earth Tech under contract with Kaipara District Council. Areas of minor development or remote from the general Village or Heads residential areas were not all to be serviced until development requirements justified such works.

Infrastructure installed by Earth Tech as part of the Ecocare project will be sized to accommodate sewage flows arising from the new subdivisions as well the existing areas.

The system will service 1,216 existing lots in the existing areas. In addition, the scheme will accommodate an additional 865 lots in the surrounding areas which have been approved for subdivision since 2002; and the council is processing another 1100 lots, making a total of 3200 lots overall.

2.1 Predicted Wastewater Flows

Analysis has been undertaken by Earth Tech to predict wastewater flows which are expected over both the course of a year as a whole and during the peak summer periods.

The analysis has been based on a number of key parameters:

- Current population
- Expected growth rates
- Generation of wastewater per capita

2.2 Current Population

The current Mangawhai population has been derived from 2001 census data and to enable an estimate of the growth to be determined, a comparison was made by Earth Tech of house counts derived from aerial photographs of the town undertaken in both 2001 and 2006.

In particular, the census data was used to determine the occupancy rates per house and the proportion of houses being permanent residencies. Coupled with the assessment of additional houses since 2001, the census data enabled an estimate of the increase in population since 2001 to be derived.

Comparison was also made with previous research undertaken for Kaipara District Council in its preparation of its District Plan.

The 2001 census data reveals that Mangawhai had:

- A population of 1,260
- 53% of houses were permanently occupied
- 560 permanently occupied houses
- Each permanently occupied household consisted of 2.25 people

The comparison of house counts in 2001 and 2006 showed that 172 new houses had been constructed.

Assuming the occupancy rates and proportion of permanent houses had not changed since 2001, a population of 1,465 people was derived. This was considered to be the lower bound solution. The upper bound solution assumes that all new houses since 2001 are permanent residencies. On this basis the population would be 1,760 people.

It was considered that 1,650 represented a reasonable estimate of the current population.

2.3 Expected Growth Rates

Using the actual census data and the estimate of the 2006 population, growth rates have been determined. These are tabulated below:

Date	Average Annual Growth over preceding 5 year period
1991	6.3%
1996	6.0%
2001	1.6%
2006	6.1%

Population growth

Since 2001 resource consents applications have been granted for the subdivision of 875 new lots. Of these:

- Construction works have been completed on 590 lots
- Works have not started on the remaining 270 lots (some consents have not been granted)

- Houses have been constructed on 172 of the completed lots

House construction has averaged 34 houses per year over the last 5 years. This is equivalent to a growth rate of 3% per annum.

Growth has been particularly high during this period and may not continue at this rate. However, the basic scheme design is sufficiently robust (without being ultra conservative) and actual growth rate variations are being accommodated as detailed in the following design approaches.

2.4 Generation of Wastewater Per Capita

Normal practice for the design of wastewater treatment plants has been to adopt a wastewater flow of 180 -200 L/day/capita. This figure has been adopted after correlation with actual wastewater flows and populations for many townships. The actual flow rates vary from site to site according to particular site conditions.

Mangawhai is a beachside township which experiences a substantial influx of people during holiday periods. In order to assess whether wastewater flows are likely to be significantly different to normal expectations an assessment of wastewater flow characteristics was undertaken for a number of similar beachside communities.

As Mangawhai does not possess a reticulated water supply it was considered that wastewater flows would tend towards the lower bound of the range of possible flows.

However, as sewer reticulation design is driven more by cleansing flow requirements than capacity, the estimated flows do not have a significant impact on reticulation design. For the purposes of designing the reticulation system a wastewater flow of 210 L/day/capita was adopted by Earth Tech.

This flow consists of:

- a dry weather component of 180 L/day/capita (sewage from toilet, laundry, kitchen, bathroom)
- a wet weather component of 30 L/day/capita (rainwater or groundwater finding its way into the system).

This approach, coupled with Earth Tech's obligations during the 15 year operating period to ensure that stormwater ingress directly into their system is controlled, should provide flexibility for additional connections and infill developments to be connected. Large developments in areas presently not identified may require modifications. It is not practical, nor possible to cover all eventualities.

Few of the new developments drain directly into the reticulation network servicing the "existing development". Most of the new estates will drain into a trunk system which will deliver wastewater directly to the wastewater treatment plant.

Significant increase in flows emanating from the "existing area" could arise if the style of the residential changed from predominantly single occupancy sections to a substantial proportion of multi occupancy sections. This is considered unlikely as it would require Council to make a specific change to the development controls in the District Plan.

Furthermore standard industry sewer grades and diameters have considerable robustness to manage a range of flows.

