Carterton District Council
Carterton Sewage Treatment Plant

Discharge to Land and Water
Assessment of Effects on the Environment

DATE: 31 May 2010
PROJECT: C22009/4

AUTHOR: Stu Clark

REVIEWER: Michelle Robertson & Andy Duncan

REPORT STATUS: Submitted to GW

New Zealand Environmental Technologies Limited
81 Gillespies Rd P.O. Box 40-339 Upper Hutt New Zealand.
Phone NZ (0)45264109 Fax NZ (0)45264190
Email office@nzet.net.nz

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1 Summary

Carterton is the second largest town in the Wairarapa. It has reticulated water and wastewater systems and provides these services to a population of some 4200 people. The town includes several medium sized “wet” industries including Premiere Bacon, a meat processing plant, and a factory which manufactures paua shell products.

A piped wastewater collection, treatment, and disposal system services the town. Wastewater primarily flows to the treatment plant at the southern end of Carterton by gravity. Six small pump stations discharge into the gravity lines at points where there is insufficient natural fall to allow gravity flow.

The pipe system feeds the collected wastewater to a wastewater treatment plant located at the southern end of the town on Dalefield Road. The plant’s treatment processes consist of: fine screening, primary sedimentation with sludge digestion, secondary and tertiary oxidation ponds, and surface flow wetlands. Further treatment occurs during summer when the plant discharges to land.

Currently, during the period April – December inclusive, the outflow from the wetlands flows into a surface drain and from there to the Mangatarere Stream. Downstream of the plant discharge, the Mangatarere flows into the lower Waiohine River, and then (the Waiohine) flows into the Ruamahanga River.

During the summer period (January to March inclusive) there is no discharge to water except when there are extreme rainfall events. At all other times during this period, the flow out of the surface flow wetlands is collected and pumped to a small holding pond, further treated by disc filtration and UV irradiation, and discharged to council-owned land through some 2.5Ha area of surface and subsurface drip line irrigation. In summer 2010, the duration of this discharge to land was extended through the month of April. The location of this existing system and its receiving waters are shown in Figure 1 below.

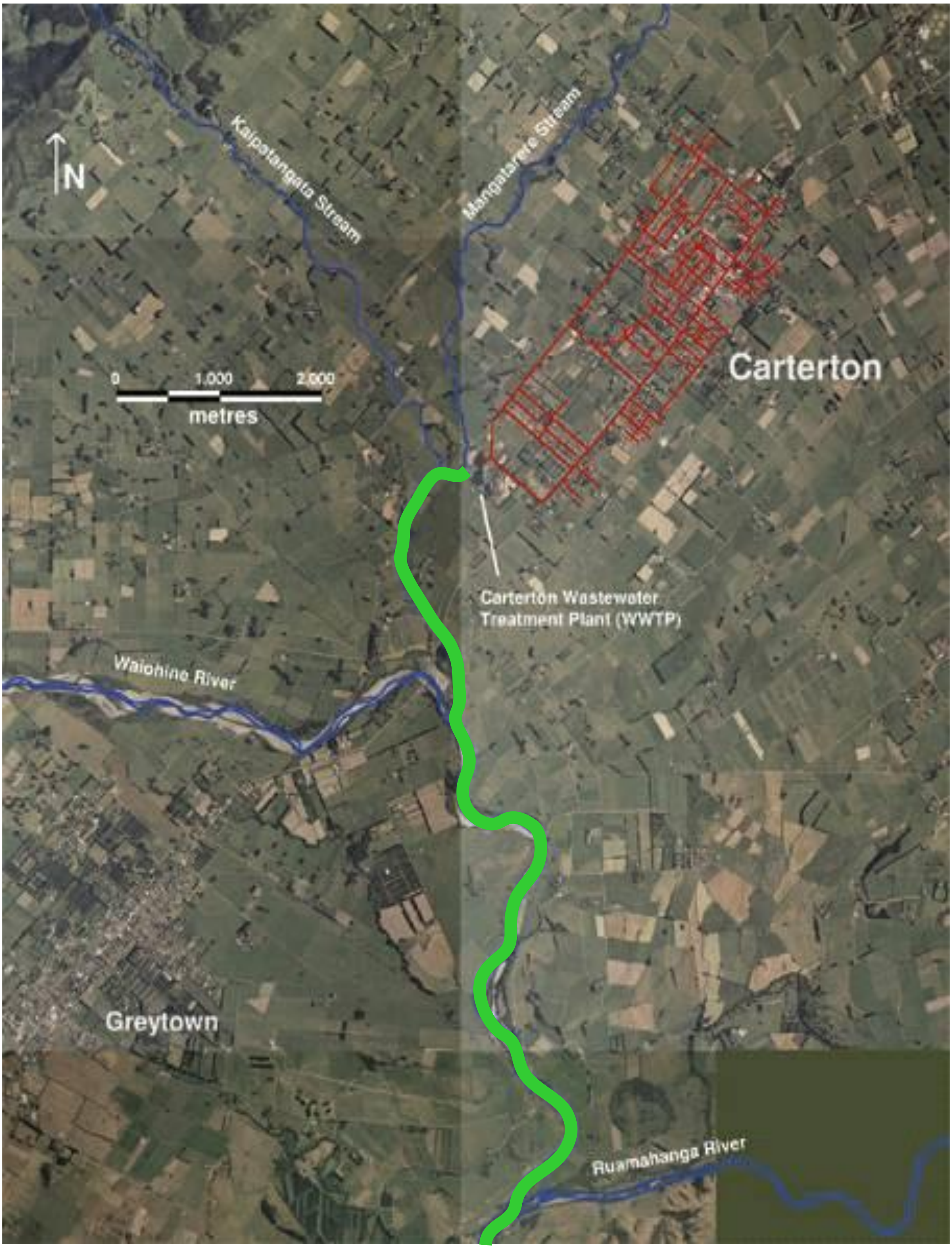


Figure 1. Layout of existing wastewater system and discharge receiving waters - (the streams flow down the page, green line indicates zones impacted by discharge to water).

Flows into the system are season and rainfall variable. Without leakage into the system, the theoretical daily flow should be around 1000-1500m^3, (each m^3 is 1000 litres so this allows 250 litres per person per day plus an additional amount for wet industries). This flow range typically occurs during the dry periods of the summer months in a dry year, however, once rainfall events or the wetter periods of autumn through to spring occur, flows increase dramatically and under extreme storm conditions can exceed 13000m^3/day.

These additional flows, representing up to 10 times the expected wastewater flow, are due to additional water entering the system. This water may be rain water directly connected to the system, for example if the spouting and downpipes on a house are connected to the sewage system pipes, or water ponds above gully traps on private land or manholes on council land and flows into the system. Such direct connection is termed inflow. If a typical house has all the roof water discharging to sewer, a relatively modest rainfall event of 10mm total rain can cause that house to discharge the same amount of additional flow as the sewage from 10 people for 1 day. So, if 100 houses had direct connection of storm water down pipes to the sewer, even in a light rainfall event, this would be the equivalent of a 25% increase in the town's population in terms of the additional flow generated by such connections. Inflow will usually occur during and / or soon after the rainfall event

Water can also enter the sewerage system from groundwater; through such faults as: cracked pipes, pipes where the joint sealing rings have failed or been displaced, poorly sealed connections, especially connections of the pipes from individual households into the street main, and manholes; unsealed riser joints, unsealed pipe penetrations, and cracks in risers and bases. Groundwater entering the pipe system through this type of fault is called infiltration. There will often be a significant delay between a rainfall event and infiltration occurring. Often infiltration will result from a more seasonal trend in ground water levels rather than a specific rainfall event.

Both; direct observations of the sewerage system and the extent and patterns of flows recorded at the wastewater treatment plant provide evidence that both inflow and infiltration into the Carterton system are very significant. Figure 2 below is a plot of wastewater flows coming in to the treatment plant (continuous blue line), and rainfall (black bars). The close relationship between a given rainfall event and increased flows clearly shows that the system currently suffers from significant inflow.

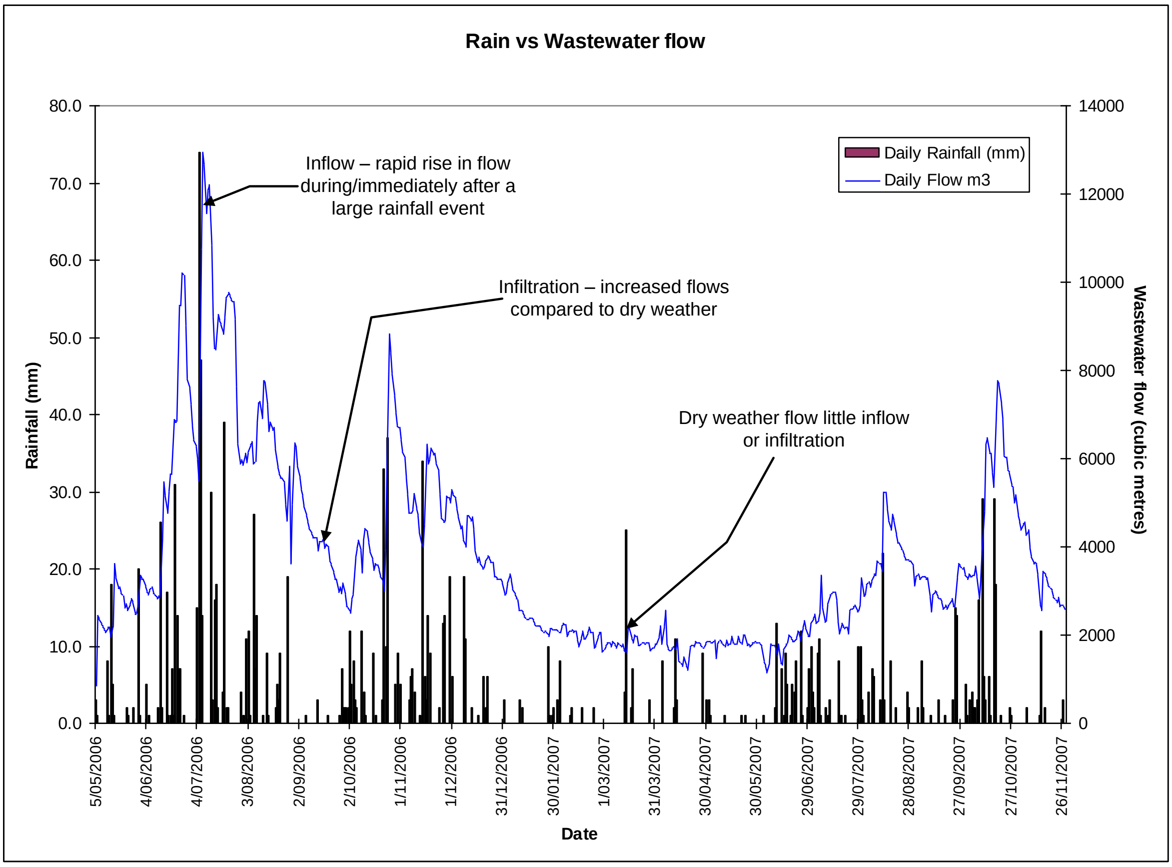


Figure 2. Flow coming in to wastewater treatment plant (blue line) vs. rainfall (black bars).

Section 2 of this AEE report provides more detail on the existing wastewater reticulation and treatment systems.

Section 5 of this AEE report describes the impact of the existing discharge on its receiving environment. Although Carterton has been upgrading the wastewater treatment system since 2002, the discharges to water and land are still having a measurable impact on the quality of the receiving waters.

In considering these impacts; there are two discharge scenarios: January to March, when the flow goes to land and then back to the Mangatarere Stream through groundwater and subsurface seepage, and April to November when the flow is discharged directly to water.

There are also different substances; (for example - chemicals such as phosphorus, microbes, as characterised by E coli, and physical constituents such as suspended solids), in the wastewater discharge, which are present in both the discharge and the receiving waters upstream of the discharge, at different strengths. Therefore, the discharge may increase the level of one substance in the Mangatarere Stream at a given time by 5%, and under the same flow conditions, it may increase another substance by 30%.

The impact of any discharge on the receiving water quality will also depend on where in the downstream flow path the impact is being considered, as the Mangatarere

Stream mixes with the Kaipatangata Stream soon after the discharge point, then the Waiohine and the Ruamahanga Rivers. The location and interrelation of the plant and discharge with these receiving water bodies can be seen in Figure 1 above.

So for example, a substance which increases its concentration in the Mangatarere downstream of the plant by 30% (compared with the concentration upstream of the plant) may then only increase the strength in the combined flow from the Mangatarere and the Kaipatangata by 15% (when measured against the levels which would exist at those points without the discharge), in the Waiohine by 5%, and by less than 1% in the Ruamahanga.

The use of the strength or **concentration** of a substance discharged is one way of predicting / describing its impact; another way is to use the mass flow. The mass flow is calculated from the concentration discharged, multiplied by the flow rate, so for example if 1000 cubic metres of water is discharged in a day at 3 grams per cubic metre concentration of a substance, that is also 3kg (3g x 1000), mass of that substance discharged per day. In section 5 of this AEE document, the impact of the existing discharges is described according to both concentration and mass flow.

Historically, the nature of wastewater discharges and the design of wastewater treatment plants have often been determined by starting at the highest concentration a substance is allowed to be at in the receiving water, then designing a treatment system which, (following mixing), could achieve this level of performance. The Carterton District Council, who were the first local authority in the Wairarapa to install both a wetland treatment system and a discharge to land treatment system for treating the flows from a larger community, have been working since 2002 on options for further improving the performance and minimising the impact on our environment from the Carterton wastewater system.

Having considered a range of options, as discussed in Section 7 of this report, Council feels that it is time for a paradigm shift in how wastewater is treated and utilised. This shift is driven by; community and tangata whenua aspirations and the general public abhorrence to discharges of wastewater directly to our rivers, the availability of improved treatment technologies, such as membrane-based treatment systems, which are becoming more reliable and affordable, and are able to achieve a high standard of treatment with respect to the removal of disease causing organisms and trace contaminants. With such treatment, the treated wastewater (still containing the harder to remove but potentially beneficial nutrients – nitrogen and phosphorus) can then be considered as a resource rather than a waste, and used accordingly, for irrigation to land.

Primary agricultural, service industries and businesses form an important part of Carterton's economy. As such Council is very aware of the current issues and trends in the local agricultural sector: increasing numbers of dairy conversions and increasing livestock loading rates, reducing available water resources for irrigation, increasing frequency and duration of drought periods, and increasing costs of fertilizer.

Whist an ideal technical solution would simply be to treat all wastewater to a high standard and then discharge it to land; there are some problems with being able to do this. The high flows into the wastewater system due to inflow and infiltration mean that the size of the treatment plant required to treat the maximum flow currently received would need to be some 6 or more times the size that it should be. As costs of modular membrane type treatment systems are more or less proportional to the flow the treatment plant is designed to handle, that means that the costs, to both construct and operate such a plant, would also be 6 times what they should be if the excess water were not present.

Another problem is that whilst land irrigation on some soil types (predominantly free draining sands and gravels) is possible all year round, intensive irrigation during the period from late autumn through to early spring is likely to be bad for the health of many crops, and irrigation into free draining soils or crops over this period is also likely to be much less effective in removing remaining substances from the wastewater (such as nutrients), than is irrigation onto finer grained more active loamy soils, and irrigation during periods when the ground is drier and crops are more actively growing. To extend the irrigation system for as long as possible into autumn and spring means irrigating at application rates which are much lower than are achievable in the peak of summer, and this in turn means irrigating over a large area of land. If a flow of 1500m^3/day treated wastewater was to be applied at a rate reducing to say 1mm/day during the cusp periods of late autumn and early spring, this would require an irrigated land area of 150Ha, achievable using land owned by others, but not realistically affordable at today's land prices for Council to purchase such an area of suitable land.

Another issue is that whilst Council have spoken to a number of farm owners who would be prepared to irrigate with highly treated municipal wastewater (indeed "free water" laced with nutrients would be accepted with open arms by many), some have concerns over liability issues, and, for irrigation onto land grazed by dairy cattle, or land where fodder crops are grown which are subsequently fed to dairy cattle, both parties, Council and land owners, are vulnerable to the dictates of the companies who purchase the milk, such as Fonterra. Fonterra have varied their policies on this matter, initially accepting treated municipal wastewater irrigation onto dairy pasture, then banning it, and more lately accepting it but with more stringent treatment and assurance of consistency of quality required. Whist there are unlikely to be any technical reasons why Fonterra's current policy cannot continue (allowing direct dairy herd grazing with highly treated wastewater), Fonterra sell much of their milk based products to an international market where there is an advantage for New Zealand products which comes from perceptions that New Zealand is cleaner than many other countries. In such a marketplace, the concept (rather than the reality) of human effluent wastewater irrigation to dairy pasture, regardless of how well pre-treated it is, may be vulnerable to the dictates of the marketplace. Fonterra's current acceptance criterion for the quality of wastewater irrigated to dairy cattle grazed pasture is attached to this report as Appendix A.

The same may well be true of other crop types. Council have considered along with a prospective purchaser of a block of land adjacent to the wastewater treatment plant, the option of the purchaser producing certified organic crops irrigated with council wastewater. Again, the certifying agencies, whilst having no specific rules excluding crop irrigation with a highly treated human effluent sourced wastewater, could not guarantee that certification could be obtained and could not even specify a list of parameters with maximum acceptable values for checking against the treated effluent quality. Similar risks (of rejection for non-technical reasons) exist for irrigation of any crop which is likely to be used for human or animal foodstock, for example dry stock grazing.

Given these uncertainties, Council and land owners are not in a position to be able to enter into binding legal agreements for wastewater irrigation, and similarly, Council are not in a position to obtain a resource consent which requires such irrigation as a mandatory feature.

Therefore; considering these issues, Council's strategy for upgrading the wastewater system is as follows:

Reticulation System Controls

- Monitor and charge industrial wastewater producers based on the fees set in the recently introduced Trade Waste Bylaws (these fees were introduced in 2009 and create a financial incentive for commercial and industrial waste producers to reduce both flows and contaminant levels).
- Monitor water usage through the recently introduced universal water metering, and charge to discourage excessive water use (which may be coupled to excessive wastewater generation in some cases). The meters are installed and measuring for charging has already started.
- Undertake a systematic inflow and infiltration control programme, on all pipe systems, aimed at eventually excluding 90% of inflow and infiltration (note that this will take many years to complete, but this work has already started with; smoke testing of lines, the purchase of portable flow meters, the set up and calibration of a hydraulic model of the wastewater reticulation system and significant expenditure on pipe replace through the centre of town, and extensive sections of Kent and Garrison streets).

Initial Wastewater Treatment Upgrade

- Apply for a consent to continue with the existing summer time land irrigation system, as a fall back if farm irrigation is not possible, but extend the irrigation period to as long as the ground conditions will sustain land irrigation (this could increase the period from the existing 3 months to 6 months or more in a dry year).
- Apply for a consent to continue to discharge to water during periods when discharge to land is not possible, but subject to improved treatment.

- Install a membrane based treatment plant with a design flow in the range 1500 - 2000m^3/d, so that the impact of such discharges to water are reduced, and flows up to this rate are available to be applied to land through farm irrigation systems. Should the consent process occur on the timetable indicated, the anticipated earliest start up time for the membrane plant is November 2011, (refer Figure 3 for assumptions to meet this date).
- When the wastewater flows exceed 1500 - 2000m^3/d, the receiving waters are also in higher flow condition and therefore the impact of the discharge is reduced.

Discharge to Farm Lands

- Pursue the discharge of membrane treated wastewater onto farms with a target of reticulating to a single farm initially (ideally within 18 months of the above consents being granted), and then expanding the system to multiple farms over a period of years.

Winter Time Storage

- Depending on the extent of the year during which wastewater can be irrigated to farms, consider the long term option (and due to the very high costs involved, this may also be contingent on an appropriately located irrigation scheme and storage reservoir being constructed by others and Greater Wellington reviewing their criteria for requiring detailed consent applications for irrigation to land of highly treated wastewater effluent), of discharging flows during non irrigation periods to winter time storage for subsequent summer time irrigation. The incorporation of this measure, if necessary at all, may well be decades away.

This strategy provides for a staged improvement in a manner and over a time frame which does not create excessive economic hardship for the ratepayers of Carterton who will be funding this upgrade work.

This AEE report provides the supporting information for the consent applications required to progress this wastewater strategy.

The expected time frame and interrelationship for the works covered by this AEE and, to put them in context, the complete upgrade strategy for the Carterton wastewater system, is shown in Figure 3 on the following page.

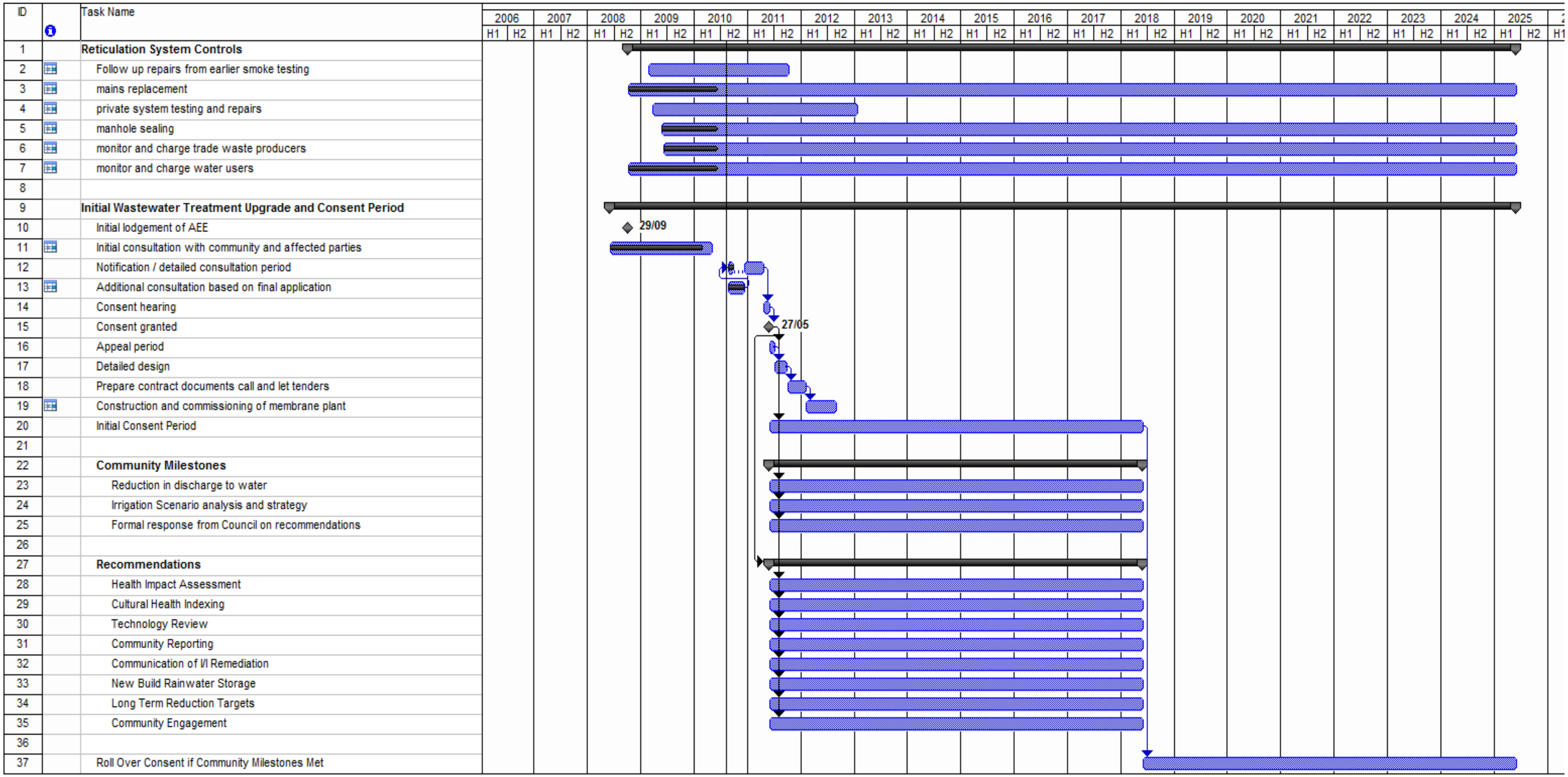


Figure 3. Proposed timeframe for the wastewater system upgrade covered by this application..

2 Description of the Proposal

2.1 The Catchment

The wastewater system catchment comprises predominantly the urban area of Carterton township, some 4km long by 1.2km wide, and comprising some 80 specific streets, totalling 270km in length. The ground slopes with the general contours of the larger Wairarapa Valley, from elevation 95m above msl at the northern western end of the town to 60m at the wastewater treatment plant located at the south eastern end.

As at census night 2006, Carterton had an urban population of 4122. This had increased by 21 people (0.5%) since the previous (2001) census. The population is significantly older than the median age for the Wellington region, with 19.4% of Carterton people being aged 65 years and over, compared to 11.4% for the Wellington region as a whole. The median income for people aged 15 years and over is also substantially less than the median for the Wellington region ($19,800 vs. $28,000). These figures are relevant to this report as they determine what impact costs incurred by Council may have on the Carterton community.

The 2006 Census of Population and Dwellings showed a resident population count of 7,101 people or 2,757 households in the Carterton District. The Carterton District Wastewater System serves only the Carterton township with a 2006 resident population count of 4,122 people or 1,645 households. Approximately 95% of the Carterton township is connected to the wastewater system. Some houses still remain on septic tanks, although if these systems are found to be not working satisfactorily a connection to the wastewater system has to be made. All new houses have to connect to the wastewater system. Although there are a number of new subdivisions in Carterton and new houses being constructed, there is yet to be any sign of significant increases in population as a result, and it appears that the same number of people are just occupying a greater number of dwellings. This was reflected in the 2006 census data for average number of residents per dwelling, which was 2.5 for Carterton, (vs. 2.6 for the Wellington region as a whole), the same level as in 2001.