The standard minimum sewer diameter is 150 mm as required by normal reticulation design practice. Most of the catchments have a 150 mm sewer as the main branch line leading to the respective pump station. In these instances the sewer will be operating at between 30% and 60% of full capacity.

Three of the catchments have a 225 or 300 mm sewer serving as the main branch line leading to the pump station. In these instances the sewer will operate at between 80 – 90% capacity.

We have also previously raised with Kaipara District Council the importance of Kaipara District Council managing illegal house plumbing or stormwater discharges to the system from houses. If this is not carried out effectively, maximum capacity will be reached earlier than expected.

The Ecocare scheme is designed to manage sewage flows. These flows include discharges emanating from laundry, bathroom, toilet, and kitchen waste.

Entry of rain water and run off needs to be separated from sewage flows. However one frequently finds that either:

- home owners have connected stormwater drainage pipes to the septic tank system
- landscaping or paving works undertaken by homeowners surrounding overflow relief gullies lead to stormwater entering into the home owners sewer drains, or
- in older systems, the pipes adopted for sewer drains do not have effective seals to prevent ingress of water into the system.

The volume of run off from a relatively small paved area during a storm effect of a few minutes can exceed the sewage flows expected during the entire day from the house.

If one percent of houses in the town allowed stormwater into the sewage network, a noticeable impact on peak wet weather flows would be observed.

For a low intensity storm, calculations show that a one percent increase in the number of houses allowing stormwater to enter into the sewer can increase the peaking factor from three to four.

Naturally the impact on peaking factor varies in relation to the storm intensity and duration. However these calculations demonstrate that a thorough and rigorous assessment of each landowner's existing sewer drains can deliver:

- significant reductions in peak flows
- reductions in the cost of the wastewater treatment plant for a given population
- increases in the population that the treatment plant can handle for a given volumetric capacity.

2.5 Pump Stations

The wet well of each pump station will contain two submersible pumps which transfer the wastewater through a rising main either to the downstream catchment or the treatment site.

The pump stations consist of conventional submersible sewage pumpsets set into a wet well.

The pumps have been selected on a conservative basis, as there is little difference in cost to provide larger pumps. The pumps will be capable of handling peaks of 6 times estimated dry weather flow. Again, the actual peaks are expected to be considerably less than 6 times (potentially as low as 3 or 4 times) due to the stormwater ingress controls, and therefore significant capacity should be available for normal development for some time.

Each of the pump stations could potentially accept more flows. Despite this apparent over-capacity, it does not lead to Council incurring extra costs.

It is important to note that the majority of the pump station cost is due to the civil works, switchboard, telemetry and internal pipework – all of which is unrelated to the sewage flow.

The pump unit itself does vary in size and cost according to the flow rate. All bar three of the pump stations require relatively small pumps. These pumps are standard "off the shelf units" and little cost advantage is achieved in adopting smaller units.

The three major pump stations are situated in more sensitive locations where the consequence of sewage overflows is more significant. Whilst some reductions in costs could be achieved by adopting a lower flow rate, it is considered preferable, in these instances, to have higher capacities so that the system can deal with unexpected influxes of sewage flow.

2.6 Rising Mains

Rising Mains are pressurised pipelines for transfer of wastewater from pump stations to adjacent gravity systems or to the Water Reclamation Plant (WRP), and also for transfer to the re-use area.

Conservative figures (as for reticulation) have been used to calculate sizing, as there is little difference in cost between adjacent sizes. Again, subject to good management of inflows, these pipeline systems should have significant capacity for further growth.

The diameter of the pipeline has typically been chosen to ensure that there is sufficient velocity to ensure that silt and sand is continually flushed along the pipeline. Also higher velocities have been adopted to control slime growth within the pipelines.

This objective means that the sewage velocity in the rising mains is higher than it would be if it matched the peak flows arriving at the pump stations.

For the smaller catchments a minimum rising main diameter of pipelines 100 mm has been adopted in accordance with normal design practice. It should be noted that little cost advantage exists in reducing the pipeline diameter. Accordingly these pipelines operate at between 25% and 85% of capacity.

For the larger diameter pipelines where cost savings can be achieved by optimizing diameters, the pipelines operate at between 70% and 90% of capacity.

Finally it should be noted that "capacity" is somewhat arbitrary for rising mains. The percentages have been derived on the basis that a velocity of 1.8 m/s is the maximum desirable flow. However Industry standards set the absolute maximum velocity at 3 m/s.

In summary the rising main design provides robustness without leading to cost penalty.

2.7 Water Reclamation Plant

The sizing of the WRP has been established from a range of population and flow assumptions. The sizes modelled are based on various estimates of population (permanent and summer peak), and flow assumptions per head.