Approximately 20 rural properties on Lincoln Road, which are situated near the boundary of the township, are also connected to the wastewater system. These properties are those less than 4,000m^2 in area.

There are a number of commercial and industrial premises contributing to the wastewater system. In 2007, Council introduced trade waste bylaws, and charging under these bylaws was introduced in 2009. Commercial and industrial properties identified have been advised their discharges are monitored and charged under the bylaw. These properties are listed in Table 1 below.

In concert with the introduction of the trade waste bylaws, Carterton have now purchased an automatic sampler which is designed to operate with councils portable flow meters. This is in use to monitor the discharge from the main industries discharging into the wastewater system. This monitoring is more accurate than previous attempts which were based around grab samples. The sampling has confirmed the current discharge from the Premiere Bacon plant is contributing a major source of nutrients and a significant source of organics and solids to the Carterton system. Full charging for this discharge under the scheduled rates in Carterton's trade waste bylaws would however make the factory’s continuing operation untenable. The factory is being levied for full trade waste charges, other than nutrients, and is now undertaking trials on installing their own wastewater treatment plant. Trials to date have centred around the dissolved air flotation process and have indicated that approximately >70% reduction of the key constituents; BOD, suspended solids nitrogen and phosphorous, is possible. Premier has asked council for sufficient time to complete the trials and procure and install a treatment plant before full charging is levied. This is an important issue with respect to the proposed upgrade of the Carterton system as the current nutrient levels discharge by Premier would have a major influence on the amount of land required for land treatment - as this is likely to be determined by maximum allowable nutrient (nitrogen and phosphorous), loading rates, as opposed to hydraulic loading rates or other factors.

Permitted Trade Waste (some of these industries may require a consent as conditional trade waste)	**Estimated Volume** (Based on 80% of water usage)	**Waste Composition**	**Conditional Trade Waste**	**Estimated Volume**	**Waste Composition**
Bakeries/ Takeaways/ Restaurants Carterton Bakery New World Café Ole Wild Oats Bambinos Centerway Snack Attack Tasti Takeaways Empire Restaurant Chopsticks Jacobees pizza Marquis Hotel Royal Oak Lounge Buckhorn Club Hotel (backpackers) Istanbul Salvation Army Kitchen Carterton Memorial Club	 ? Nil ? ? ? ? ? ? ? ? ? 399 over 74 days 772 over 115 days ? ? ? ? 5123 963	Grease, food waste, detergents, human waste Flow data unavailable for most of these as flow meter installation delayed until main street upgrade was completed.	**Dentists** Anil Ramen ← Banks Dental Surgery ←	 67 over 218 days 131	Human waste, detergents, sterilization products etc
Schools Carterton St Mary's Sth End School Sth End Kindy Carterton Kindy Playgroup	 ? Nil 65 over 228 days ? 65 over 198 days Howard Booth Park	Human waste, detergents	**Food Processors** Fritter Factory ← Ranchmans ← Premiere Bacon John Kippenberger 021964045 ← Carterton Meat Processors ←	 ? 61 150-250m3/d ? 114 over 95 days	Animal waste, blood, grease, high nutrient content Typical analyses; for premiere, BOD/SS 1000-2000g/m3, N and P 100-300g/m3

Motels Matadore←	 191	Human waste, detergents,	**Mortuaries** Richmond Funeral Home←		Embalming preservative, detergent
Hairdressers Ari Asrinas Supreme Beauty Herbs ~~Headquarters~~ Little Red Barber	 94 over 213 days ? ? 87 over 198 days ?	Hair products i.e. hydrogen peroxide, shampoos etc	**Manufacturer / Industry** Massons Implement Co← C & F Ltd← Tower Gates← Paua Shell Factory← Trimspec←	 12 over 75 days ? 536 over 233 days 1756 over 212 days Nil	Acids and alkalis, cyanide, pickling salts, calcium.
Medical Drs Surgery← Chemist← Blood Lab←	 ? ? Nil	Human waste, blood, chemicals	**Spray Painting** Carterton Auto body Repairs ← Dalefield Spray Painters← Taylor Street←		Paints, turpentines
Resthomes Roseneath← Carters Court←	 1570 over 96 days ?	Human waste, detergents, grease	**Tankered Wastes** Wairarapa Plumbers Wairarapa Liquid Waste GT septic services Carterton Plumbers	 Nil Nil Masterton ?	Human waste, chemical waste
Factories Superior Meats← Renalls Timber← Kings Joinery← Renalls Doors	 ? ? ? ?	Animal waste, blood, grease	**Truck Wash** Hammond Transport← Pinfolds ←	 339	Detergents, petrochemicals, hydrocarbons, grease, mud and silt
Veterinary / Animal Clinics Sth Wairarapa Vets← Wags To Whiskers←	 ?				

Mechanical Workshops/ Service Stations Smith & Hare🡐 Cheers Auto🡐 Carterton Motors🡐 Lambess Motors🡐 Peter O'Leary Motors🡐 Sth Wairarapa Auto Services🡐		Mechanical waste products i.e. petrochemicals (hydrocarbons), grease, oil etc			

Table 1. List of Trade Waste premises in Carterton (those marked with a blue arrow are assessed as requiring backflow prevention).

2.1.1 Demand Projections

Carterton has experienced a period of static growth in the period from about 1980 to the late 1990's. In the last 5 years, however, there have been an increasing number of subdivisions within the township with approximately 100 new lots subdivided. There are still large areas within the Carterton Township boundary that are able to be subdivided and it is expected that the current rate of growth (0.5% per annum) will continue for the next 5 years.

There is no expectation that there will be a significant increase in industrial activity within the Carterton Township that may impact on the wastewater system. The Carterton District is encouraging industry to locate around the Waingawa area. Waingawa, however, is so remote from Carterton that it is not practicable to reticulate wastewater from there back to Carterton, and although Carterton have recently taken over the Waingawa wastewater reticulation, this discharges to the adjoining Masterton wastewater system and is not relevant to this application.

2.2 The Reticulation System

The reticulation system consists of:

- domestic pipes on private land – approx 1640 houses plus industry,
- the pipes and manholes of the municipal system; pipes range in diameter from 80mm to 380mm and the network consists of 30.8 km of underground piping.
- 6 pump stations at strategic locations throughout the town to lift sewerage from low lying areas up into the gravity network.

The current network has adequate capacity for normal flows, but experiences some surcharging during heavy and prolonged rainfall events. The surcharging results from both inflow and infiltration. A hydraulic model of the network has been completed and calibrated. The model incorporates all areas of the town where it is known that either sub-division is planned or may occur in the future. Preliminary results indicate that the network can accommodate current dry weather flows but will require some upgrading to minimise the likelihood of surcharging during significant rainfall events. The model will also be used to evaluate the effectiveness of inflow and infiltration control measures which will be ongoing.

As at June 2005 the CDC Wastewater Asset Management Plan valued the replacement cost of the community portion (as opposed to pipes on private land) of the reticulation system at $7.6M ($5.6M for pipes, $1.8M for fittings, and $0.15M for pump stations).

Carterton's wastewater reticulation extends throughout the Carterton Township to transfer wastewater from the township to the treatment plant. The percentages of pipe materials and sizes in the reticulation are presented below.

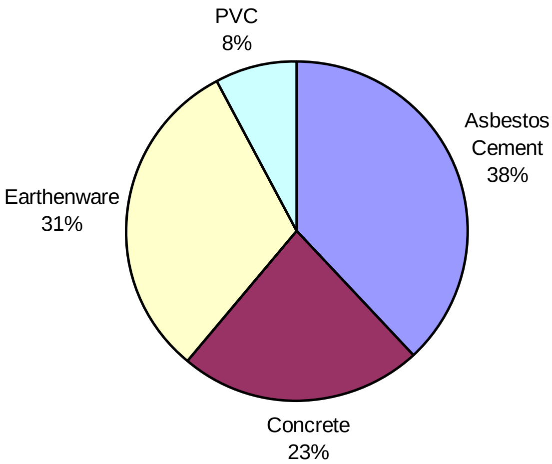


Figure 4. Pipe Material Distribution

The pipes in the municipal portion of the system are also of varying diameter, with the predominant sizes being 150mm and 225mm.

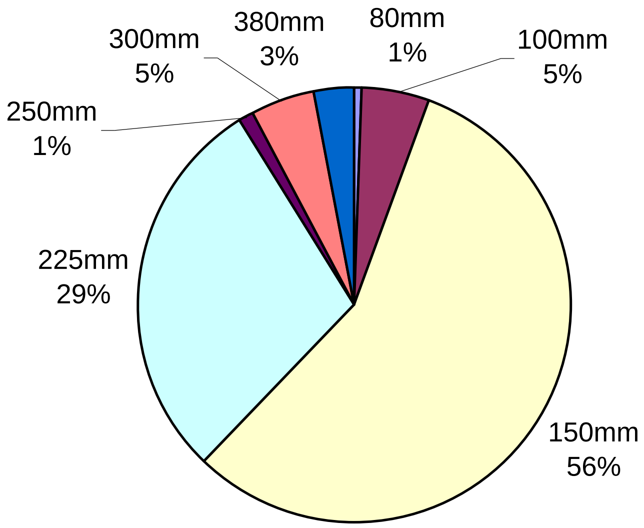


Figure 5. Pipe Size Distribution

The pipe condition has been assessed as shown in table 2 below. The current mains replacement programme was selected to more than match this rate of degradation.

Estimated Remaining Years of Wastewater Pipes

Material	Length (m)	1-5 yrs	6-10 yrs	11-15 yrs	16-20 yrs	20-30 yrs	>30
Asbestos	11,153.00	308	1,732	0	3,965	5,148	0
Concrete	6,772.00	0	0	0	2,696	1,840	2,236
Earthenware	9,122.00	0	0	0	4,720	3,682	720
PVC	2,241.00	0	0	0	0	0	2,241

Table 2. Wastewater pipe age and material type vs. lengths of mains that are estimated to require replacement within the time interval.

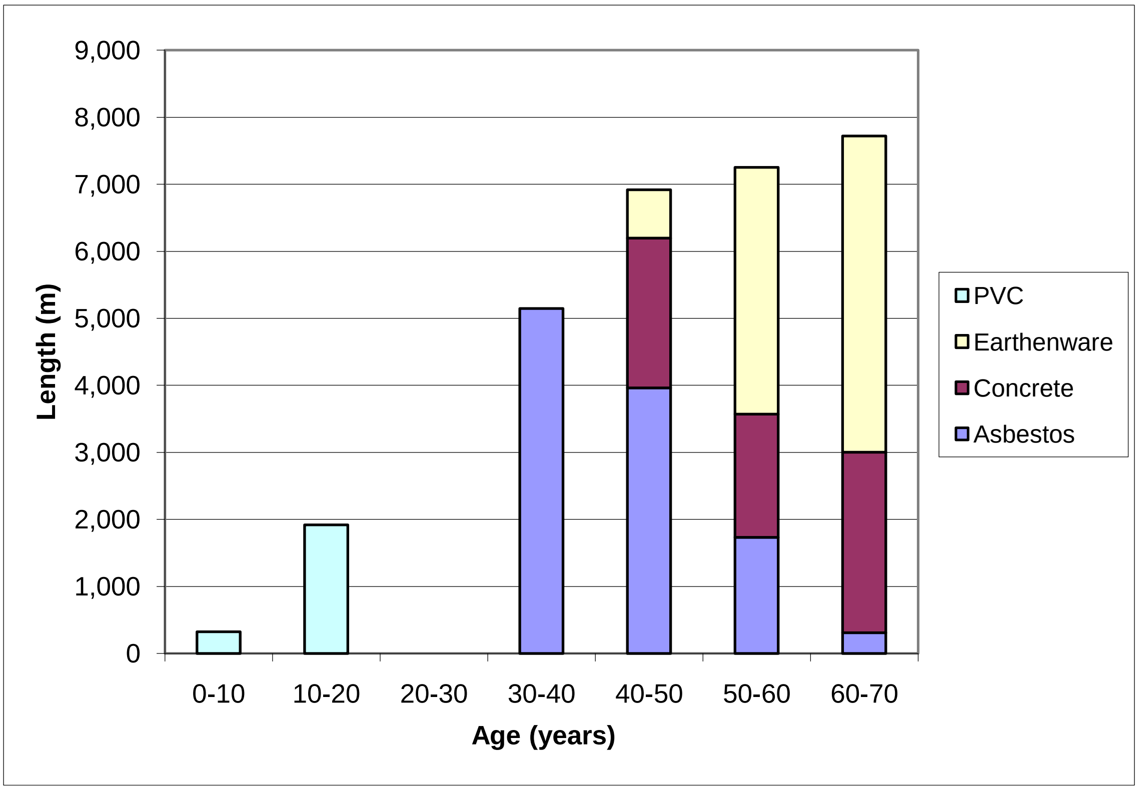


Figure 6. Wastewater Pipelines: Age/Material Distribution

Carterton's wastewater reticulation utilises a variety of pipe materials. The original network was constructed using glazed earthenware pipes, which were either butt or rubber ring jointed. These pipes are known to fail at joints or from cracking due to inadequate; bedding, cover, or increased vehicle loadings. The nominal life of earthenware pipes have been assessed at 80 years. There is approximately 9km of this pipe that is between 40 to 60 years old.

The wastewater reticulation also includes 38% by length of asbestos cement (AC) pipelines. The nominal life of AC pipes has been assessed at 60 years. Carterton has approximately 2km of AC pipe that will require replacement over the next 10 years. In 1996 a detailed review of the capacity and operation of the Carterton Wastewater System was undertaken. This is reported in the document "Carterton Sewage System – Capacity/Infiltration Study" dated June 1996.

Data for the study was gathered from flow measurements at selected manholes, the sewage treatment plant and CCTV surveys. Computer modelling was used to determine system capacity and to investigate the effects of proposed modifications to the system. All data indicated that Carterton has a significant problem with excess input due to both stormwater inflow and groundwater infiltration. This information plus the data obtained from the recently developed wastewater system model has been used to identify and prioritise the worst areas for stormwater inflow and infiltration control.

The wastewater system includes 6 wastewater pump stations:

- Costly Street
- Park Road
- Diamond Street
- Kent Street
- Hilton Road, and
- Fisher Place

Report on Carterton DC Wastewater Reticulation remedial works 2006-2009

The following work has been completed on the reticulation system:

- 2006-2009 Opus measurements and calibration of wastewater system model.
- 2006-2008 Inclusive, no physical works
- 2009 Main St from Belvedere Rd to Pembroke St 390m of 300mm diameter Jan – March 09
- Garrison St from Rexwood to Victoria Sts, 280m of 200mm diameter Started March Completed May 2009
- Kent St from Tasman to Wyndham Sts, and from Taverner St to Wyndham Sts, 555m, Started Feb 2009, completed April 2009.

Monitoring is currently underway to provide assessment of the benefits achieved from this work. Preliminary results seem promising, however it is prudent to monitor over the winter months to fully assess the situation. A report defining the effects of the works is planned for late winter 2010.

The forward programme for II control works will commence in the 2011-12 financial year and has targeted between $150.000 and $300,000 per year expenditure on pipe repair and replacement works. Manholes have also been surveyed and prioritised and some 4-5 per year are sealed and repaired on an ongoing basis.

2.3 The Existing Treatment Plant

2.3.1 Overview

The Carterton Wastewater Treatment Plant (WWTP) is located off Dalefield Road, South Carterton. The ponds are owned and operated by CDC. The WWTP provides treatment of wastewater collected by Carterton's reticulated sewerage system as per the figure below.

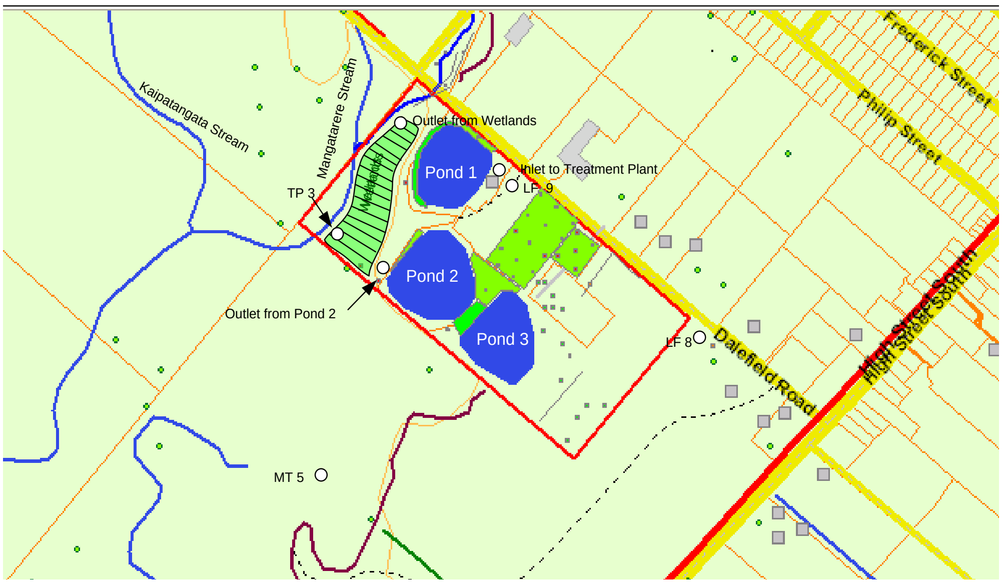


Figure 7. Carterton Wastewater Treatment Plant, wetlands, receiving stream and monitoring bores. The red box encompasses the 16ha site of the wastewater system and closed landfill).

The valuation reference for the site is 1814055100, and the legal description is Lots 1 and 2, DP 24549, and Lots 1 and 2 DP 30724, Block X, Tiffin Survey District. The NZMS 260 grid reference is S26 205 154.

The treatment process comprises: a fine screen, primary clarifier, sludge digester, two stage oxidation ponds, surface flow wetlands, and an intermittently used (summer time only), land treatment system. The final effluent discharges into a small, unnamed drain, and then to the Mangatarere Stream. The plant occupies a site of approximately 16ha of land area, which also includes the (now closed) Carterton Landfill.

The screen removes debris and floatables prior to a pumping chamber which raises the flow up to the level of the primary clarifier. The screenings are deposited into a thick-walled plastic liner at the site. The liner is then sealed and disposed of with solid refuse. Weekly volumes of screenings disposed of are in the order of 0.5 – 0.75 m^3.

The primary clarifier removes some one third of the BOD and two thirds of suspended solids from the incoming flow, along with most of the oil and grease. The removed material is then pumped to the digester where volatile constituents are broken down and converted to a relatively inert material which can be used as a soil conditioner. The digester has recently been upgraded by heating one cell and there have been some unpleasant odours associated with the system prior to the upgrade. The new heated cell has the capacity to cope with increased loads and should remove the historical problem of periodic odour production during spring to early summer as the previously cold digesters started heating up with the ambient temperatures which in turn started the biological activity with associated odours until they became stabilised.

Oxidation Ponds 1 and 3 act in parallel as secondary treatment ponds, and Pond 2 provides a polishing function as a tertiary pond. Treated effluent from Pond 2 discharges via flow splitters into 16 surface flow wetland plots, then into a common outlet collection channel and then into a small unnamed drain at or around map reference (NZMS 260) S26:201-156. Approximately 200m further downstream (to the southwest), this unnamed drain discharges to the Mangatarere Stream.

Upstream of the oxidation pond discharge point, dry weather flows in the unnamed drain are negligible.

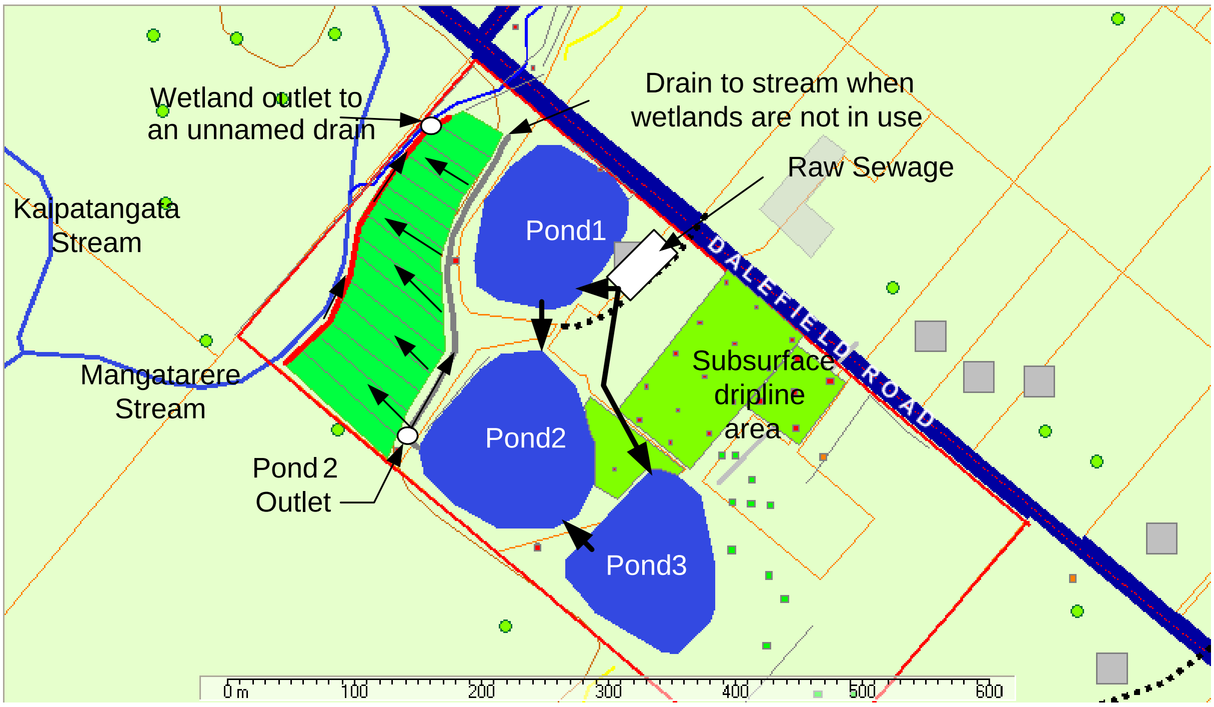


Figure 8. Flow path for Carterton Sewage Treatment Plant discharges, starting at point named “wetland outlet to unnamed drain”, and then south west some 100m to the Mangatarere Stream.

2.3.2 Wetlands

Prior to 2003, the outflow from Pond 2 was discharged to a small drain and then to the Mangatarere Stream. From late February 2003, this discharge was directed over 8 grass plots, which then fed into the drain and then the Mangatarere Stream.

The performance achieved by the grass plots was variable, but did tend to produce improvements in bacteria levels. It was therefore decided to increase the number of the plots and convert them to surface flow wetlands as part of the treatment plant upgrade.

Figure 9. Historical over land flow plots

The wetland upgrade was completed by Dec 2003. 16 wetland plots were constructed and planted with wetland plants sourced locally. Establishment of wetland plant vegetation on some plots has been slow, and some plots have not sustained good growth and have really only acted as maturation cells. Performance monitoring has show that it is important to ensure even flow distribution over the 16 beds. A contractor is currently engaged to undertake this flow equalisation on a weekly basis. The wetlands typically provide a moderate to excellent reduction in faecal coliform bacteria and some oxidation of ammonia and reduction of nutrients. The pictures below show the different types of wetlands species planted in Carterton (which have been sourced locally), and include:

Figure 10. Isolepis prolifer- of the sedge family

Figure 11. Schenoplectus tabermontani --Lake club rush

Figure 12. Typha orientalis – raupo

Figure 13. Juncus spp. - rush

When the land treatment system is not operating, all the flow passes through the ponds and wetlands to the stream. The surface area of the ponds and wetlands (at some 4 ha total) contribute to both an increase in final outflow under rainfall conditions, and a decrease in final outflow flow under high evapotranspiration conditions (warm weather and strong wind runs).

Figure 14. Wetlands in 2005 with lush growth to the back of one wetland plot

Monitoring of the performance of the wetlands is by 10 samples per month for the basic parameters: BOD, suspended solids, and faecal coliform bacteria, and monthly for a more comprehensive range of parameters including nutrients. This data is reported in section 5 of this report.

In 2010, the wetlands were substantially cleaned out and replanted with selected species to improve the performance and density of the vegetation. This replanting work is ongoing, with new growth expected to commence in spring 2010. It will likely be 12 months or more before the new plants have become well established. In the interim, wetland performance is more like that of maturation cells, still providing a reasonable level of reduction in indicator bacteria.

2.3.3 Discharge to Stream

From the wetlands, when discharge is to water, (usually April – December inclusive), the pump chamber feeding the land irrigation treatment plant is not used, and a baffle is opened which allows the flow to discharge through a culvert pipe into a ditch / ephemeral stream which runs adjacent to the wetlands. From the discharge point the ditch flows approx 120m to the Mangatarere stream, where it flows into a deep pool on a stream bend.

The MfE's August 1994 discussion documents on reasonable mixing, does not recommend any absolute values (eg distance of 10 x channel width, or 300m), but instead recommends that consideration be given to the intent of the water quality classification for the stream. The Mangatarere is classified in the following sections of the GW Regional freshwater Plan; Appendix 4; Water to be Managed for Fishery and Fish Spawning Purposes, Appendix 7 Water Bodies with Water Quality Needing Enhancement. These classifications therefore require the following standards to be adhered to;

- A8.1; the minimum standards given in sections 70 and 107 of the Act; conspicuous films, scums or foams, conspicuous change in colour or clarity, emission of objectionable odour, rendering water unsuitable for consumption by farm animals, significant adverse effects on aquatic life,
- A8.2; temp not to change by > 3 degree C, no; pH change, increase in deposition of matter, discharge of contaminant, if they have an adverse effect on aquatic life, DO to remain above 80% saturation. No undesirable growths.
- A8.4; water temperature not to exceed 25 degrees C, fish to be rendered unsuitable for human consumption,
- A8.5; water temperature not to affect the spawning of specified fish during the spawning season.

The key water quality criteria are therefore those which may effect fishery or fish spawning. Clearly if the existing discharge is to continue under the new consent, some testing of actual mixing will be required to confirm or redefine the point of mixing, however, intuitively, and based on visual clarity mixing when the pond effluent has high algal cell counts and appears very green, it appears that the location of the downstream sampling point (Man-down), as shown in figure 15 below, is at a point where the discharge from the unnamed drain appears to be fully mixed with the stream waters.

The monitoring points currently used downstream of the outfall to the Mangatarere Stream are 100m downstream for the Man-down biota sampling point and 250m downstream for the Man-down water quality sampling point. It is proposed that these, (subject to some sampling for confirmation), would equate to the reasonable and complete mixing zones. As detailed in the Resource Management Water Quality Guidelines No. 2, reasonable mixing includes the processes of dilution and dispersion of effluent, while complete mixing includes dilution, dispersion and additional degradation, by biological, chemical and physical processes.

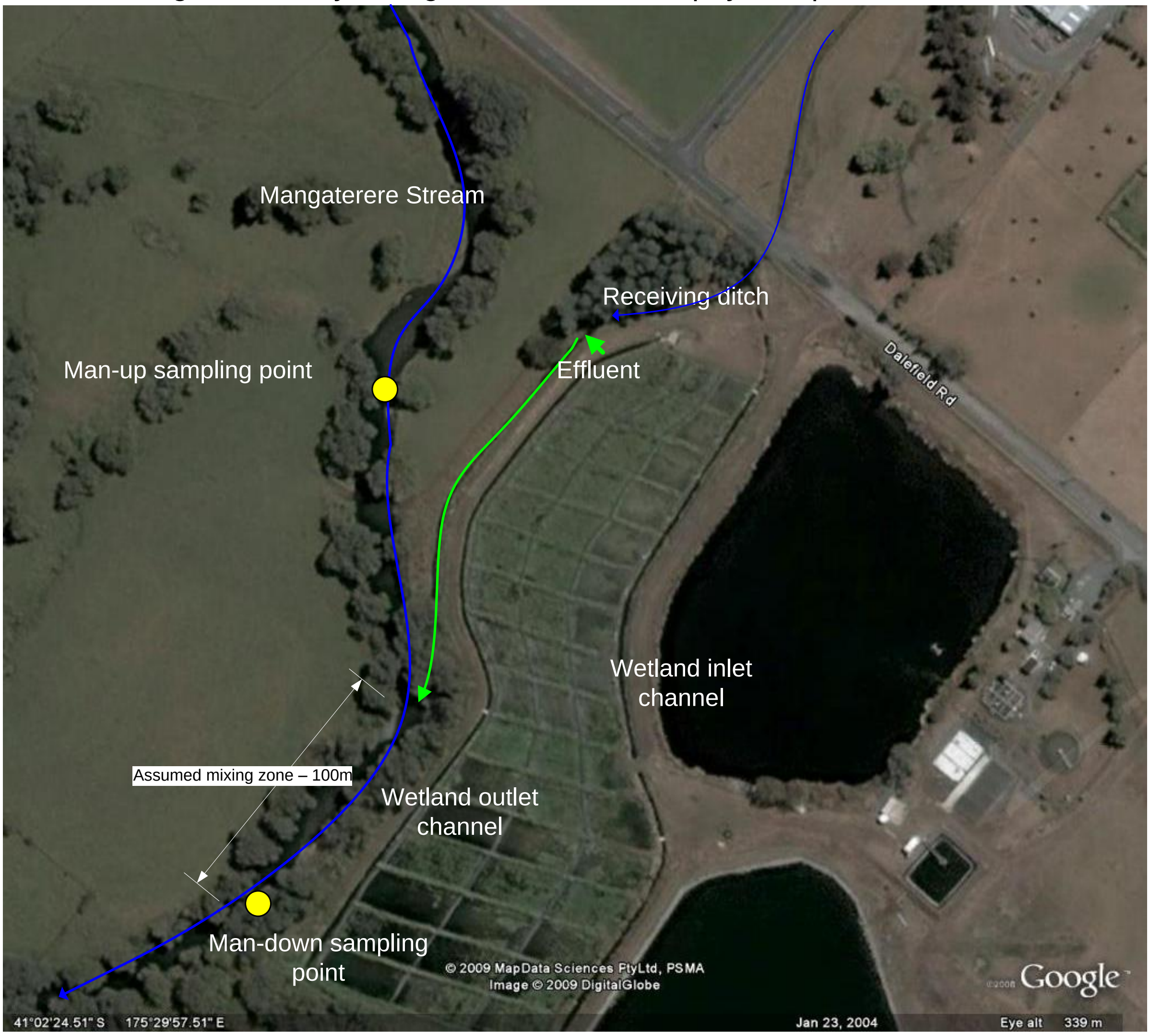


Figure 15: Effluent outfall, sampling points and recommended reasonable mixing zone.

2.3.4 Land Treatment System

The existing land treatment system has a number of different stages and options for treating effluent, these systems include:

- Filtration of the wetland effluent (all flows),
- UV disinfection of the wetland effluent (required for all surface flows and infiltration bores but is currently used on all flows),
- Subsurface drip line irrigation, irrigation option (typically used all the time land irrigation is occurring),
- Surface irrigation, irrigation option (typically used in daylight hours to maximise evapotranspiration or when good soakage is occurring),

- Infiltration bores, irrigation option, after the first 2 years operation these have clogged and now take virtually no flow,
- Pond storage (in the oxidation ponds), used to buffer fluctuations between incoming flows, and irrigated flows. The summer period is usually entered with the ponds drawn down to a relatively low level and usually ends with the ponds full

The treatment system for the effluent discharged to land is first filtered through disc filtration (bank of black filters at the rear of figure 16 below), followed by UV light disinfection (two stainless steel tubes at the front of figures 15 and 16 below).

Figure 16. Existing Filtration Plant with the UV reactors in the foreground

A smaller disc filtration unit was installed at this plant for the first two years of operation. The performance of this filter under summer time conditions was fully evaluated, and a decision made to purchase a larger unit (shown in above picture). This larger unit was installed in the summer of 2005.

Based on trial results, in conjunction with measurements taken of the UV light transmission of the effluent, and considering the improvements expected from the wetland treatment and disc filtration, a Steriflow low pressure UV system was selected to treat 15L/s to give 200 faecal coliform cfu's /100mL, at 40% transmission. Intermittent monitoring has shown that typically the faecal coliform levels are lower than this number, and often the level of total coliform bacteria approach the level specified by Fonterra for discharge to dairy pasture. (Annex A)

Figure 17. UV treatment reactors at the Carterton plant

The main land treatment area is 2.1Ha, divided into different irrigation plots of approx 0.5ha each, as shown in figure 18 below. This land has retained the original grass cover. It is grazed by stock on the flat land, and hand mowed on the steeper landfill faces.

The subsurface dripline is in 5 different blocks and each block has been laid at different depths. The blocks are shown in Figure 18 and depths are as follows:

Block	Depth of dripline (mm below surface)
1	200
2	300
3	400
4	500
5	100

Table 3. Depth of dripline below surface

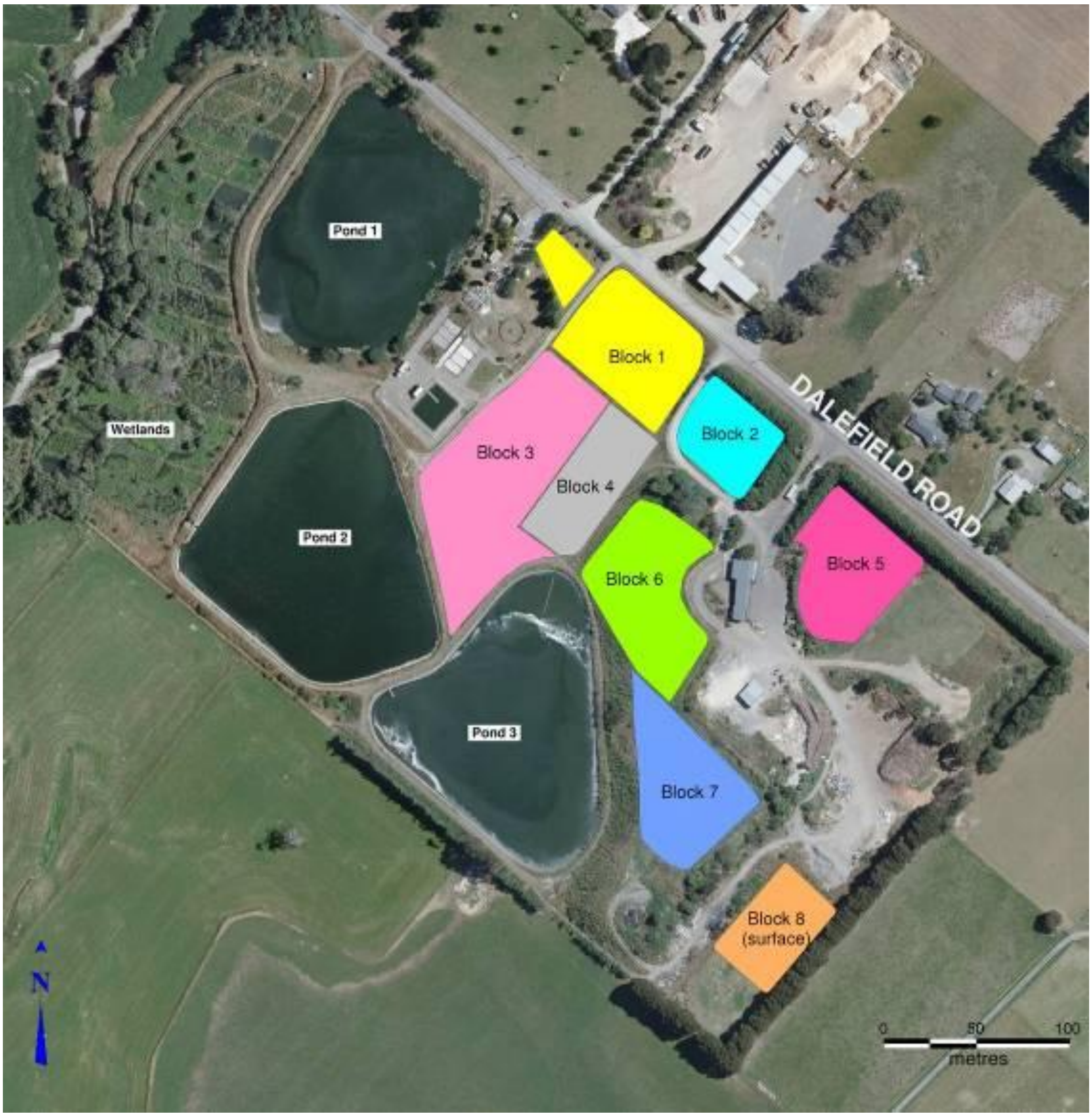


Figure 18. Subsurface and surface dripline plan

This drip line installation was treated as a large-scale trial, which was monitored for the duration of the initial consent, during which time application rates were varied and the impact on the ground, groundwater and stream, were evaluated (refer section 5 of this report).

The system is operated at varying flow rates, giving aerial loading rates of up to 20mm/day, and flows up to 6L/s. When these rates exceed the moisture uptake by evapotranspiration, there is a net discharge to ground, and, ultimately to groundwater. The groundwater flows towards the Mangatarere Stream, in a south-westerly direction. Groundwater quality monitoring bores are located between the site and the stream and measure the degree of renovation obtained in the seepage waters. Typically the only contaminants which have been found to return to the stream at significant levels from the land irrigation site operation are the nutrients: nitrogen and phosphorus.

The original design was that when soil moisture levels in the subsurface and/ or surface irrigation trial plots are too high, the surplus flows would go to infiltration bores located along the banks of the Mangatarere Stream and the tributary drain, at the western end of the site. The flow into these was first to be treated with disc filtration and UV light irradiation. It then passed through an existing subsurface gravel layer before flowing into the groundwater and then the stream as a diffuse seepage through the drain banks. A schematic of the infiltration bores and effluent flow path is shown below.

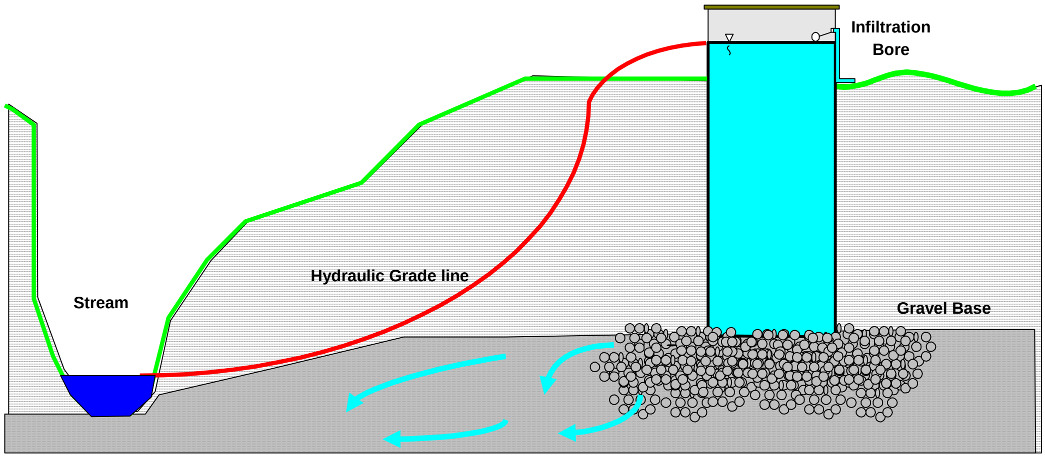


Figure 19. Infiltration Bores Schematic

Initially the bores worked well and received up to 5L/s of flow. After 2 years operation, however, the, flow dropped back as the ground around the rock / soil interface clogged, and since 2006 the infiltration bores have received negligible flows.

The water and sludge levels in the oxidation ponds were measured on 16/10/2003. Measurements were made from a boat, with a steel rod being forced through the sludge layer to measure the full constructed depth to the pond base. A weighted large diameter perforated plate was used to measure the top of the sludge layer. The depths to these two layers for the 3 ponds are tabulated below.

Parameter (all measurements in cm)	Pond #1	Pond #2	Pond #3	Design Specifications[19]
Average Water Depth	128	118	118	60 (minimum)
Average Sludge Depth	58	44	29	1/3 total depth
Amount Pond can be drawn down from level at time of measurement so minimum depth is maintained.	68	58	58	To maintain 60cm
Excess depth available, above level at time of measurement	55	56	61	
Total height variation possible.	123	114	119	No specific criteria

Table 4. Measured Pond Water and Sludge Levels and Available Buffer Storage

Conservatively, allowing an average of 1m total height variation, the ponds provide a buffer storage volume of 38,000m^3. At the net summer time average daily flow of 900m^3 (allowing for seepage and evaporation from the ponds and wetlands, without allowance for rainfall), this provides a theoretical 42 days buffer storage, assuming none of the land treatment systems were operating.

Under dry weather conditions, however, most of this storage is not used. The storage is used to accommodate any shortfall found with the land treatment system's application rates, and to accept short duration / high intensity rainfall events without the need to discharge to stream, even if the land systems are unable to operate for a period.

Under higher inflows (storm events, etc.), when the subsurface and surface irrigation trial plots are too wet, and the flow capacity of the infiltration bores is exceeded, the stream levels are high and discoloured, and excess flows from the wastewater system pass from the wetlands directly to the stream. This, however, is at times of very high dilution, into a stream flow already carrying an elevated contaminant load, and so the immediate impact is negligible.

During the first summer of operation the pond levels fluctuated markedly due to the high rainfall experienced in the area. This is shown in figure 20 below.

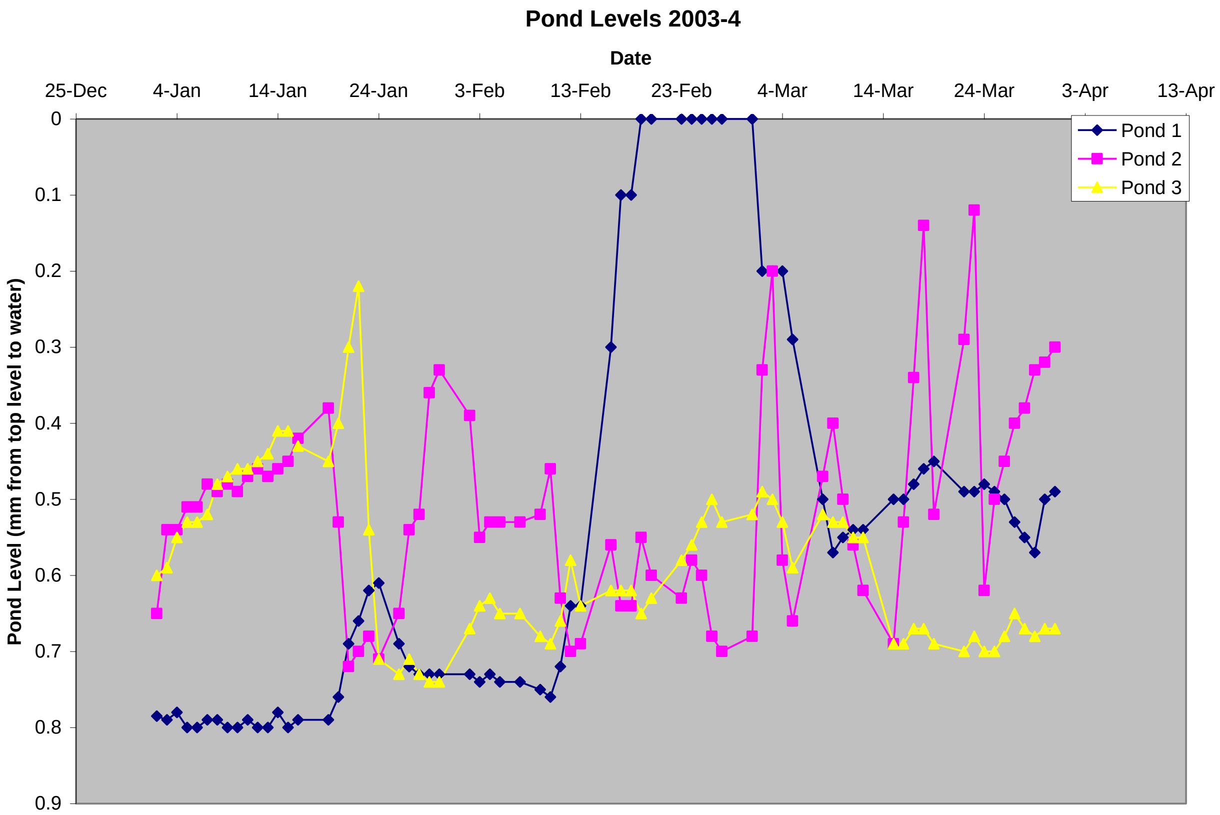


Figure 20. Pond operating levels for the period 1st Jan 2004 – 30 March 2004

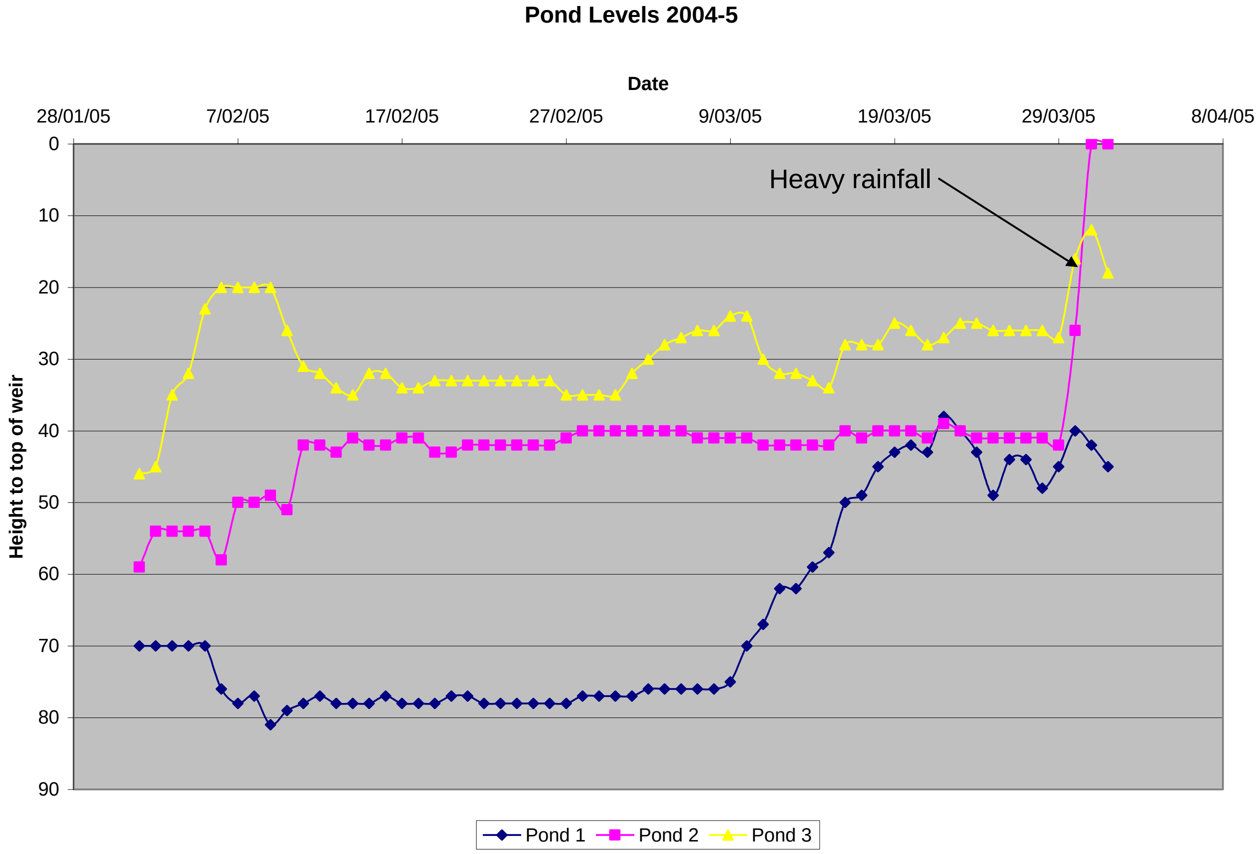


Figure 21. Pond operating levels for the period 1st Jan 2005 – 30 March 2005

During the summer of 2004-2005 the ponds were managed so that they acted as a buffer for the rainfall events. The land treatment system operated all summer with zero discharge to the stream, even with a very late high rainfall event which pushed the ponds to full capacity on the last day of summer time operation.

Performance for the land treatment system over the periods 2003-2004, and 2004-2005 is tabulated below.

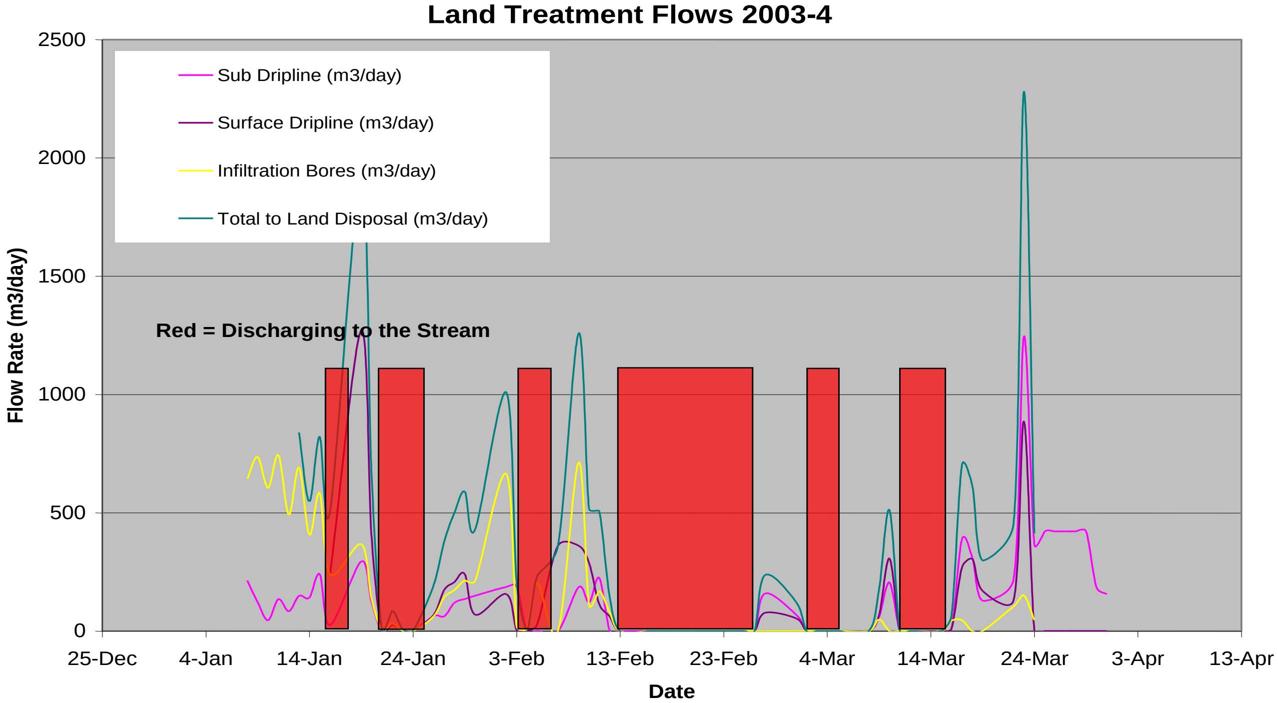


Figure 22. Land treatment flows for the period 2003-2004

In Figure 22 above the land treatment system was halted up to 6 times in the summer of 2004. There were 5 smaller rainfall events and one massive flooding event during Feb 2004.