The WRP has been generally sized to conform to the original contract offer of a plant of nominal capacity of 1.8ML/day. This equates to a plant servicing approximately 3000 permanent residents and a peak holiday population of 8100 for 28 consecutive days.

At peak holiday wet weather flows the plant is capable of treating 5.51 ML/day. Average dry weather operating flow for 3000 permanent residents is estimated at 0.51 ML/day. The plant will not be designed to cope with the estimated maximum holiday peak hourly wet weather flow as there is 12 hours holding capacity in each of the pump stations and hourly peaks will be attenuated within the reticulation system.

As noted earlier in this report, the current population is estimated to be 1,650 people.

The plant inlet works will be designed to cope with the maximum estimated flow that the pump station delivery pumps will produce. This is expected to be equivalent to approx 9ML/day.

Peak flows within the plant will be attenuated within the main CASS tanks and the filtration and disinfection systems will be designed with allowance for this attenuation.

The modelling of design options has covered a range from:

- Population 1,500 permanent/4,050 peak, 140 litres per person (105ML/annum); to
- Population 4,000 permanent/10,800 peak, 170 litres per person (413ML/annum).

The estimated cost of plants for that range of capacity is between $4.1M and $7.7M respectively.

The proposed sizing of the plant as designed by Earth Tech is for 248 ML/annum at a cost of $5.33M.

Depending on actual flows, this sizing is expected to be suitable for a permanent population of 3000 residents with a holiday peak of 8100 residents. This provides the potential for capacity up until 2014 at 7.8% growth in population, or 2024 if actual flow assumptions are correct and if growth averages 3.5%.

As can be seen from these figures, a smaller plant could be built (perhaps saving an initial $500,000), however the mid range size is considered appropriate and is estimated to provide capacity up to at least 2014 but probably considerably longer than that with good management of inflows. A smaller plant increases the likelihood of an expansion being

required within the first few years of operation. Re establishment on site and expansion works under this scenario would be expected to be in the $1M+ range.

2.8 Re-use Site

The re-use scheme has been designed for estimated flows from a permanent population of 2200 and 28 day peak population of 5940 in year 2014. This population corresponds to the current permanent population estimate of 1650 residents with a growth rate of 3.5% projected to year 2014.

The re-use scheme undergoes annual variations only as hourly, daily, weekly and wet weather peaks are stored in the re-use storage at the secured site. Therefore this system is designed on the basis of lower bound "real" projected flows. The scheme is augmented simply by constructing additional re-use storage and commissioning additional irrigation area.

Flows produced by the scheme are estimated to be 140ML/annum in year 2008, 184ML/annum in year 2014 and 284ML/annum in year 2023.

Initial design of the storage and irrigation portions of the scheme will be for the estimated year 2014 flows.

Once the scheme commences operations and the flows are known, peaks established etc, the projected life of the storage and irrigation areas before further expansion is required can be more accurately predicted.

Again, with good management of the overall system, and variations in Mangawhai growth and actual population numbers, it may be that no expansion will be required before 2020 or beyond.

It would be possible to construct a lesser re-use and irrigation system to suit 2007/08 estimates (140ML per annum). This would involve a saving of approximately $500,000 in initial capital, however the cost to expand the facilities in the short term (if that proved necessary) would be substantial. (An additional storage dam would be required. This may cost $1 to $2M).

It is possible that the estimates used for flows are conservative due to issues such as:

- permanent population being less than estimated;
- flows per head being less than estimated (particularly due to Mangawhai not having reticulated water);
- existing plumbing or sewer systems installed in new developments having less stormwater inflows than estimated; and,
- peak holiday flows being less than estimated.

Kaipara District Council could elect to direct Earth Tech to provide the re-use and irrigation facilities to suit 140ML per annum and take the risk on this. However we do not recommend this approach. The option of targeting to provide capacity to meet nominal 2014 population estimate is considered prudent as this is the major cost driver and if additional flows occur there will be time to manage either through tracing illegal inflows, modifying the reuse/

irrigation facilities or entering into additional reuse agreements with alternative potential users such as the golf course.

3 Conclusion

The population projections for Mangawhai are a key to establishing the design for the system and Earth Tech has developed its proposed system on the basis of prudent population projections and conservative design assumptions as indicated above.

The key decision for Council is reflected in the design assumptions for the Reuse Site related to the dam size. As indicated above immediate capital design savings can be made by directing Earth Tech to design to estimated 2008 flows (140ML) with immediate capital savings of approx. $500,000 or target the nominal 2014 flows (184ML).

It is recommended that Council accepts the proposal as designed by Earth Tech, adopting the 2014 nominal flows as the basis for the design of the Reuse site and request Earth Tech to formally submit its Resource Consent on this basis and also provide detailed pricing for this option as a Council Modification.