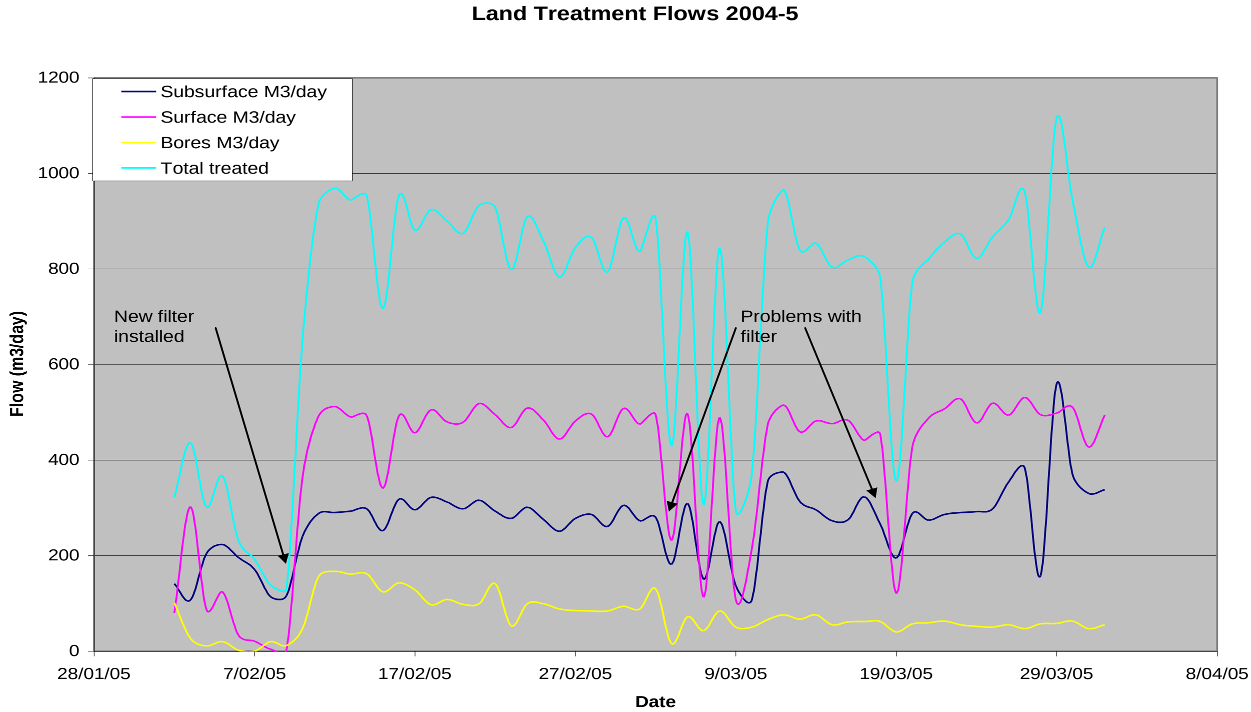


Figure 23. Land treatment flows for the period 2004-2005

Figure 23 shows a marked improvement in the consistency of operation of the land treatment system for the summer of 2005. At no stage during the three months of Jan, Feb, and March did the STP discharge to the Mangatarere Stream. The graph shows that the plant was mostly discharging effluent to the surface and subsurface dripline and that with time the flow rate discharging to the infiltration bores tapered off.

2.3.5 Discharges to air

The Wellington Regional Council's Air Quality Plan became operative on 8 May 2000. This plan requires a resource consent to cover activities associated with community sewage treatment systems. Such consents are discretionary activities under the Plan.

The Carterton Wastewater Treatment Plant is such a system. The treatment works at the site consist of a fine screen, primary clarifier, sludge digester, two stage oxidation ponds, (two primary and one tertiary), and an intermittently used land treatment system. The final effluent discharges into a small-unnamed drain and then to the Mangatarere River. The plant occupies approximately 16ha of land area, which also includes the Carterton Landfill.

The nearest dwellings to the treatment plant are located to the north and northeast, across Dalefield Road, approximately 100m from the plant boundary. The built up area of Carterton is approximately 500m to the north and east from the plant boundary.

The serviced population is 4100 persons, plus a small industrial loading, (assume 20%). In terms of Biochemical Oxygen Demand (BOD_5), (organic loading), this gives (at 70g per person / day), an expected inlet loading of approx 350 kg/d. An appropriately loaded primary clarifier can be expected to reduce this by 33%, and typical loading for (facultative), oxidation ponds is up to 84kg/ha/d, although this can be increased up to at least 150kg/ha/d if the ponds are aerated. Ponds 1 and 3, (the two secondary ponds which operate in parallel), have caged rotor aerators installed and operating, and are 3.3Ha in combined surface area. This gives an allowable BOD_5 loading of 495kg/d for these two ponds combined, at the 150kg/ha/d (aerated), loading rate.

Plant monitoring has allowed actual BOD_5 influent data to be collated to provide a more accurate understanding of BOD_5 loadings coming through the wastewater treatment system. The calculated average daily loading over an 18 month period was 706kg/d. The data on which this value is calculated is tabulated below, and has been based on inlet flow and analytical analysis results.

Date	**BOD (g/m3)**	**Flow (m3/d)**	**BOD (kg/d)**
29/05/2006	304	2500	760
28/06/2006	97	7286	706.742
25/07/2006	51	9553	487.203
30/08/2006	112	6361	712.432
25/09/2006	94	2963	278.522
26/10/2006	72	8382	603.504
28/11/2006	170	5747	976.99
20/12/2006	108	3524	380.592
16/01/2007	272	2395	651.44
26/02/2007	349	2064	720.336
27/03/2007	366	1832	670.512
26/04/2007	410	1809	741.69
29/05/2007	292	1852	540.784
27/06/2007	337	2312	779.144
26/07/2007	489	2650	1295.85
28/08/2007	297	3689	1095.633
26/09/2007	181	3615	654.315
30/10/2007	155	5166	800.73
27/11/2007	212	2642	560.104
Average			706.1328

Table 5. Calculation of average BOD loading to Plant

This does not, however, take into consideration that whilst the flow is taken over a 24 hour period, the BOD loading for the day, is based on one grab sample. This is typically sampled around 1100 hrs to provide time for despatch to and reception at the analytical laboratory. Whilst daily flow is reasonably consistent, due to the usually high levels of inflow and infiltration, it is highly likely that the daily BOD load will vary, and that the 1100 hr sample will be disproportionately high, compared to the average value for the whole day. Figure 24 below shows a textbook relationship of municipal diurnal BOD loading vs time of day to illustrate this.

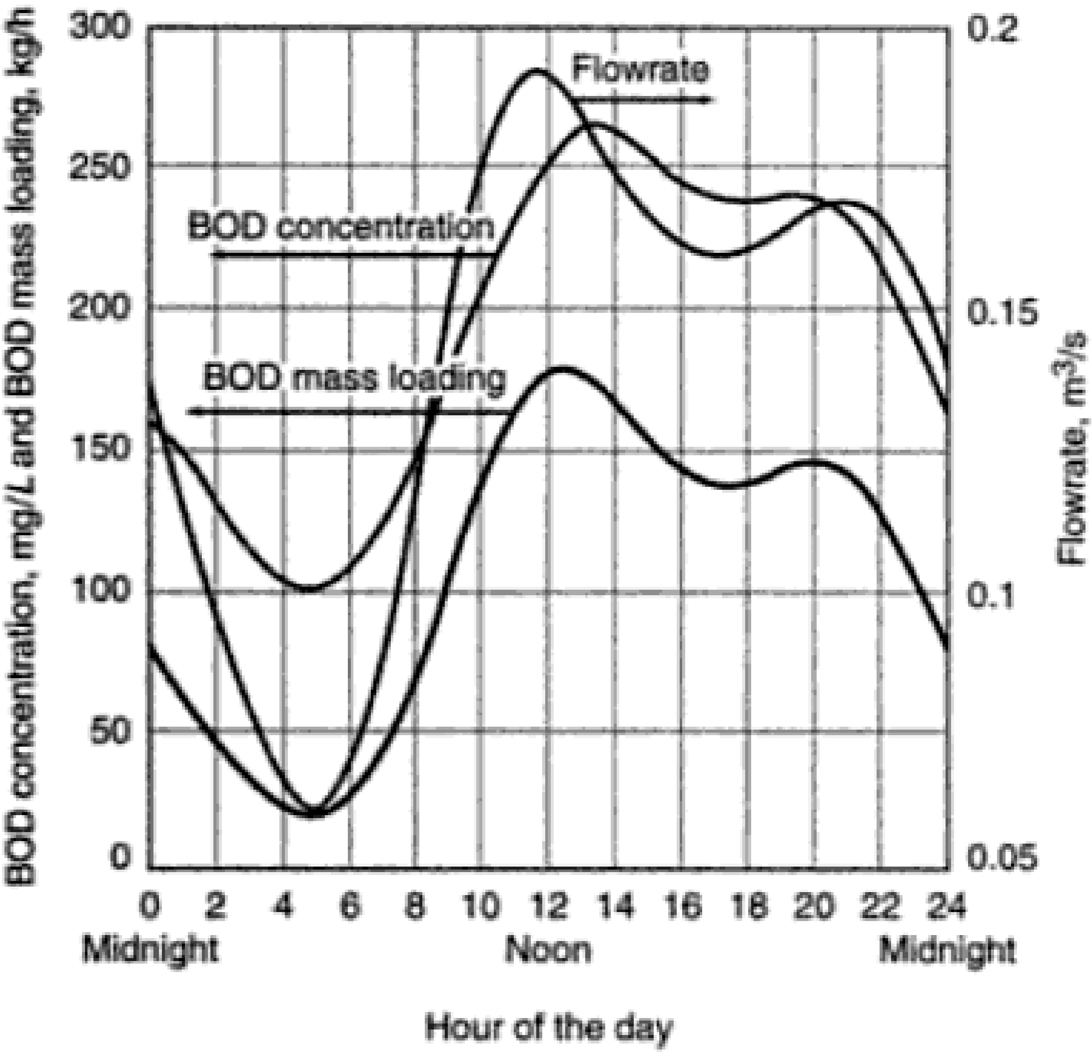


Figure 24. Diurnal BOD Variation

However, in lieu of 24hr BOD sampling, assuming that the load to the plant is the measured 706kg/d, the primary clarifier can be expected to reduce this by 33%, leaving 473kg/d loading onto the primary ponds. This is within, (although only marginally so), the allowable loading for the two “”secondary”” aerated facultative ponds, however, as there is clearly a significant level of commercial / industrial organic load on the plant, it is expected that the introduction of the Trade Waste Bylaw Charging, in June 2009, and associated moves by the larger waste dischargers to modify their processes, will see this load reduce to give a more comfortable margin.

Typically, odours which do come from the plant are related to either the ponds, or the sludge digestion and drying system. Pond odours can be caused by:

- Anaerobic conditions in the ponds (lack of oxygen).
- Blue – green algae growth, leading to a “bloom” covering the pond surface, and eventually dying off, with attendant oxygen demand and odours caused by decomposition.

Anaerobic conditions can be caused by either insufficient reoxygenation, or excessive organic loading. The loading may be external, from high strength wastes, or internal, from gas buoyed sludge.

Algal blooms appear to be seasonal phenomena in many ponds in temperate regions such as most of NZ. The factors which can contribute to blooms are pond loadings, pond retention time, and temperatures.

Corrective action for these situations can include:

- Break up of floating scum, septic sludge or blue-green algae mats (repeated attempts may be necessary, as mats tend to re-form).
- Use of copper sulphate or algaecides, (with appropriate environmental controls), to kill off problem algae,
- Desludging ponds before water depth becomes too low and sludge depth becomes excessive.

The ponds currently receive a daily inspection. The inspection requires a visual observation of issues such as; pond levels, vegetation, blockages, algal blooms, debris on wavebands, presence of warning signs, etc, and the monitoring and recording of pond levels, dissolved oxygen and temperature. The pond aerators in the two secondary (facultative) ponds are also on automatic dissolved oxygen level control.

A Meteorological Service report on the Wairarapa Region provides some data relevant to this report. The wind rose for the nearest monitoring station, (East Taratahi), gives the data tabulated below:

Direction	Mean Annual % of Time Wind is from Direction
N	7.1
NE	14.6
E	2.9
SE	1.6
S	4.6
SW	15.1
W	13.2
NW	7.3
Calm	33.4

Table 6. Wind direction at East Taratahi

This means that, with nearby residents being primarily located in the quadrant north to east, the wind will come from a direction (south to west quadrant) which would move odours towards these residents for approx 30% of the time (on an annual basis).

Mean monthly wind speeds at the East Taratahi site were found to be consistent throughout the year, in the range 6-8 knots, with speeds over 30 knots for only 0.4% of the time.

Typical annual air temperature variations are from freezing in winter, to 30 degrees in summer, with recorded extreme values for the period 1972-1978 being –9.3 to 35 degrees Celsius. Temperature is relevant to odour potentials as both the incoming sewage and some of the treatment processes are more likely to become upset or odiferous during periods of elevated temperature. Colder temperatures are normally associated with the southerly winds, (wind flow towards residents), and warmer temperatures with the northerly winds, (wind flow away from residents). Sunshine hours for the period 1930-1980 were approximately 2000 hrs/yr, varying from 110hrs in June, to 230hrs in January.

Discussions with CDC officers and a review of Council's complaints records indicates that there have been historical complaints related to discharges to air from the treatment plant. These occurred intermittently over the period 2006-2009 and have been related to two issues; the sludge digesters, and the oxidation ponds.

The sludge digesters have been upgraded, by converting one cell of the 4 cells to a heated system. All the incoming sludge from the primary clarifier is directed to the heated cell and it is handling the load well, with stable pH and no odour problems. This upgrade is expected to be fully completed including the installation of a permanent cover on the heated digester cell by late 2010.

Odour from the ponds has occurred previously when the aerators were on DO meter control and the meters were not performing reliably. This last occurred in March 2008. At that time the odour was significant and there were multiple complaints. This has now been resolved, with the installation of different DO probes and operation of the aerators on time as well as DO.

Unfortunately, odours have been frequent enough that some nearby residents, (one especially), have probably become sensitised to them, as evidenced by a recent complaint, (March 2009), of odour from the digesters, when the investigating Regional Council officer was not able to determine a significant odour at the boundary. This is not to say the odour was not occurring, just that the resident has possibly become more sensitive to this odour than the RMA test threshold requires.

Since late 2009 there have been no odour complaints related to the treatment plant.

2.4 Proposed Upgrades to the Treatment Plant

The main proposed upgrade to the treatment process is to incorporate a membrane filtration step as a final treatment stage prior to discharge to water or land. As there is limited experience with operating membranes on oxidation pond effluents, which can have relatively high concentrations of algae and algal by-products, a pilot plant was constructed and operated during 2008. Four rounds of samples were taken pre- and post-membrane treatment, and analysed for a range or parameters. The feed water was the wetlands effluent. The pilot plant was a microfiltration membrane plant, although both micro and ultrafiltration membranes are being considered for the full scale upgrade. The figure below shows the differences between micro and ultrafiltration membrane pore sizes.

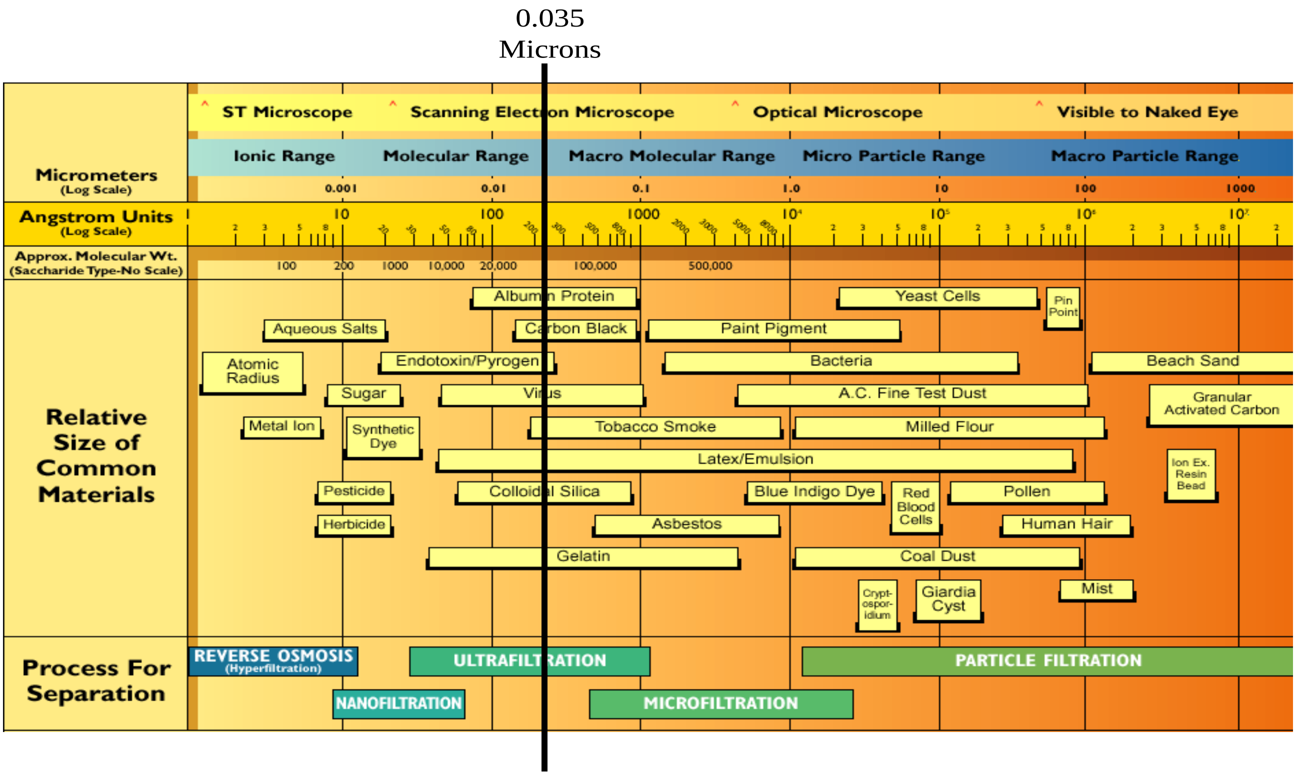


Figure 25. Relative aperture sizes of micro and ultra filtration membranes.
(The line at 0.35um is the aperture size of one particular make of ultrafiltration membrane that Council is considering using. The performance of this membrane can be expected to be even better than the larger micro filtration membrane used in the pilot trials)

Although the membrane aperture sizes are significantly different between ultra and microfiltration, the performance difference between the two systems is not so great, as many small contaminants tend to adsorb onto larger particles and become trapped by either system even though they would theoretically pass through the membrane aperture. Membrane plants tend to be constructed in modules which can be slotted together like a series of building blocks to achieve the required flow capacity. The layout of a typical membrane module is shown below.

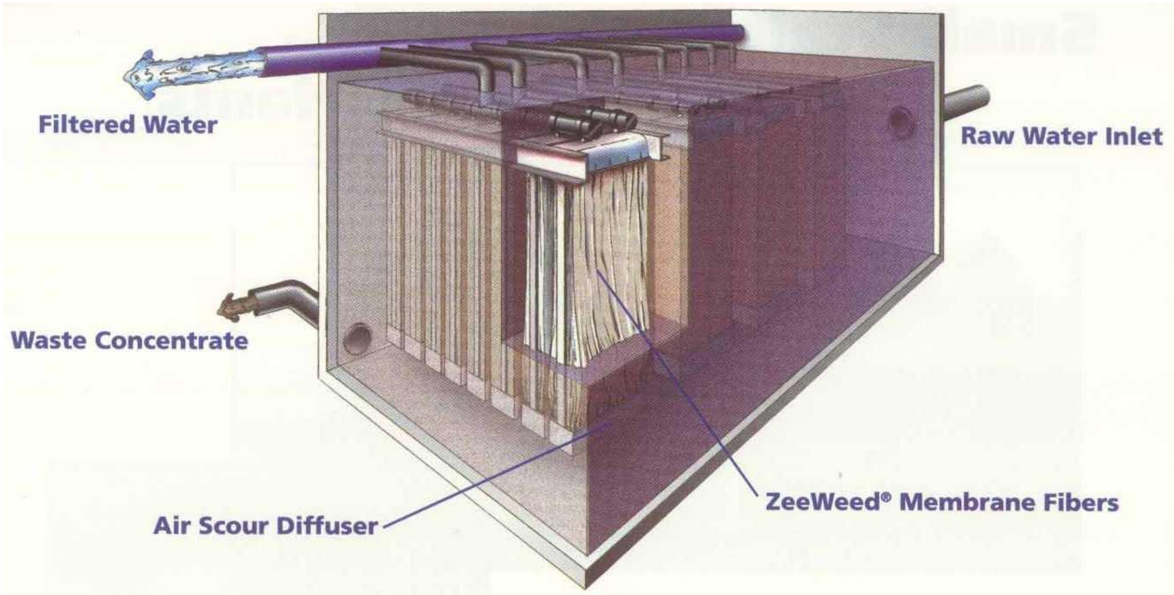


Figure 26. Typical membrane module.

Membrane plants can be built into containers. The plant shown below is rated at 900m^3/d , and so is approx half the size of the proposed Carterton plant.

Figure 27. 900m^3/day Membrane Plant.

The microfiltration treatment trialled achieved the following changes to the feed water quality:

Carterton Mircofiltration Pilot Plant Performance

	17-Sep-08			10-Sep-08			9-Sep-08			
Parameter	**In**	**Out**	**% Removal**	**In**	**Out**	**% Remova**	**In**	**Out**	**% Removal**	**Average % Change**
Organics										
TOC	6.9	4.3	38	7.4	4.6	38	6.7	4.1	39	38
DOC	5.5	4.2	24	6.5	4.4	32	6	4.1	32	29
COD	23	7.5	67	26	17	35	31	7.5	76	59
BOD	4	0.5	88	5	1	80	6	0.5	92	86
Physical										
Transmissivity	68.3	81	-19	68	80.6	-19	69.2	82	-18	-19
Nutrients			.							
NH3-N	4.54	4.63	-2	5.64	5.66	0	5.96	5.71	4	1
TN	7.15	6.02	16	6.51	6.46	1	7.4	6.48	12	10
TP	1.3	1.56	-20	2.29	2.17	5	2.48	2.31	7	-3
			.			.			.	
Metals										
Arsenic	Below detection levels for both			Below detection levels for both			Below detection levels for both			
Cadmium	Below detection levels for both			Below detection levels for both			Below detection levels for both			
Chromium	Below detection levels for both			Below detection levels for both			Below detection levels for both			
Copper	0.006	0.001	83	0.004	0.001	75	0.003	0.001	67	75
Lead	Below detection levels for both			Below detection levels for both			Below detection levels for both			
Nickel	Below detection levels for both			Below detection levels for both			Below detection levels for both			
Zinc	0.01	0.006	40	Below detection levels for both			0.007	0.0025	64	35
Volatile Organic Contaminants										
80 compounds	Below detection levels for both			Below detection levels for both			Below detection levels for both			

(Yellow) Value was below detection limit - 50% of detection limit assumed level
(Orange) For transmissivity increased level means cleaner water

Table 7. Carterton Microfiltration Pilot Plant performance

Whist these results show an improvement in a number of parameters, and this improvement is a useful addendum to the membrane plant's performance, its key purpose is to remove bacteria and microbes to reliably meet the Fonterra criteria for land irrigation. This criteria is *the median concentration of total coliform bacteria must not exceed a most probable number (MPN) of 23 per 100mL (based on a 7 day period) and the maximum number in any one sample over a 30-day period must not exceed an MPN of 240 per 100mL* (refer Appendix A).

The membrane pilot plant was also being monitored for treated water quality using the same sampling runs as for the surveillance of the town's potable water supply. The results were no total or faecal coliform bacteria found in the pilot plant effluent. Note that this was achieved without the additional benefit, 9in terms of bacteria killing power), of over 1g/m^3 of free available chlorine which is continuously added to the town supply.

Carterton Microfiltration Pilot Plant Monitoring Data

DATE	TIME	TEMP	HETRO 35	COLIFORMS	ECOLI	NTU
01/08/2008	9.35	12	2010	<1	<1	
06/08/2008	9.2	14	48	<1	<1	
14/08/2008	9.35	16	20	<1	<1	
20/08/2008	10.35	11.5	39	<1	<1	
22/08/2008	11	16.5	2592	<1	<1	
25/08/2008	10.36	16	864	<1	<1	
27/08/2008	10.3	17	2600	<1	<1	
01/09/2008	10.3	17.5	1200	<1	<1	
08/09/2008	11.02	15.5	260	<1	<1	
17/09/2008	10.2	15.5	5760	<1	<1	
25/09/2008	10.05	15	2880	<1	<1	
02/10/2008	11.06	16	90	<1	<1	
07/10/2008	10.08	20.5	2800	<1	<1	
15/10/2008	10.15	12	<1	<1	<1	
23/10/2008	10.25	19.5	1460	<1	<1	
31/10/2008	10.08	20	4320	<1	<1	
06/11/2008	11		15840	<1	<1	
10/11/2008	955	18.5	3260	<1	<1	
18/11/2008	952	18	43200	<1	<1	0.55
26/11/2008	10.2	19.5	2750	<1	<1	0.34
04/12/2008	10	25.5	56400	<1	<1	0.67
10/12/2008	9.25	15	64800	<1	<1	
18/12/2008	9.45	22	388800	<1	<1	0.96
30/12/2008	10.3	22.5	648000	<1	<1	
07/01/2009	10.29	25	1440	<1	<1	0.84
23/01/2009	9.3	20.5	1267200	<1	<1	1.41
27/01/2009	11.55	23.5	273600	<1	<1	0.39
03/02/2009	9.45	19	273600	<1	<1	0.85
10/02/2009	10.1	14.5	115200	<1	<1	0.42
18/02/2009	10.06	17.5	230400	<1	<1	
24/02/2009	11.4	24.5	36000	<1	<1	
04/03/2009	10.55	19	230400	<1	<1	0.6

Table 8. Monitoring data for microbiological quality of pilot membrane plant treated effluent

The other organisms measured (Hetero 35 – the heterotrophic or standard plate count at 35 degree C incubation temperature), is measuring more general bacteria such as those which exist naturally in most waters and soils and are not in themselves of any public health significance.

The layout of how a membrane plant is proposed to be added to the existing treatment process train is shown below.

Project: Wastewater Treatment Plant Upgrade	Drawing Title: Layout of proposed membrane treatment plant.			
	Showing: Location, main components, and associated pipework			
Client: Carterton District Council	SIZE A4		DWG NO CDC Wastewater / 2008 Upgrade / 4/0	REV 0
© CDC & New Zealand Environmental Technologies Ltd, PO Box 40-339, Upper Hutt pH 04 5264109, 0274492837, emial office@nzet.net.nz	SCALE NTS	Drawn: SDC 20/9/2008	SHEET 4 OF 10	

Figure 28. Layout of proposed membrane treatment plant.

Discharge for the upgraded treatment process would be to land when flows and ground conditions allowed this. At times of higher flows and saturated ground conditions, the flow would be to storage where possible, and where not possible through the existing discharge point with as much of the flow as possible being treated. Ultimately as inflow and infiltration is reduced, the frequency and extent of non filtered discharges to water would be reduced.

3 Existing Consents

There are three existing consents held by the CDC for the wastewater treatment system:

- Discharge Contaminants to Air, WAR 950148 (variation added on 16 May 2003, expired 30 March 2009)

- Discharge treated domestic sewage effluent to the Mangatarere Stream, (WAR 950148 – expired 30 March 2009), and is to discharge treated sewage at a maximum discharge rate of 3270m^3/d, (38 litres/second). Key conditions of this consent are:

  - **Condition 20**. The permit holder shall provide to the satisfaction of the Manager, Planning and Resources, Wellington Regional Council, an appropriate place at the outlet of oxidation pond number 2 to sample the treatment plant effluent before it flows to Mangatarere Stream.

  - **Condition 21**. The permit holder shall sample the sewage treatment plant effluent by means of a grab sample taken at the sample point provided in the preceding condition. Notwithstanding this, the permit holder may sample the sewage treatment plant effluent when it is to land. Samples shall be taken on least 10 different days during each calendar month and every sample taken shall be tested for the following parameters
    Faecal coliforms (#./100ml)
    Suspended solids (g/m^3)
    BOD5 [unfiltered (total)] (g/m^3)

  - **Condition 23**. After 31 Dec 2002 the following effluent sampling quality criteria shall apply to the treatment plant effluent as sampled in condition 25. Compliance shall be based on a running geometric mean and ninety percentile calculated using 40 test results.

    a) BOD – the geometric mean of 40 consecutive BOD5 sample values shall not exceed 25 g/m^3 and no more than 10 percent of 40 consecutive values shall not exceed 50 g/m^3.

    b) Suspended solids – the geometric mean of 40 consecutive SS sample values shall not exceed 45 g/m^3 and no more than 10 percent of 40 consecutive values shall not exceed 90 g/m^3.

    c) Faecal Coliforms - the geometric mean of 40 consecutive faecal coliform sample values shall not exceed 3,000 per 100 millilitres and no more than 10 percent of 40 consecutive values shall not exceed 25,000 per 100 millilitres.

Discharge to land and discharge to water (consent WAR 060211) effective 15th May 2007, expired 30 March 2009. This covers the summer time discharge to land and extended the trial period so that its end coincided with the discharge to water consent. This consent comprised;

- 25782 - Discharge tertiary treated effluent to groundwater via direct injection into bores/trenches
- 25783 – Discharge tertiary treated effluent to land via direct into bores/trenches.
- 23784 - Discharge tertiary treated effluent to land dripline irrigation
- 25780 - Discharge tertiary treated effluent to land via seepage from base of wetlands
- 25785 - Discharge tertiary treated effluent to land via soakage through the base of the oxidation ponds

Under the RMA operation can legally continue under the condition of expired consents provided new consents are in the process of belong applied for, (application time restrictions apply). Carterton is therefore operating under this clause of the RMA.

3.1 Consents Sought

Consents sought are:

- Renewal of consent 23784 - Discharge tertiary treated effluent to land dripline irrigation
- Renewal of consent 25780 - Discharge tertiary treated effluent to land from base of wetlands
- Renewal of consent 23170 - Discharge tertiary treated effluent to land via soakage through the base of the oxidation ponds
- Renewal of consent WAR 950148 – part of consent issued in 2003 relating to discharge to air.
- New consent – Discharge of tertiary treated effluent to water under conditions when it is not possible to discharge to land, effectively a renewal of consent. WAR 950148, except that the first 1500m3/d of flow would be treated by membrane filtration prior to discharge.

3.2 Other Consents Required

As above, discharge of contaminants to water, and land use, (covered by land zoning), consents are already held by the CDC.

3.3 Consent term

A consent term of five years is applied for, with provision for an extension of an additional five years to be granted on the satisfactory fulfilment of the community milestones outlined in section 4 of this report.

4 Consultation

4.1 Background

The assessment of environmental effects was first lodged on December 18th 2009, at which time preliminary discussions had been held individually with Ngati Kahungunu ki Wairarapa, Rangitane o Wairarapa, Choice Health, and Department of Conservation. Greater Wellington Regional Council wrote to Carterton District Council on 1st December 2009 requesting that consultation be commenced with other key stakeholders and completed prior to 31st March 2010.

4.2 Consultation Group

A consultation group was formed in January 2010, with representative members of:

- Ngati Kahungunu ki Wairarapa
- Rangitane o Wairarapa
- Department of Conservation
- Fish and Game
- Sustainable Wairarapa
- Carterton District Council
- Wairarapa District Health Board

In addition to technical staff, the meetings were attended by two Carterton District Councillors and the Chief Executive Officer.

The group communicated by emails and used a forum created on the consultation page of the Carterton District Council website, where the Assessment of Environmental Effects, minutes and other documents have been posted, and discussions held.

The group met three times between January and March 2010. Minutes of the meetings are appended to this report.

The broad concept was that the consultation group should focus and define issues and voice general community aspirations to assist Carterton District Council in directional planning. This would then be used as a basis to approach the broader community.

4.3 Long-term strategy

Of singular importance in the consultation discussions was the strategic significance of the Council's long-term wastewater vision. Whilst this had been outlined in general terms previously, at the request of the consultation group, Council formally ratified a vision statement in this regard:

"The Carterton District Council's long-term vision for the Dalefield Road Wastewater Treatment Plant is to discharge all treated effluent to land, except in extreme weather events, for the purpose of improving environmental and cultural outcomes. The Council's aim is to achieve this in partnership with the wider community and in particular with landowners in the vicinity rather than the Council having to acquire land for the purpose. The rate of progress towards achieving this vision will be governed by the practical realities of achieving suitable arrangements and the ability of the Carterton community to pay for the improvements."

The key point to note is that the aspirations of achieving a total discharge to land involve a time-frame and process that far exceeds that of the consent application now under consideration. This larger vision was deemed more important in terms of strategy, community aspirations, and actual environmental impact.

Fulfilment of the vision was seen to involve two distinct processes:

The regulatory consent of which this application forms a part. The consent process can only be applied to proposed actions within the term of the consent, and those with *legal certainty*. There is therefore sometimes a miss-match between the short-term regulatory process and the long-term community goals.

The community process. In order to achieve long-term goals, and the Council vision, it is important that the community is part of the overall process. Thus as Council members come and go in a three year cycle, and short-term consents expire, the long-term vision is carried on by the community.

In summary, it was agreed that a continuing involvement between the Council and Consultation group is beneficial for both parties and for the community as a whole. It was also agreed that because of the long-term nature of Council's vision, a somewhat different approach is called for in terms of this consent.

The group established that as well as the regulatory consent conditions, a separate set of ***community milestones*** should be established. In a cooperative manner, Council and the consultation group established provisional community milestones. The group agreed that achievement of the community milestones should, if possible trigger a 'roll-over 'of the consent for an additional five year period.

The group also agreed that adoption of this format (subject to agreement on consent conditions) would mean that members of the group would no longer require to be heard at a hearing. This is an important point because Carterton, as a small rural town, has limited funding to address the wastewater issue. Any expense on legal fees and hearings that can be avoided can be spent actually addressing the issue and achieving the vision.

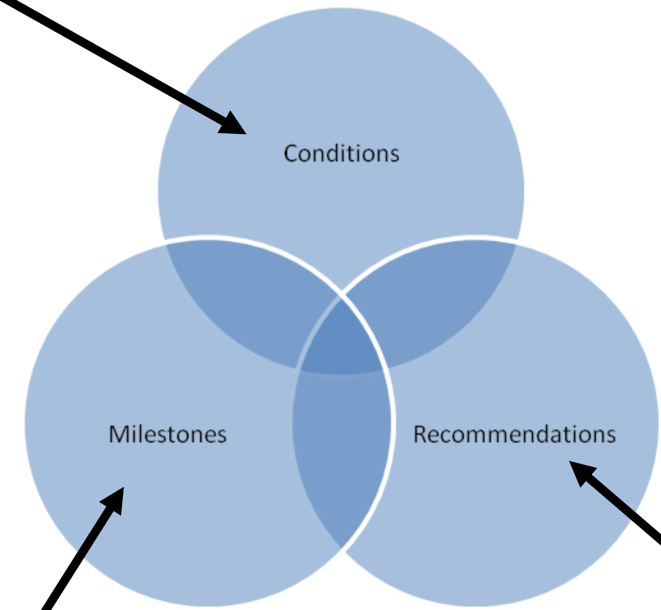
In addition to community milestones, the group decided to present ***recommendations*** to Council. These are generally associated with the broader, holistic aspects of the wastewater system. One of the milestones requires that Council formally respond to these recommendations during the period of the consent.

The mix of topics discussed was narrowed down to a realistic number as depicted in the figure 29 below.

Figure 29. Composite strategy for achieving long-term objectives

CONDITIONS

- Treatment plant upgrade
- Reporting on trade waste issues
- Reporting on infiltration remediation
- Effluent quality
- Monitoring regime
- Trial irrigation area
- Technology review



RECOMMENDATIONS

- Health Impact Assessment
- Cultural health indexing
- Technology review
- Community reporting
- Communication of I/I remediation
- New build – rainwater storage
- Long-term reduction targets
- Community engagement

MILESTONES

Milestone	**timeframe**
10% reduction in discharge to water	Year 4
Irrigation scenario analysis & strategy	Year 3
Formal response from Council on recommendations	Year 2

4.4 Storage and Land irrigation

Achievement of the vision requires the balancing of three key elements:

- Treatment of effluent to appropriate irrigation standards
- Storage and irrigation of effluent
- Flow reduction

The strategy to date has been focused on methods of improving effluent quality to meet the Fonterra standard for pasture irrigation, as described elsewhere in the assessment of environmental effects. This is of primary importance as it facilitates irrigation to a much broader 'client' base than is otherwise possible. Indeed, of the responses received from farmers over 300 hectares fell into this category.

Storage

During the consultation process, it was identified that it would be beneficial to have a better idea of the details of how the long-term goal is achieved. To this end, investigations have been commenced to gain a picture of the relative importance of the primary elements that would be required in a total discharge to land system. Of significance in this investigation was clean (fully treated) effluent storage.
Because irrigation is only needed during the summer months, flows outside of the irrigation season must be stored (about 900,000m^3 for an average year). Preliminary assessment for storage on-farm indicates that the area of land required and cost of construction are both significant.

Council is therefore investigating land for centrally storing these flows. Council is currently looking at land it owns in the Tararua foothills. Council is also seeking partnerships with other parties (like the Wairarapa Irrigation Trust) in case there are options to combine resources and provide better outcomes.

Whilst this is of almost no relevance to the current 5-year consent application, it is of the utmost importance to the long-term Council goal, community aspirations, and ultimate environment impact, and is a direct result of the consultation process.

Irrigation

As part of the process, Carterton District Council has investigated discharging treated wastewater effluent to land in cooperation with farmers. A letter requesting expressions of interest was sent out to some 130 land owners throughout the district. A number of responses were received over a wide geographical area. Each land parcel identified has unique properties in terms of soil, rainfall, depth to groundwater, distance from the treatment works, irrigation requirement, and crop.

To progress Council's stated vision of discharging to land, evaluation needs to be carried out of which parcel of land or which 'group' of land parcels should be used for irrigation. Council has to weigh up the cost versus the benefit of piping and pumping effluent to each 'group' of irrigation areas. One proposal mooted has been to select a close group for the short-term period (during this consent), with pipes to other, more distant areas as the next 'stage' of work. This concept met with a good response from the consultation group.

4.5 Public consultation

A document has been prepared to engage the public (Appendix D) and inform, in layman terms, key aspects of both the consent application and more importantly the long-term vision. It is intended to compliment the assessment of environmental effects and provide an easy-to-read summary. It is proposed that a public meeting or series of meetings be held once the consent has been notified. Indeed Council wish any notification announcements to be used to alert members of the public to the meeting date and venue.

As the application progresses documents will continue to be added to the consultation page of the Carterton District Council website.

5 Assessment of Environmental Effects

5.1 Summary

Overall, the irrigation to wetland system, which has been in place since 2004, has produced a substantial reduction in microbial levels when the flow is discharged to water.

The discharge to land system, which is normally only operated over the period January to March inclusive, (April inclusive in 2010), using the small area of council-owned land, has provided a significant reduction in summer time low stream flow impacts on the Mangatarere Stream. This is illustrated by Figures 35 and 36.

Nevertheless, there are still effects from the existing land treatment system, on both surface and ground waters, and the land area currently irrigated is insufficient to sustain long term irrigation at higher rates and other an in the height of summer.

In a July 2010 a draft report titled Mangatarere Stream Catchment Water Quality Investigation, authored by Greater Wellington officers reported; removal of the Carterton WWTP discharge from the lower Mangatarere Stream would significantly reduce the existing DRP loading on the stream and related nuisance periphyton growth. However DRP: DIN ratios in stream waters suggest that nitrogen inputs also need to be managed. In the case of DIN, the primary contribution is from diffuse sources indicating that wastewater application to land and agricultural management practices need closer attention.

With respect to the Carterton wastewater discharge, the proposed upgrade will minimise these existing effects and open the way for widespread irrigation use of the treated effluent, ultimately making this a truly negligible impact system.

5.2 Monitoring

5.2.1 Monitoring locations

Monitoring sites are located at a number of locations as shown in the figure below.

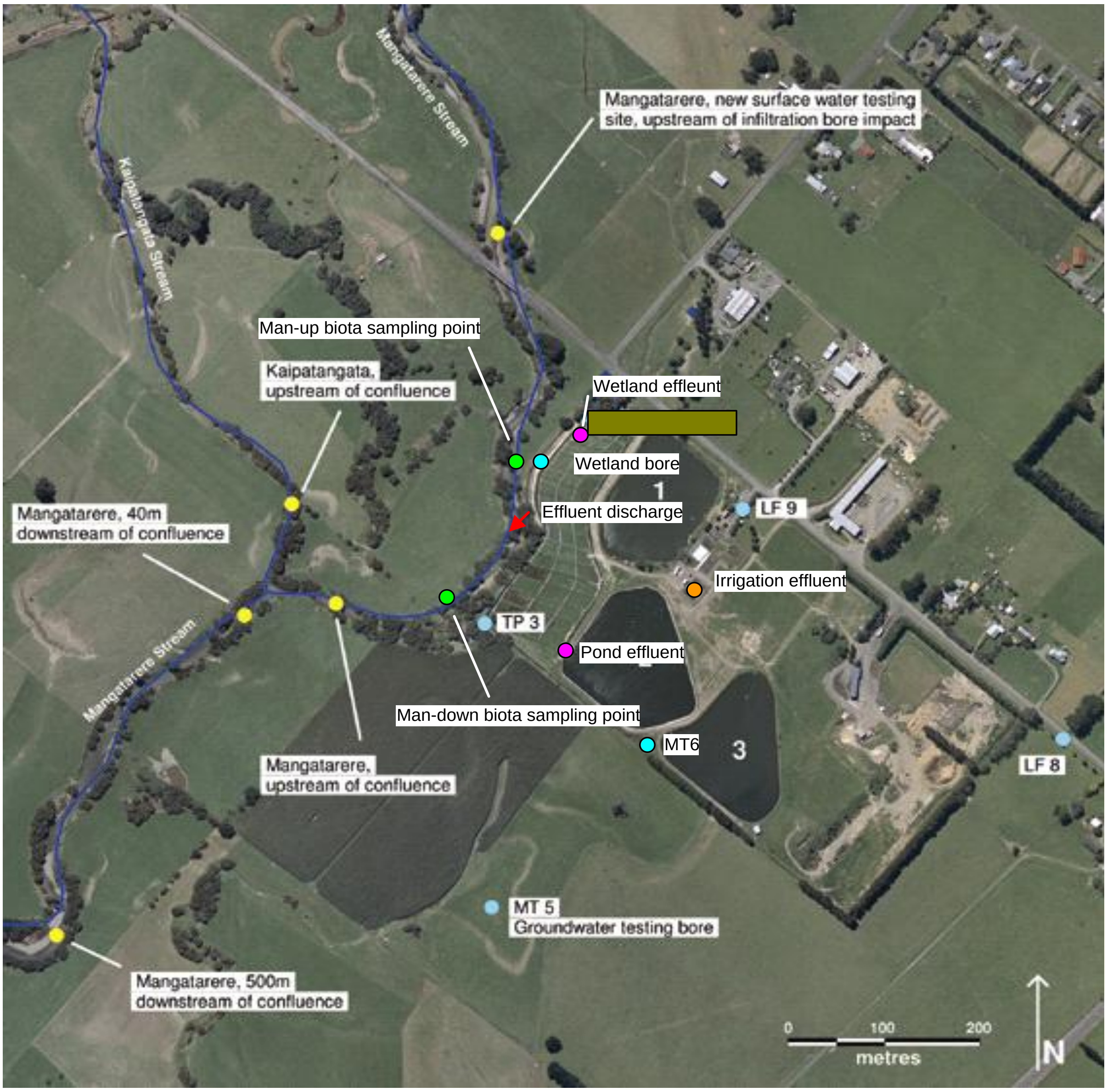


Figure 30. Sampling locations for wastewater impact monitoring.
Groundwater bores (light blue), routine wastewater quality (purple), stream impact (yellow), biota surveys, (light green), and summer time irrigation system effluent, (orange). Additional samples at more remote bores, (Fitzgerald and McLennan), were required under the previous discharge to land consent but are not required in the latest, (issued 15 may 2007) discharge to land consent.

Sampling is undertaken for wastewater monitoring purposes at the frequencies and parameters indicated in Table 9 below.

Location	**Sampling Frequency**	**Parameters Measured**
Ex #2 pond	10 / month	BOD/SS/Faecal coliforms
Ex wetlands	10 / month	BOD/SS/Faecal coliforms
Raw wastewater, final discharge, Mangatarere upstream and downstream, (at locations labelled Man-up and Man-down in figure 28 above), plus bores;TP3, LF8, LF9.	1 / month	Suspended Solids - Total Turbidity BOD5 - Total Faecal Coliforms Ammonia - unionised Inorganic Nitrogen Nitrite Nitrate Nitrogen Nitrate - Nitrogen Ammonia Nitrogen pH - onsite reading Temperature E. coli Total Phosphorus Dissolved Reactive Phosphorus Total Nitrogen
Mangatarere upstream and downstream (more extensive locations than normal monthly sampling), Kaipatangata, and Mangatarere downstream of Kaipatangata confluence (2 locations), additional bores; wetlands bore and MT6.	1 / month during irrigation to land.	Flows plus pH Suspended Solids - Total Conductivity at 25°C BOD5 - Total Faecal Coliforms by MF - Non-Potable Water E. coli by MF - in Non-Potable Water Nitrate - Nitrogen Ammonia Nitrogen Dissolved Oxygen Total Phosphorus Dissolved Reactive Phosphorus Total Nitrogen
Upstream and downstream of discharge, (Man-up and Man down)	6 monthly	Biota survey: Species Richness, MCI, QuantitativeMCI, % Ephemeroptera, ratio Ephemeroptera, Plecoptera, and Trichoptera to Chironomidea.

Table 9. Summary of current monitoring.

The results from this monitoring are shown in the charts below and tabulated in Appendix B.

5.2.2 Wetland Performance

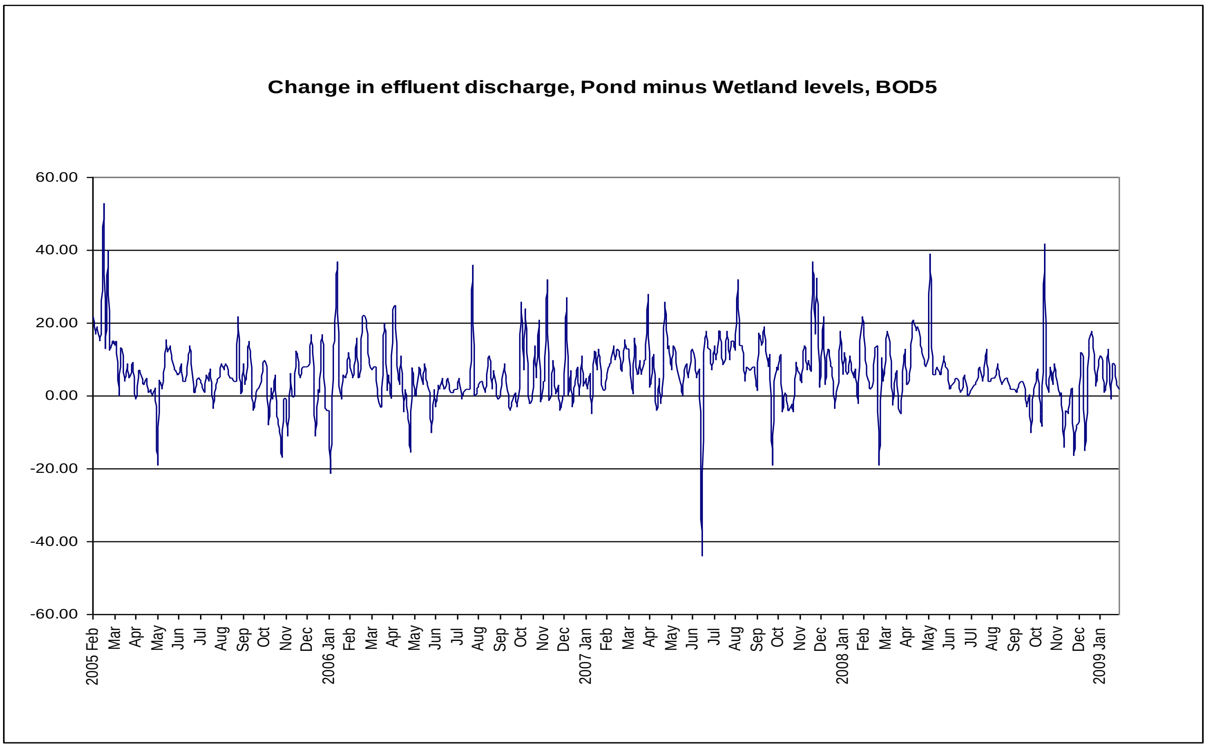


Figure 31. Change in BOD between pond outflow and wetlands outflow
This shows a significant improvement of typically 10g/m^3 occurring.

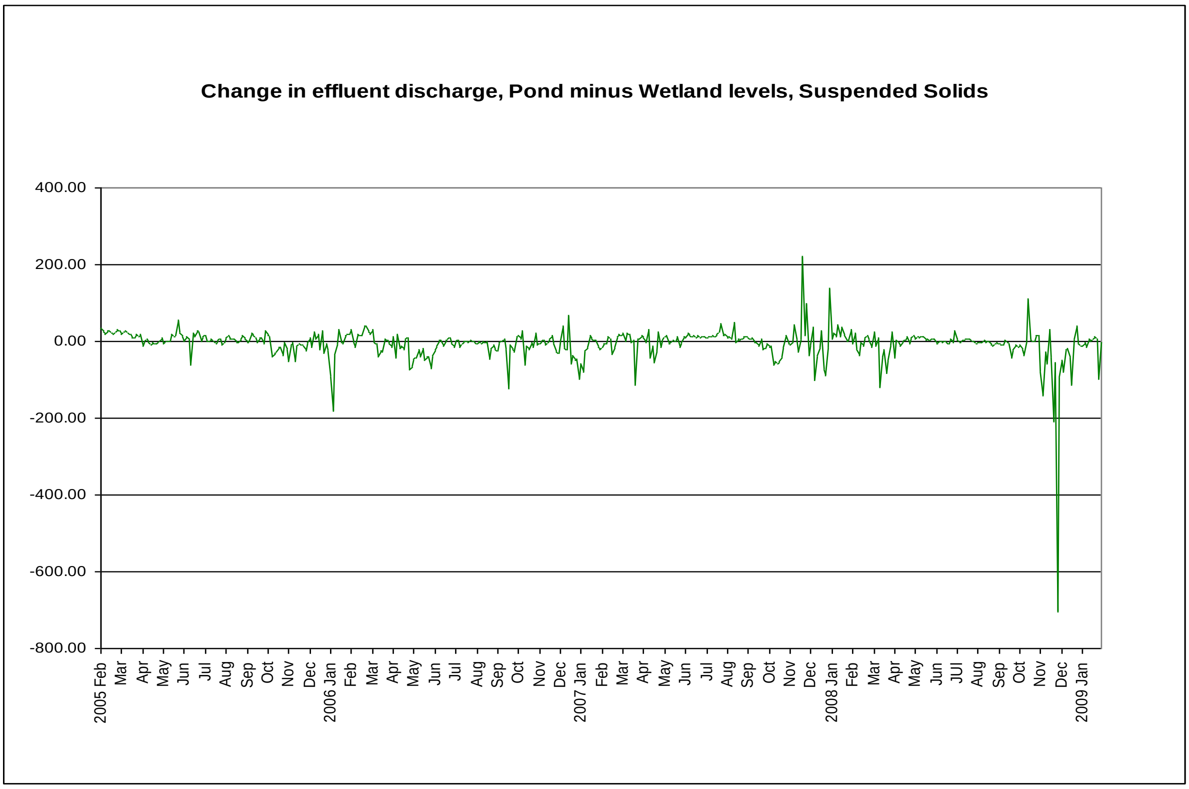


Figure 32. Change in Suspended Solids between pond outflow and wetlands outflow.
This shows a slight improvement occurring, typically 5-10g/m^3.

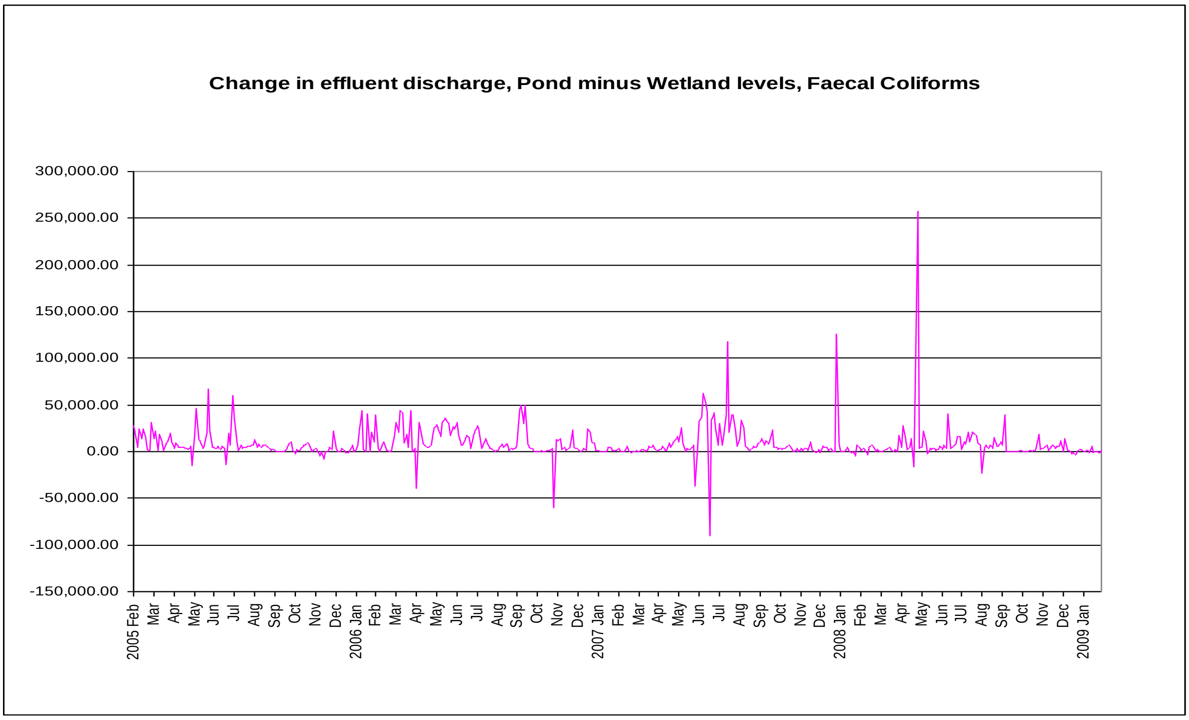


Figure 33. Change in Faecal coliform numbers between pond outflow and wetlands outflow
This shows a very significant improvement occurring, typically 1000 organisms / 100mL.

5.2.3 Overall Discharge Quality

Figure 34 below shows the quality of discharge of all the parameters measured at the point of discharge into the unnamed drain. These samples are taken monthly.

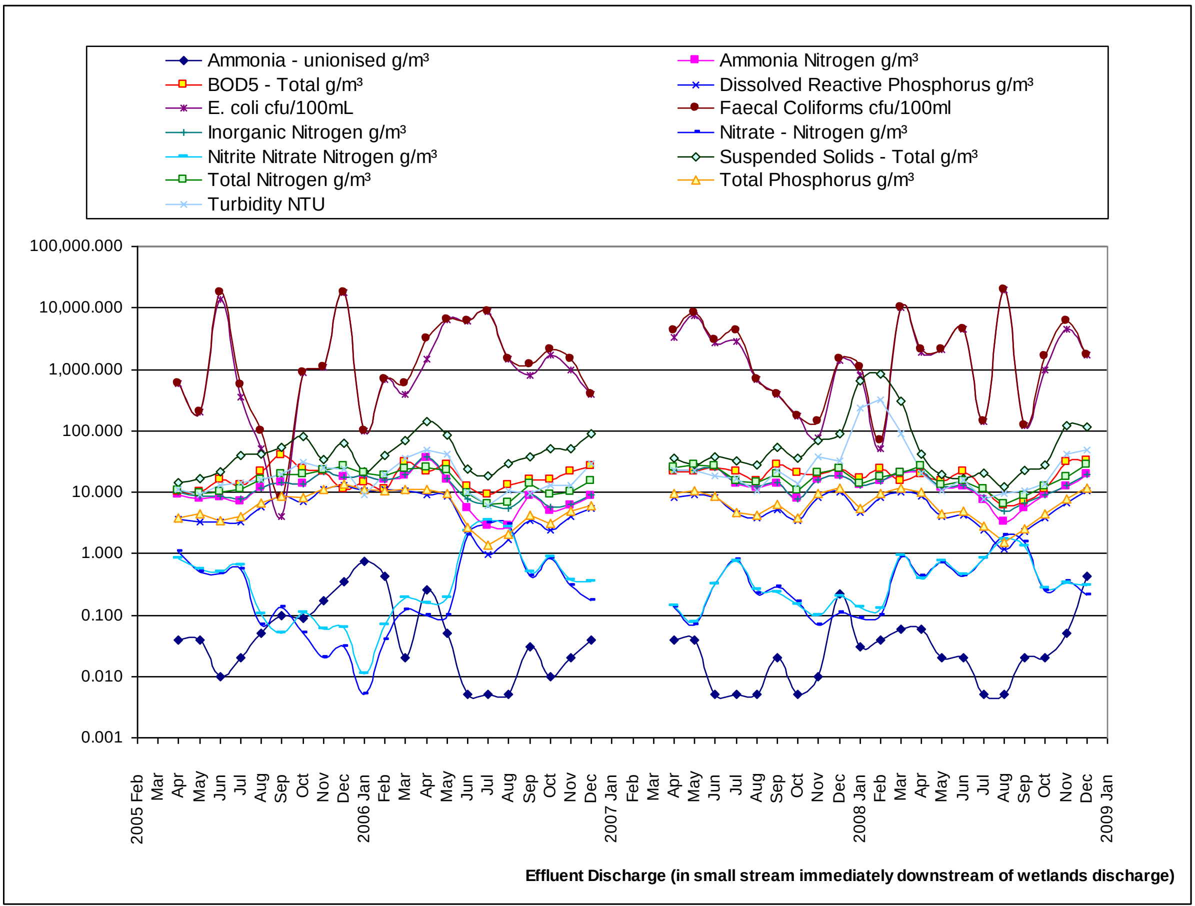


Figure 34. Effluent discharged into unnamed drain
Data gap is for duration of land irrigation when no effluent was discharged.

Figure 35 below provides a closer look at the discharge quality with respect to BOD, SS, and Faecal coliform bacteria. Compliance levels (mean) when discharge is to water are: 25g/m^3 BOD, 45g/m^3 SS, and 3000 cfu/100mL for faecal coliform bacteria. The chart shows BOD and SS mean levels slightly exceed these values while the mean faecal coliform level is well under 3000.

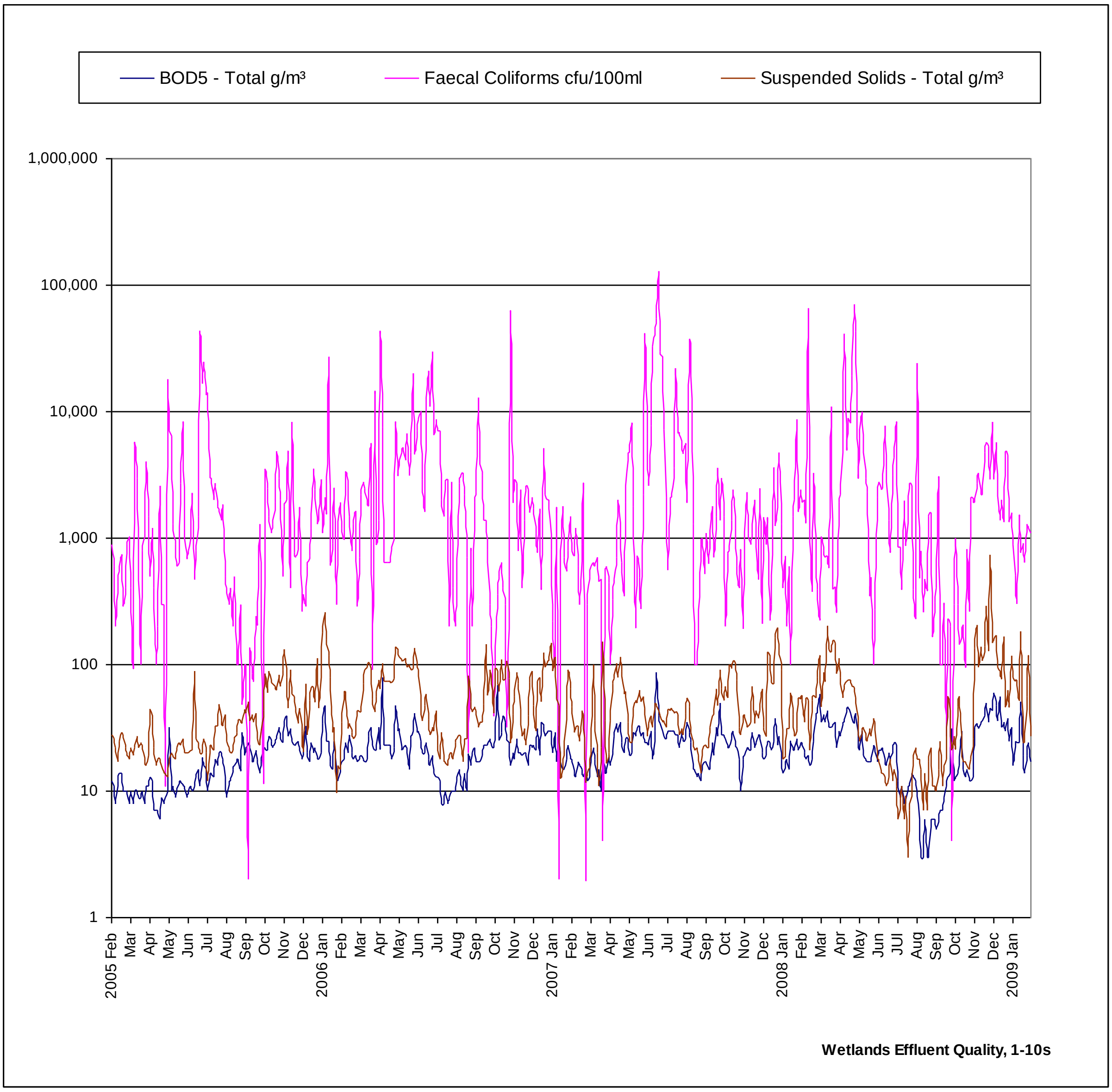


Figure 35. Wetlands effluent quality for the 3 parameters measured 10x/month, (BOD, SS and faecal coliform bacteria)

5.2.4 Stream Impact

The following five charts show the Mangatarere upstream and downstream of the point of discharge of the unnamed drain, as measured for concentration of the parameters monitored on a monthly basis, (first 3 charts), and for mass flow, (last 2 charts). The mass flow charts clearly show the dramatic reduction in contaminant levels when the discharge is to land, over the Jan-March inclusive period.

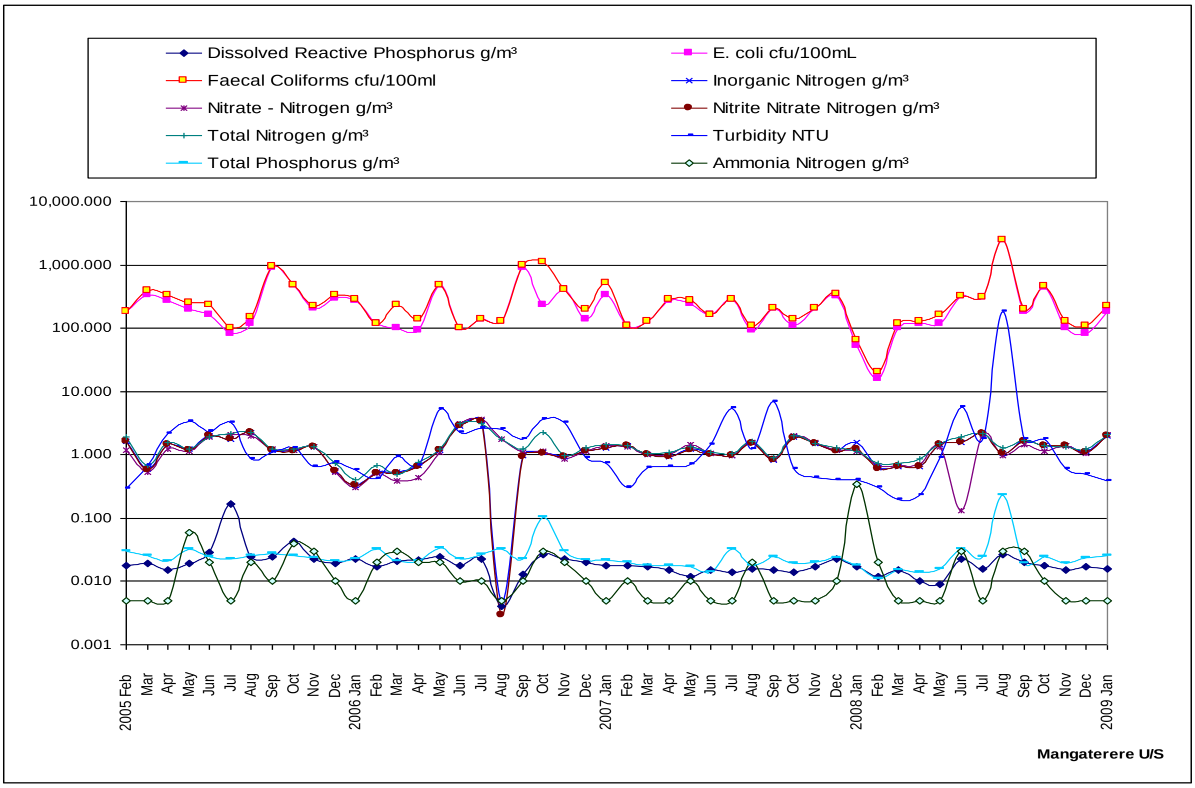


Figure 36. Mangatarere Stream water quality concentration upstream of the plant discharge.

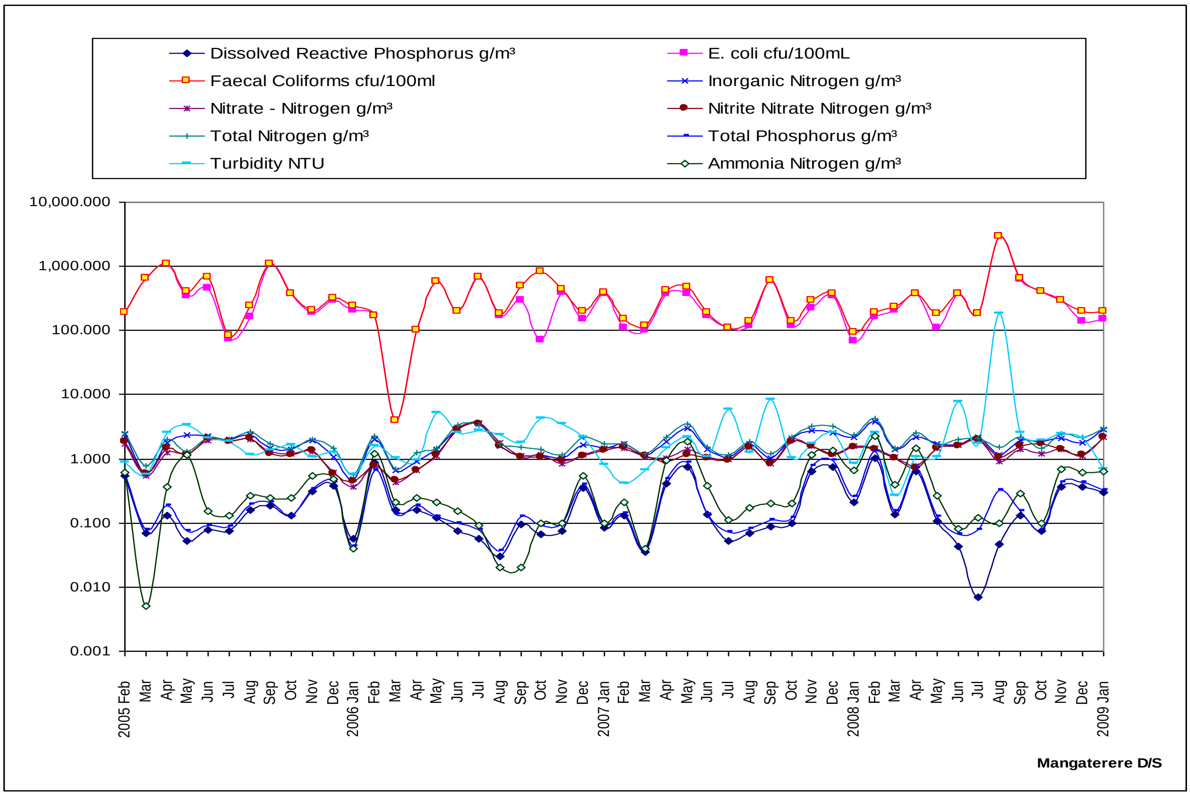


Figure 37. Mangatarere Stream water quality concentration downstream of the plant discharge.

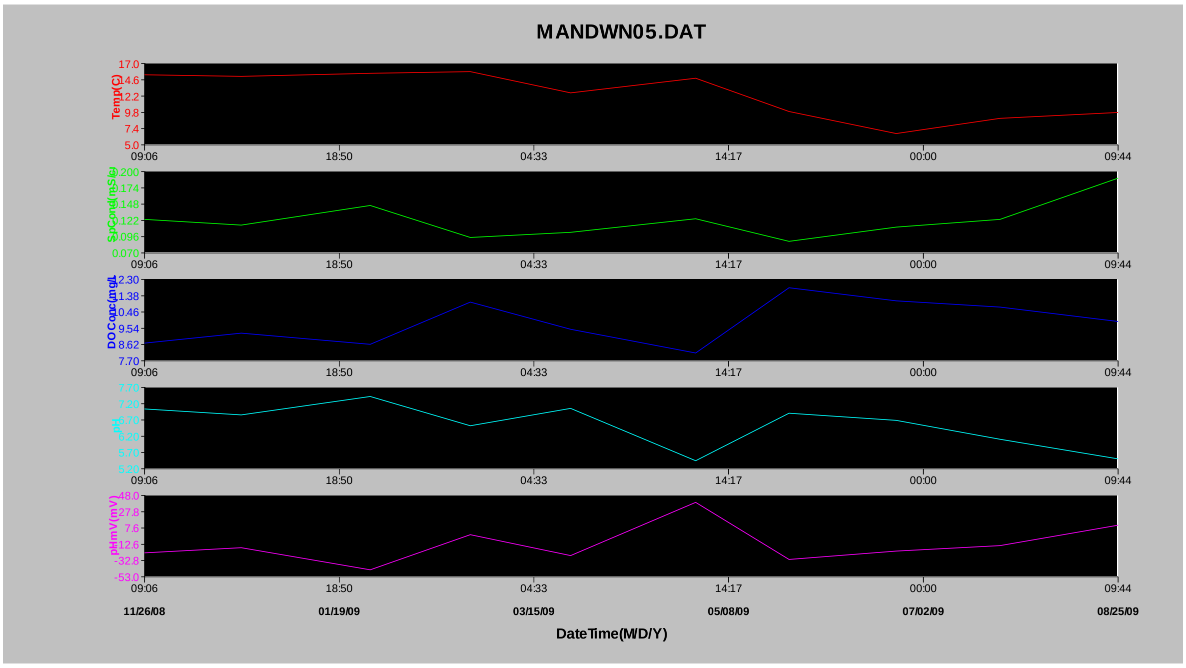


Figure 38: Field Measured Parameters – Mangatarere Stream Downstream Site 2008/2009

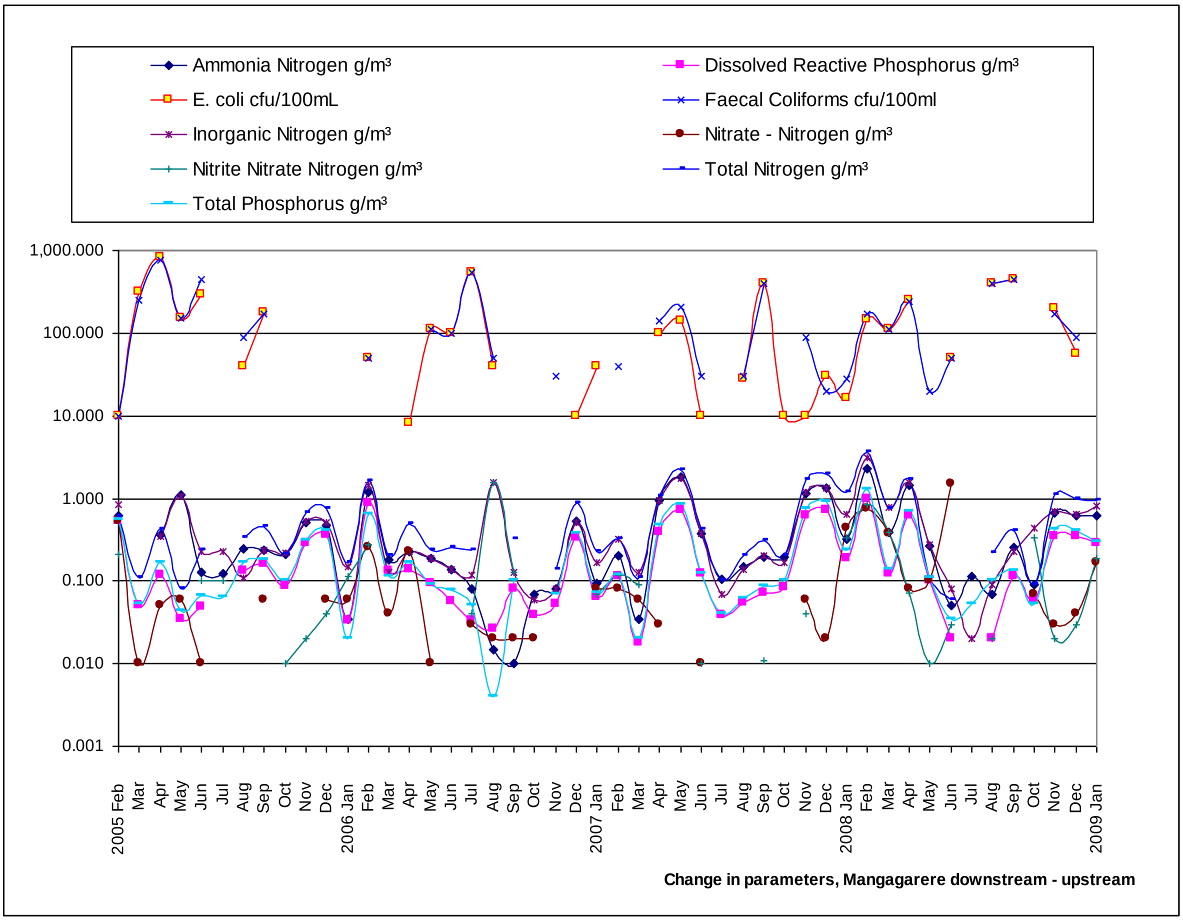


Figure 39. Mangatarere Stream water quality change concentration (downstream-upstream)

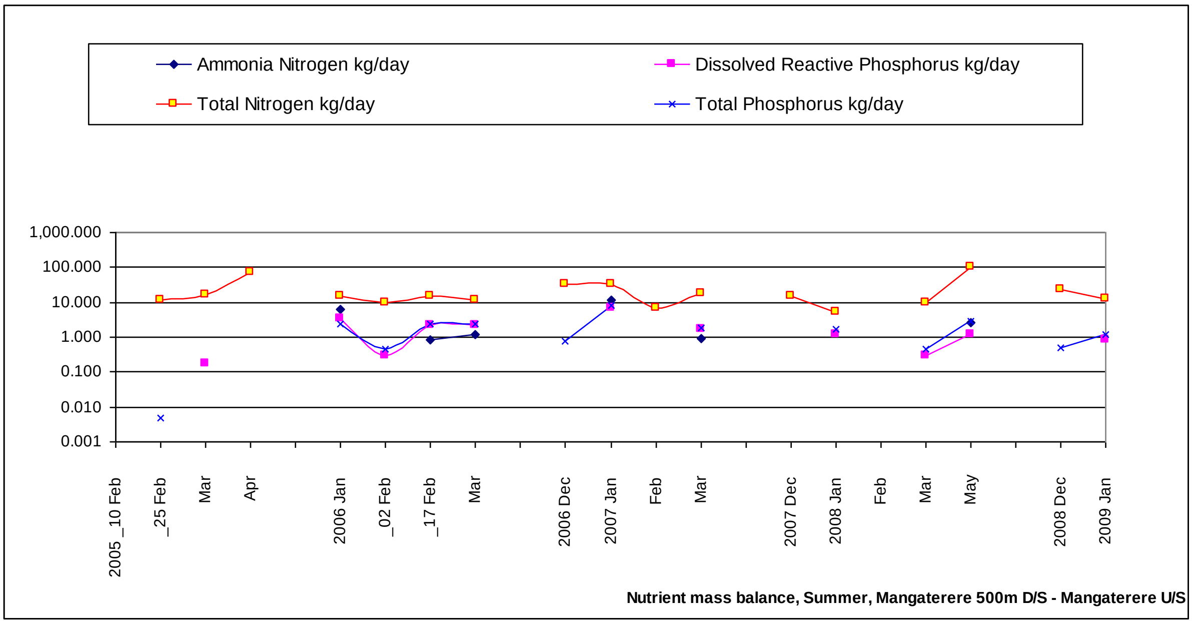


Figure 40. Mangatarere Stream sampling, mass balance water quality 500m DS - 50m US

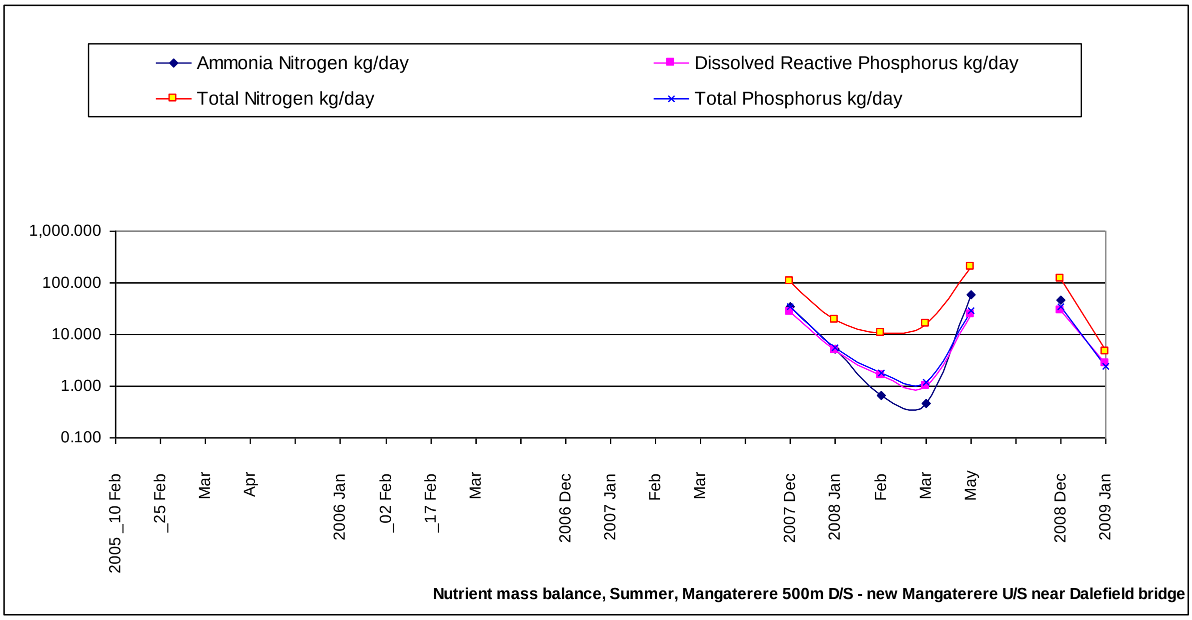


Figure 41. Mangatarere Stream sampling, mass balance water quality 500m DS - Dalefield US

Biota surveys are also undertaken on the receiving waters on a twice yearly basis, once in summer, (usually March), and again in spring, (September). Typically the reports note significant reductions in the Macroinvertebrate Community Index, Quantitative Macroinvertebrate Community Index, percentage Ephemeroptera, percent contribution of the dominant taxon and the EPT Index, downstream of the Carterton discharge relative to the upstream control site.

The stream in the vicinity of the plant is normally shallow, with a gravel bottom, flat gradient, and moderately vegetated and sheltered banks, as pictured in figure 42 below.

Figure 42. Views of the Mangaterer Stream, upstream (top), and dowenstream, (bottm) of the current discharge point.

The results of the 2008 biota survey reports - March and September 2008, were; *as* *of 12 March 2008, there were significant reductions of MCI, QMCI, percentage Ephemeroptera, the ratio of EPT to Chironomid abundance and the EPT Index downstream of the Carterton discharge relative to the upstream control site. This indicated that in keeping with recent summers, the discharge of treated wastewater from the Carterton Wastewater Treatment Plant continued to have a measurable adverse effect on instream community structure within the Mangatarere Stream.*

And for September 2008; *the upstream control site was moved 50 m upstream on this occasion to avoid the instream disturbance created by a ford across the river. This has also been the case during the winter of 2007 and the summer of 2008. As of 28 September 2008, there were significant reductions in all metrics of macroinvertebrate community structure (taxa richness, MCI, QMCI, percent Ephemeroptera, ratio of EPT to Chironomidae, percent contribution of the dominant taxon and the EPT Index) in the Mangatarere Stream downstream of the Carterton treated wastewater discharge relative to the upstream control site.*

The fact that a river ford used by agricultural machinery and stock is sited between the upstream and downstream sampling sites, (and therefore any impacts created by that ford will be assessed as an impact from the wastewater discharge) is not mentioned in the reports, but may be relevant.

The last two reports received at the time of submitting this AEE - (March and September 2008), are included in the AEE addenda and were sent to GW as separate documents to this report. The 2009 reports; March and October, have now been completed and have also been sent to GW. The March 2009 results stated; a*s of 18 March 2009, there were significant reductions of MCI, QMCI, percentage Ephemeroptera, the ratio of EPT to Chironomid abundance and the EPT Index downstream of the Carterton discharge relative to the upstream control site.*

This indicated that in keeping with recent summers, the discharge of treated wastewater from the Carterton Wastewater Treatment Plant continued to have a measurable adverse effect on instream community structure within the Mangatarere Stream.

The October results stated; *As of 9 November 2009, there were significant, although generally relatively minor reductions in QMCI, percent Ephemeroptera, ratio of EPT to Chironomidae and the percent contribution of the dominant taxon downstream of the Carterton treated wastewater discharge relative to the upstream control site. However, there were no significant differences in average taxa richness, MCI or the EPT Index.*

Generally therefore, conditions in the Mangatarere Stream downstream of the Carterton wastewater discharge were improved in the late winter of 2009 relative to previous years.

Mr Coffey noted that periphyton; *(a complex mixture of algae, cyanobacteria, heterotrophic microbes, and detritus that is attached to submerged surfaces),* levels were not high as the stream is primarily composed of small gravels which roll (and therefore remove growths), under relatively low velocity flows.

Mr Coffey also commented that the fish in the Mangatarere would be relatively unaffected by the discharge unless significant oxygen depletion occurred. Constituents in the discharge waters which could potentially impact on fish species, (both native and introduced) are; dissolved oxygen, turbidity, ammonia, taste causing compounds, and algae and algal exudates.

The table below identifies specific contaminants likely to have deleterious effects on fish species, critical levels and the levels created by the current discharge.

Parameter	Maximum desirable level	Typical effluent (WE = wetland effluent) or downstream level in Mangatarere (d/s) after influence by discharge
Turbidity (NTU)	3000 (LC 50) ANZECC 2000 5.6 Lowland rivers.	<5 (d/s)
Dissolved oxygen (g/m3)	6 min (trout – Proposed Waikato Regional Plan Variation #6).	7-10 (d/s)
Dissolved oxygen (% saturation)	98-105% ANZECC 2000 Lowland river	TBA (d/s)
Total ammonia - N	2300-320ug/L 80-99% species protection ANZECC 2000. Also pH and temp dependant 1610ug/L at pH 7.5	Not tested
Unionised ammonia	16 ug/L (based on 1% of total ammonia at 18 degrees (less at lower temperatures)	< 10ug/L (d/s)
Nitrate-N	12000-4900 ug/L (80=99% species protection ANZECC 2000 as recalculated by Chris Hickey NIWA).	2000ug/L (d/s)
Taste causing compounds	Not specified as such but some organics have T&O implications	Some testing of organics for UF trials, levels very low.
Algae	Not specified other than impact on clarity	Not tested
Algal toxins	Not specified	Not tested
Heavy metals	Various as per ANZECC 2000; Cu 1-2.5ug/L (80-99% protection), and Zinc; 2.4-31ug/L (80-99% species protection.	Cu 7ug/L (WE) Zn 15ug/L (WE)
pH	7.2 7.8 ANZECC 2000 Lowland river.	7.2-7.5

Table 10. Maximum desirable contaminant level Vs actual

It is of course overly simplistic to claim that if some critical level is not reached then there will be no effect on fish populations. Fish passage and habitat are influenced by a range of factors; water depth, current velocity, stream morphology, water quality and temperature and exposure to predation, to name a few.

However, it does appear that at least extreme values, (as tabulated above), are seldom reached and so fish passage through the Stream section immediately downstream of the discharge should not be greatly influenced. Fish habitat however is another matter and would require significant additional information to be gathered to make definitive statements on this matter.

The Mangatarere sampling points provide two sets of data (Man-up/Man-down – monthly samples) and 'Mangatarere upstream and downstream' more extensive monthly samples taken during the discharge to land. The former provide a greater number of data results and therefore better statistical representation of the environmental effect. Indicator parameters are indicated graphically and key parameters are tabulated below.

Summary statistics for effluent and receiving water data

	Ammonia Nitrogen g/m³	BOD5 - Total g/m³	Conductivity at 25°C mS/m	Dissolved Oxygen g/m³	Dissolved Reactive Phosphorus g/m³	E. coli cfu/100mL	Faecal Coliforms cfu/100ml	pH	Suspended Solids - Total g/m³	Total Nitrogen g/m³	Total Phosphorus g/m³	Turbidity NTU	Temperature
effluent discharge													
Minimum	2.74	6	55.7		0.982	4	8	6.7	12	6.24	1.39	6.09	9.5
Median	12.8	19	55.7		5.31	1050	1500	7.045	38.5	15.5	6.09	17.4	16.7
95th Percentile	22.955	30.95	55.7		10.795	13325	17220	7.615	298.7	26.39	11.885	88.26	18.2
Maximum	36.6	40	55.7		13.1	20000	20000	7.72	851	28	13.8	316	18.4
Number of results	42	42	1		42	42	42	6	42	42	42	42	5
Dalefield rd (summer)													
Minimum	0.005	0.5	9.4	3.1	0.008	32	36	6.1	2	0.2	0.009		
Median	0.005	0.5	12.5	9.1	0.017	120	130	6.8	2.75	0.99	0.02		
95th Percentile	1.899	2.375	37.32	9.71	0.0253	448	463	6.97	7.5	4.438	0.1265		
Maximum	2.7	3	47.7	9.8	0.028	490	490	7	9	5.38	0.17		
Number of results	7	6	7	7	7	7	7	7	6	7	7		
Mangatarere downstream(summer)													
Minimum	0.02	0.5	9.6	0.5	0.013	52	72	6.3	2	0.59	0.027	4.13	
Median	0.32	0.5	13.3	8.5	0.172	125	180	6.6	2.5	1.76	0.207	4.13	
95th Percentile	1.409	2.15	20.25	9.99	0.8227	992.5	1181	7.01	3	3.339	0.8863	4.13	
Maximum	2.39	3	23.4	11.7	1.36	3500	4700	7.1	3	4.32	1.51	4.13	
Number of results	19	18	19	19	19	18	18	19	18	19	19	1	
Man-up													
Minimum	0.005	0.5	10.600		0.004	16	20.000	6.5	2	0.400	0.011	0.2	9.1
Median	0.010	0.5	10.600		0.018	180	215.000	7.05	2.5	1.310	0.023	0.91	14.45
95th Percentile	0.037	0.825	10.600		0.028	753	975.500	7.172	9.55	2.243	0.034	5.631	15.6
Maximum	0.350	3	10.600		0.167	2500	2500.000	7.19	315	3.090	0.228	184	15.7
Number of results	48	48	1		48	48	48	7	48	48	48	48	6
Man-down													
Minimum	0.02	0.5	11.7		0.007	4	4	6.6	2	0.57	0.037	0.27	9
Median	0.25	0.5	11.7		0.1315	210	270	6.9	3	1.915	0.136	1.745	14.1
95th Percentile	1.435	2	11.7		0.751	997.5	1035	7.306	8.75	3.3275	0.839	7.335	15.45
Maximum	2.28	4	11.7		1.01	2900	2900	7.42	321	4.34	1.28	186	15.5
Number of results	46	46	1		46	46	46	7	46	46	46	46	6
mixed-500m - summer- no discharge													
Minimum	0.03	0.5	9.7	6	0.031	80	120	6.3	2	0.59	0.039		
Median	0.08	0.5	12.9	9.1	0.136	150	210	6.7	2.5	1.37	0.157		
95th Percentile	0.525	1.1	14.91	10.89	0.3257	565	706	6.9	3	2.323	0.371		
Maximum	0.57	2	16.8	18.9	0.521	700	760	6.9	3	2.62	0.605		
Number of results	19	19	19	19	19	19	19	19	18	19	19		

Table 11. Summary statistics for effluent and receiving water data

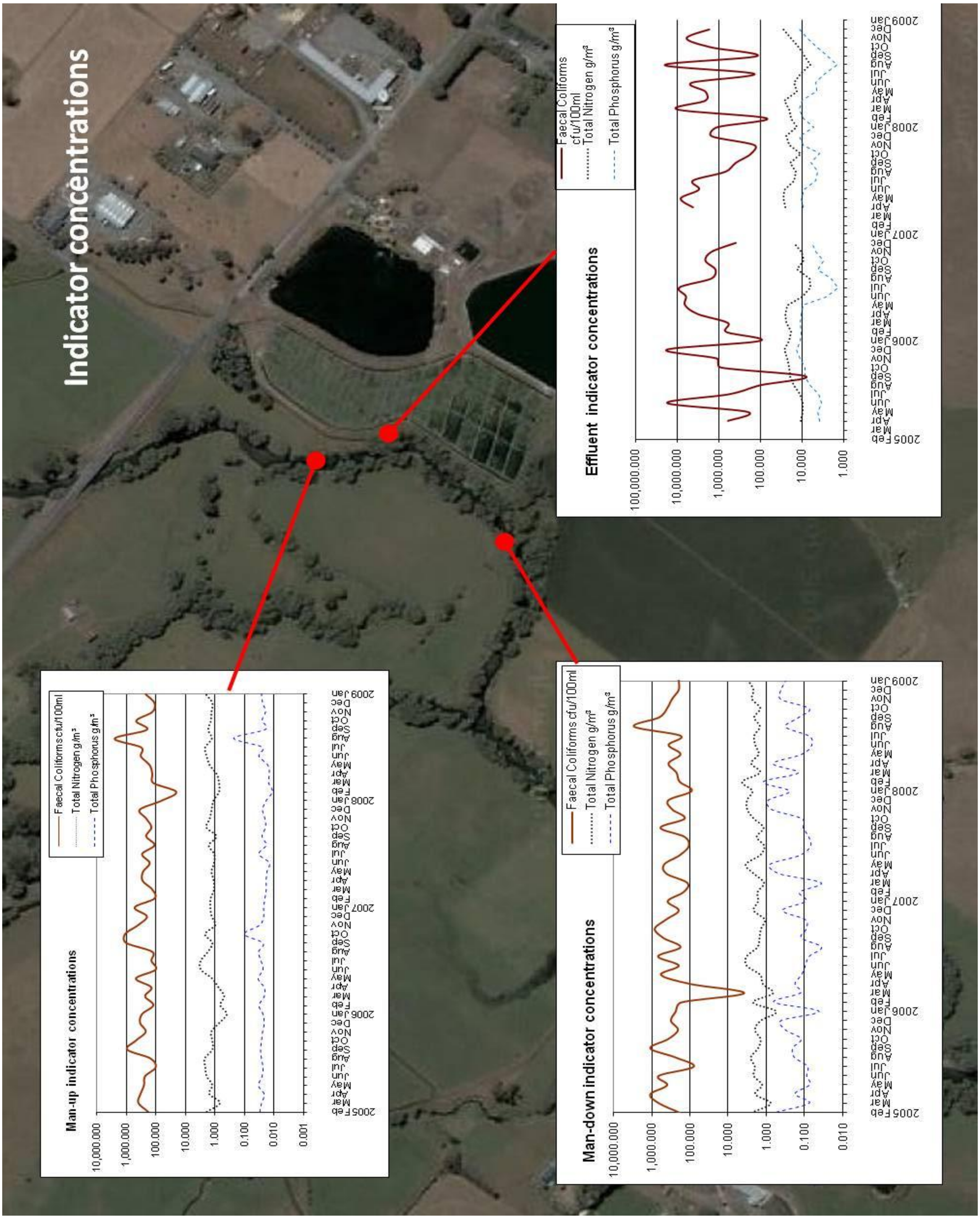


Figure 43. Overview (indicator) contaminant concentrations upstream/downstream

The percentage change between upstream and downstream of the discharge is shown in table 12:

Percentage change in key parameters Man-up/Man-down sampling points

	Ammonia Nitrogen g/m³	Dissolved Reactive Phosphorus g/m³	E. coli cfu/100mL	Faecal Coliforms cfu/100ml	Inorganic Nitrogen g/m³	Nitrate - Nitrogen g/m³	Nitrite Nitrate Nitrogen g/m³	Total Nitrogen g/m³	Total Phosphorus g/m³
SUMMARY STATS									
Minimum	0%	-56%	-96%	-98%	-2%	-8%	-12%	-36%	-9%
Median	1950%	623%	14%	19%	24%	2%	1%	25%	569%
95th Percentile	18750%	5672%	285%	230%	260%	54%	59%	182%	4538%
Maximum	29100%	8317%	900%	850%	31500%	1154%	51900%	495%	11536%
Number of results	48	48	48	48	48	48	48	48	48

Table 12. Percentage change in key parameters Man-up/Man-down

It should be noted that these results include data from since 2005. Whilst the monitoring upstream of Dalefield road and just upstream of the Kaipatangata confluence are likely to be the preferred long-term monitoring sites, the limited data set hinders statistical analysis. This year's data may provide a suitable data set. Since 2005, works have been progressively carried out, with positive effects on the effluent quality, and notably cessation of discharge to water during the summer months. The full data set may therefore be skewed in a negative light by earlier results.

The results from the full data set indicate an increase in pathogens (median 19%) downstream of the treatment works, although in terms of contact recreation there is no discharge to water during the summer from the treatment works bar significant rainfall events. There is therefore some loss of amenity attributable to the discharge (for Winter/Spring/Autumn river users); however the discharge has only minor effect on primary contact recreation (swimming) under the current discharge regime.

In terms of stock watering, the discharge causes a further loss of quality although the upstream quality is already sufficiently degraded to fail stock watering target values (Fig. 42).

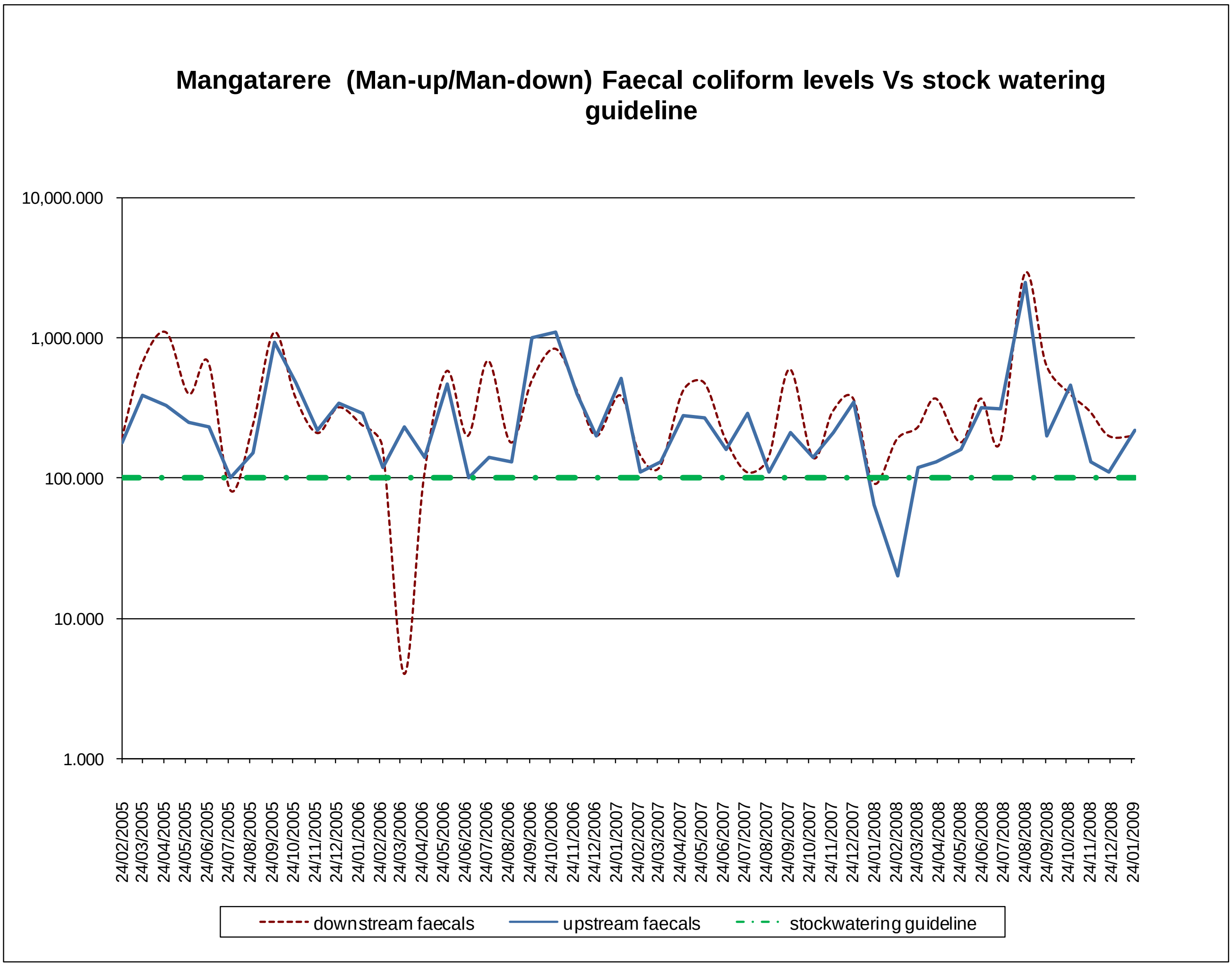


Figure 44. Mangatarere faecal coliform levels Vs stock watering guideline

All data points are held in the attached excel spreadsheet, however in addition a summary of nutrient loads is included below. Figures indicate the change in nutrient load in kg/d between the Man-up site and the site 500m downstream of the Kaipatangata confluence during summer conditions.

Mass balance statistics 500m D/S minus Man-up	Ammonia Nitrogen kg/day	Dissolved Reactive Phosphorus kg/day	Total Nitrogen kg/day	Total Phosphorus kg/day
Minimum	-6.77	-2.59	-2.49	-2.91
Median	-1.09	0.29	14.57	0.63
95th Percentile	6.92	3.84	77.75	3.67
Maximum	11.43	7.11	101.25	8.01
Number of results	18	18	18	18

In summary then, the following effects on the stream water quality with respect to indicator bacteria and nutrients are evident:

- A slight increase in indicator bacteria occurs, however, levels both upstream and downstream are generally above stock watering guideline values from ANZECC 2000 – 100 E. coli / 100mL. The recreational water quality, as per the Microbiological Guidelines for Recreational Water Quality – MfE 2003; (again both upstream and downstream rate the same), is categorised as Sanitary Inspection Category High, and the Microbiological Assessment Category D, giving a suitability for recreation of very poor.

- A significant increase in total nitrogen levels, but these are already in excess of desirable values to minimise nuisance algae growth in the upstream samples - (default trigger value - lowland stream 0.614g/m3 – ANZECC 2000). This increase is less evident during summer time discharge to land.

- A significant increase in phosphorus levels, which are also typically above desirable values to control nuisance algal growth, (default trigger value – lowland stream 0.033g/m3 – ANZECC 2000), even in the upstream samples, although this increase is less evident when summer time land disposal is occurring, in spite of the lower river flows.

5.3 Effects on groundwater

Monitoring of impact on groundwater is undertaken at a number of locations under different monitoring regimes. These are tabulated below, along with the sampling frequency and duration of records, and their location is shown in figure 30, page 55.

Bores	Frequency of Monitoring	Period of Results
New Wetland, New MT (MT6), upgraded MT5	Monthly	Since Jan 2008
Previous bores; LF8, MT5, TP3, LF9.	Monthly	2004-2009
McLennan and Fitzgerald	3 months per year during irrigation	2004-2007

In summarising the bore monitoring statistics, as tabulated below; there are a limited number of results for the new bores (Wetland and MT6 – 5 samples), and for the now discontinued remote Fitzgerald and Mclenan Bores – (7 samples), however, bores MT5, LF8, LF9 and TP3 have more numerous data records, (48 samples). Monitoring statistics for the individual bores are tabulated below.

Summary of monitoring result statistics wetlands Bore

	SiteNameAddress	Ammonia Nitrogen g/m³	BOD5 - Total g/m³	Conductivity at 25°C mS/m	Dissolved Oxygen g O2/m³	Dissolved Reactive Phosphorus g/m³	E. coli cfu/100mL	Faecal Coliforms cfu/100ml	Nitrate - Nitrogen g/m³	pH	Suspended Solids - Total g/m³	Total Nitrogen g/m³	Total Phosphorus g/m³
SUMMARY STATS													
Minimum	Wetlands Bore	3.83	3	43.3	0.3	1.03	110	140	0.01	6.1	21	7.43	1.61
Median	Wetlands Bore	5.06	6	53	0.5	1.45	800	1000	0.01	6.4	37	9.92	2.75
95th Percentile	Wetlands Bore	9.61	28	65.2	0.9	4.22	3200	3200	0.63	6.6	950	10.5	5.81
Maximum	Wetlands Bore	9.65	32	66	0.9	4.41	3700	3700	0.67	6.6	1110	10.6	6.1
Number of results	Wetlands Bore	5	4	5	5	5	5	5	5	5	4	5	5

Summary of monitoring result statistics Bore MT6

	SiteNameAddress	Ammonia Nitrogen g/m³	BOD5 - Total g/m³	Conductivity at 25°C mS/m	Dissolved Oxygen g O2/m³	Dissolved Reactive Phosphorus g/m³	E. coli cfu/100mL	Faecal Coliforms cfu/100ml	Nitrate - Nitrogen g/m³	pH	Suspended Solids - Total g/m³	Total Nitrogen g/m³	Total Phosphorus g/m³
SUMMARY STATS													
Minimum	MT6	0.11	1	39.5	0.5	0.011	65	73	0.01	5.6	8	5.41	0.073
Median	MT6	2.15	11	48.1	1.5	0.046	750	1090	1.93	6.1	1320	10.4	0.503
95th Percentile	MT6	4.84	21	54.8	1.7	0.09	3665	3725	23.4	6.2	29112	25.8	21.13
Maximum	MT6	5.13	22	55.7	1.7	0.097	4100	4100	26.9	6.2	32200	27.7	24.7
Number of results	MT6	4	3	4	4	4	4	4	4	4	3	4	4

Summary of monitoring result statistics Bore MT5

	SiteNameAddress	Ammonia - unionised g/m³	Ammonia Nitrogen g/m³	Arsenic - Acid Soluble g/m³	BOD5 - Total g/m³	Conductivity at 25°C mS/m	Dissolved Reactive Phosphorus g/m³	E. coli cfu/100mL	Faecal Coliforms cfu/100ml	Inorganic Nitrogen g/m³	Nitrate - Nitrogen g/m³	Nitrite Nitrate Nitrogen g/m³	pH	Suspended Solids - Total g/m³	Total Nitrogen g/m³	Total Phosphorus g/m³	Turbidity NTU	Temperature
SUMMARY STATS																		
Minimum	MT 5	0.005	0.01		0.5	23.7	0.004	2	2	0.24	0.01	0.004	5.6	9	0.63	0.031	5.09	13.1
Median	MT 5	0.005	0.13		2	27.9	0.012	6	6	0.62	0.42	0.398	6.1	124	1.36	0.161	59	13.1
95th Percentile	MT 5	0.005	2.38		12	31.6	0.027	5100	7360	6.63	6.32	6.209	6.3	747	6.68	0.504	376	13.1
Maximum	MT 5	0.02	84.1		205	35.4	0.901	41000	41000	84.8	7.58	6.92	6.4	1370	8.28	0.935	798	13.1
Number of results	MT 5	48	48		48	48	48	48	48	48	48	48	48	48	48	48	48	1

Summary of monitoring result statistics Bore TP3

	SiteNameAddress	Ammonia - unionised g/m³	Ammonia Nitrogen g/m³	BOD5 - Total g/m³	Conductivity at 25°C mS/m	Dissolved Reactive Phosphorus g/m³	E. coli cfu/100mL	Faecal Coliforms cfu/100ml	Inorganic Nitrogen g/m³	Nitrate - Nitrogen g/m³	Nitrite Nitrate Nitrogen g/m³	pH	Suspended Solids - Total g/m³	Total Nitrogen g/m³	Total Phosphorus g/m³	Turbidity NTU	Temperature
SUMMARY STATS																	
Minimum	TP 3	0.01	3.02	1	23.1	0.24	2	2	5.47	0.01	0.003	5.8	2.5	6.18	0.554	3.57	9
Median	TP 3	0.01	10.8	3	50	2.86	36	40	12	0.23	0.223	6.3	24	12.1	4.81	15.3	9
95th Percentile	TP 3	0.02	18.2	16	67.4	6.382	476	549	19.6	4.5	4.578	6.6	83	19.1	8.462	47.7	9
Maximum	TP 3	0.02	19.7	25	77.3	8.29	3400	3600	24.6	14	21.6	6.8	338	22.5	10	88.9	9
Number of results	TP 3	47	47	47	47	47	47	47	47	47	47	47	47	47	47	46	1

Summary of monitoring result statistics Bore LF8

	SiteNameAddress	Ammonia - unionised g/m³	Ammonia Nitrogen g/m³	BOD5 - Total g/m³	Conductivity at 25°C mS/m	Dissolved Reactive Phosphorus g/m³	E. coli cfu/100mL	Faecal Coliforms cfu/100ml	Inorganic Nitrogen g/m³	Nitrate - Nitrogen g/m³	Nitrite Nitrate Nitrogen g/m³	pH	Suspended Solids - Total g/m³	Total Nitrogen g/m³	Total Phosphorus g/m³	Turbidity NTU	Temperature
SUMMARY STATS																	
Minimum	Landfill 8	0.01	0.01	0.5	6.5	0.017	2	2	1.43	1.42	1.43	5.1	2.5	1.8	0.024	0.19	11.2
Median	Landfill 8	0.01	0.01	0.5	16.4	0.025	2	2	5.65	6.19	5.6	5.6	10	5.65	0.04	5.59	11.2
95th Percentile	Landfill 8	0.01	0.17	1.5	23.4	0.075	114	114	11.1	11.6	10.5	6	417	11	0.246	368	11.2
Maximum	Landfill 8	0.01	17.5	2	26.5	3.61	64000	64000	19.7	64.5	12	6.1	490	12.2	0.509	565	11.2
Number of results	Landfill 8	47	46	47	47	47	47	47	47	47	47	47	47	47	47	47	1

Summary of monitoring result statistics Bore LF9

	SiteNameAddress	Ammonia - unionised g/m^3	Ammonia Nitrogen g/m^3	BOD5 - Total g/m^3	Conductivity at 25°C mS/m	Dissolved Reactive Phosphorus g/m^3	E. coli cfu/100mL	Faecal Coliforms cfu/100ml	Inorganic Nitrogen g/m^3	Nitrate - Nitrogen g/m^3	Nitrite Nitrate Nitrogen g/m^3	pH	Suspended Solids - Total g/m^3	Total Nitrogen g/m^3	Total Phosphorus g/m^3	Turbidity NTU	Temperature
SUMMARY STATS																	
Minimum	Landfill 9	0.01	0.01	0.5	15.5	0.021	2	2	1.11	0.94	1.1	5.3	2.5	1.24	0.029	0.41	10.8
Median	Landfill 9	0.01	0.01	0.5	24.1	0.094	15.5	16	5.69	6.29	5.67	5.8	34	5.88	0.133	9.72	10.8
95th Percentile	Landfill 9	0.01	0.04	1	30.3	0.214	3130	3200	9.44	9.81	9.43	6.1	302	9.3	0.307	130	10.8
Maximum	Landfill 9	0.01	0.04	5	35.9	0.258	65000	65000	13.1	14	13.1	6.1	576	13.3	0.68	228	10.8
Number of results	Landfill 9	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	1

Summary of monitoring result statistics Fitzgerald Bore

	SiteNameAddress	Ammonia - unionised g/m^3	Ammonia Nitrogen g/m^3	BOD5 - Total g/m^3	Conductivity at 25°C mS/m	Dissolved Reactive Phosphorus g/	E. coli cfu/100mL	Faecal Coliforms cfu/100ml	Inorganic Nitrogen g/m^3	Nitrate - Nitrogen g/m^3	Nitrite Nitrate Nitrogen g/m^3	pH	Suspended Solids - Total g/m^3	Total Nitrogen g/m^3	Total Phosphorus g/m^3	Turbidity NTU
SUMMARY STATS																
Minimum	Fitzgerald	0.01	0.01	0.5	12.3	0.022	2	2	1.78	1.95	1.78	5.9	2.5	1.93	0.021	0.08
Median	Fitzgerald	0.01	0.01	0.5	13.1	0.026	2	2	2.12	2.08	2.12	6.1	2.5	2.09	0.028	0.23
95th Percentile	Fitzgerald	0.01	0.01	0.5	14.3	0.049	2	2	3.17	3.41	3.164	6.2	3	2.78	0.056	0.67
Maximum	Fitzgerald	0.01	0.01	0.5	14.6	0.059	2	2	3.48	3.81	3.47	6.2	3	2.9	0.068	0.72
Number of results	Fitzgerald	7	7	7	7	7	7	7	7	7	7	7	7	7	7	6

Summary of monitoring result statistics McClenan Bore

	SiteNameAddress	Ammonia - unionised g/m^3	Ammonia Nitrogen g/m^3	BOD5 - Total g/m^3	Conductivity at 25°C mS/m	Dissolved Reactive Phosphorus g/m^3	E. coli cfu/100mL	Faecal Coliforms cfu/100ml	Inorganic Nitrogen g/m^3	Nitrate - Nitrogen g/m^3	Nitrite Nitrate Nitrogen g/m^3	pH	Suspended Solids - Total g/m^3	Total Nitrogen g/m^3	Total Phosphorus g/m^3	Turbidity NTU
SUMMARY STATS																
Minimum	McClennan	0.01	0.01	0.5	13.8	0.027	2	2	0.56	0.58	0.544	6	2.5	0.58	0.026	0.15
Median	McClennan	0.01	0.01	0.5	14.2	0.11	2	2	0.78	0.79	0.783	6.3	2.5	0.84	0.106	0.25
95th Percentile	McClennan	0.01	0.13	1.2	15.4	0.166	2	2	3.21	3.23	3.21	6.6	3	3.1	0.187	0.4
Maximum	McClennan	0.01	0.18	1.5	15.5	0.166	2	2	4.05	4.05	4.05	6.7	3	3.88	0.194	0.41
Number of results	McClennan	7	7	7	7	7	7	7	7	7	7	7	7	7	7	6

The 6 charts below show the water quality as measured in the six bores regularly monitored; fully upstream; (LF8), partly upstream (LF9), downstream (established bore TP3 – in the middle of the wetlands), well down stream in an adjoining field (MT5), as well as the two new bores which have very limited data (wetlands bore on unnamed drain side of wetlands, and MT6 immediately adjacent to ponds). The location of these bores is shown in figure 30 on page 55.

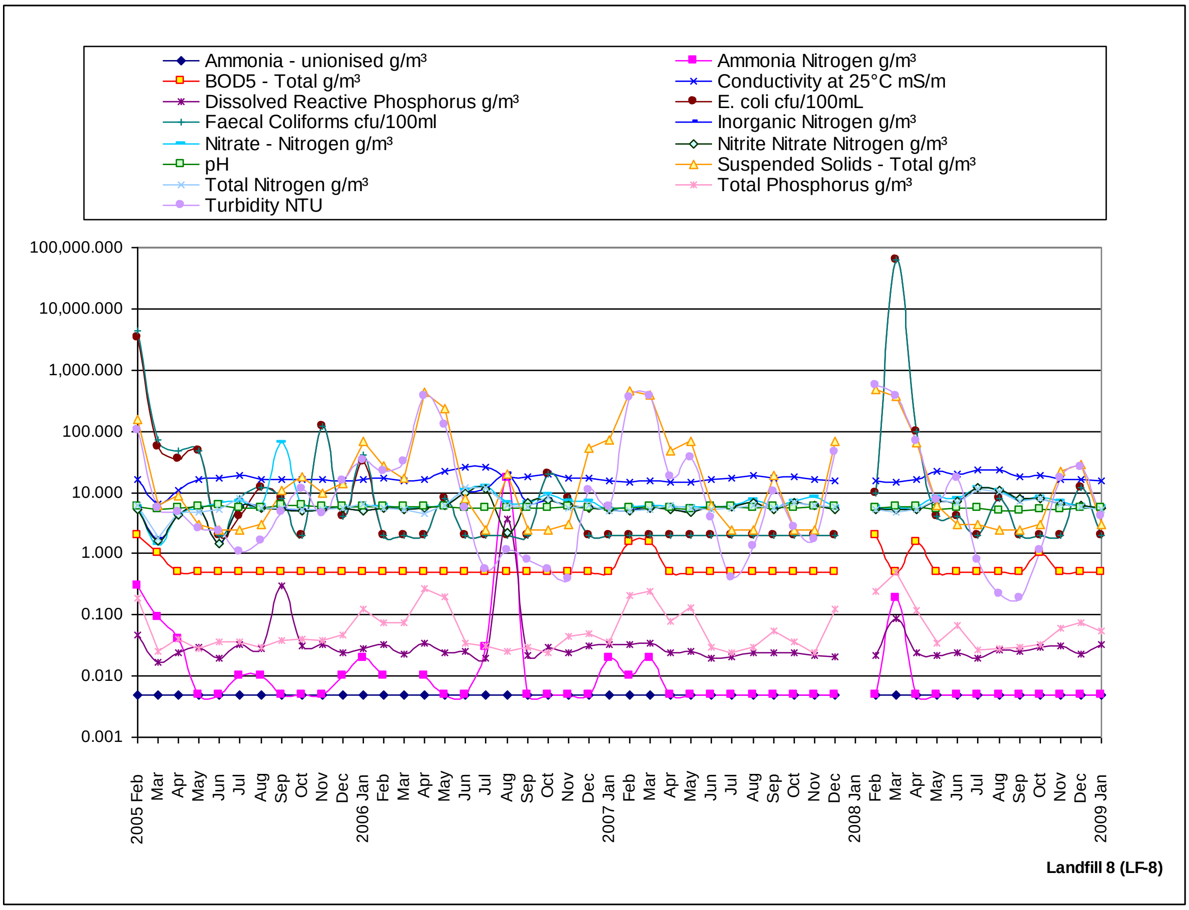


Figure 45. Bore monitoring landfill 8 – upstream of any wastewater irrigation or landfill influences

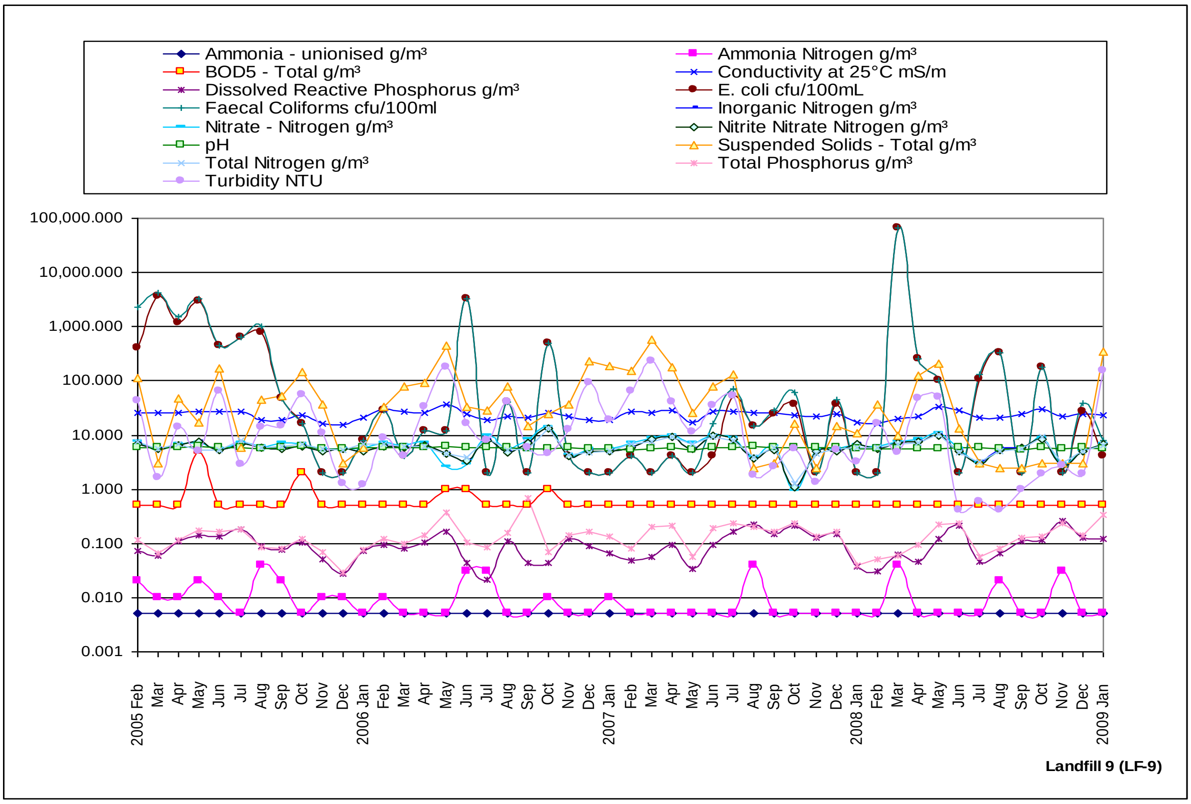


Figure 46. Bore monitoring landfill 9 – partly upstream – may be influenced by land irrigation

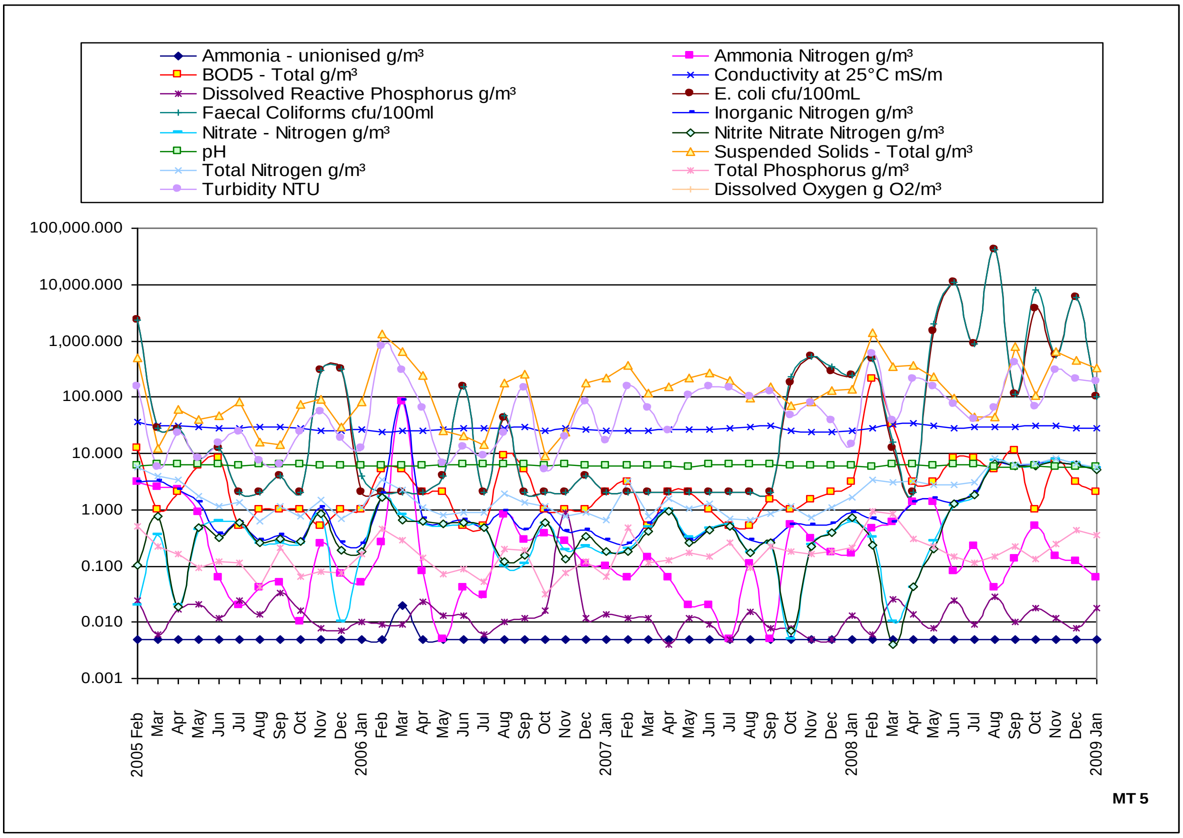


Figure 47. Bore monitoring MT5 – downstream and well to the south – could be influenced by landfill

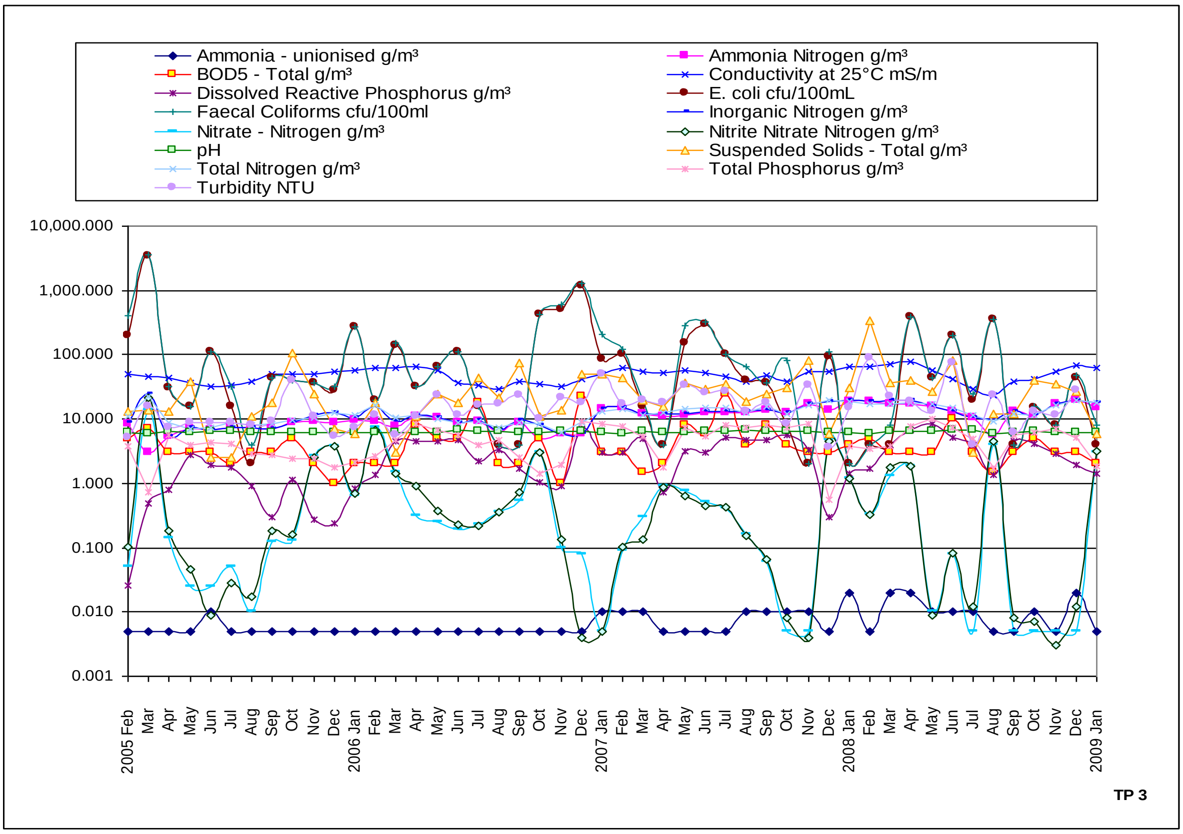


Figure 48. Bore monitoring TP3 – in centre of wetlands

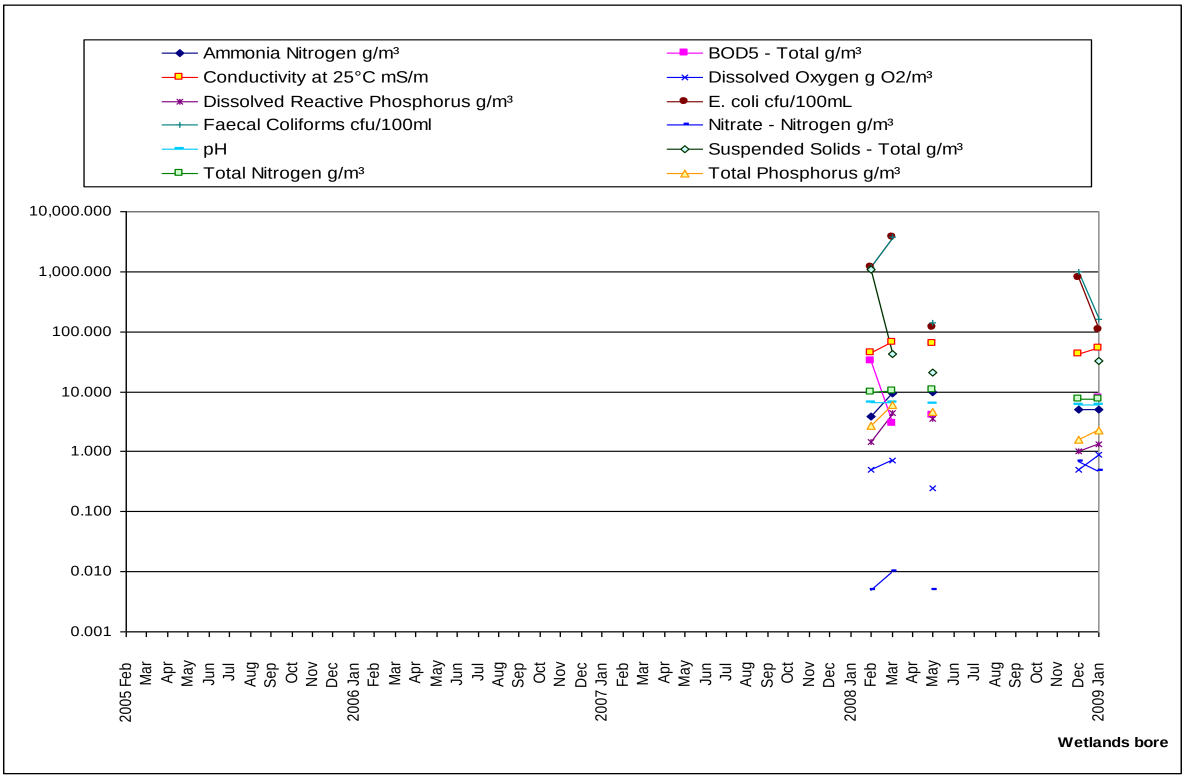


Figure 49. Bore monitoring wetlands bore – between wetlands and unnamed stream (new bore, limited data)

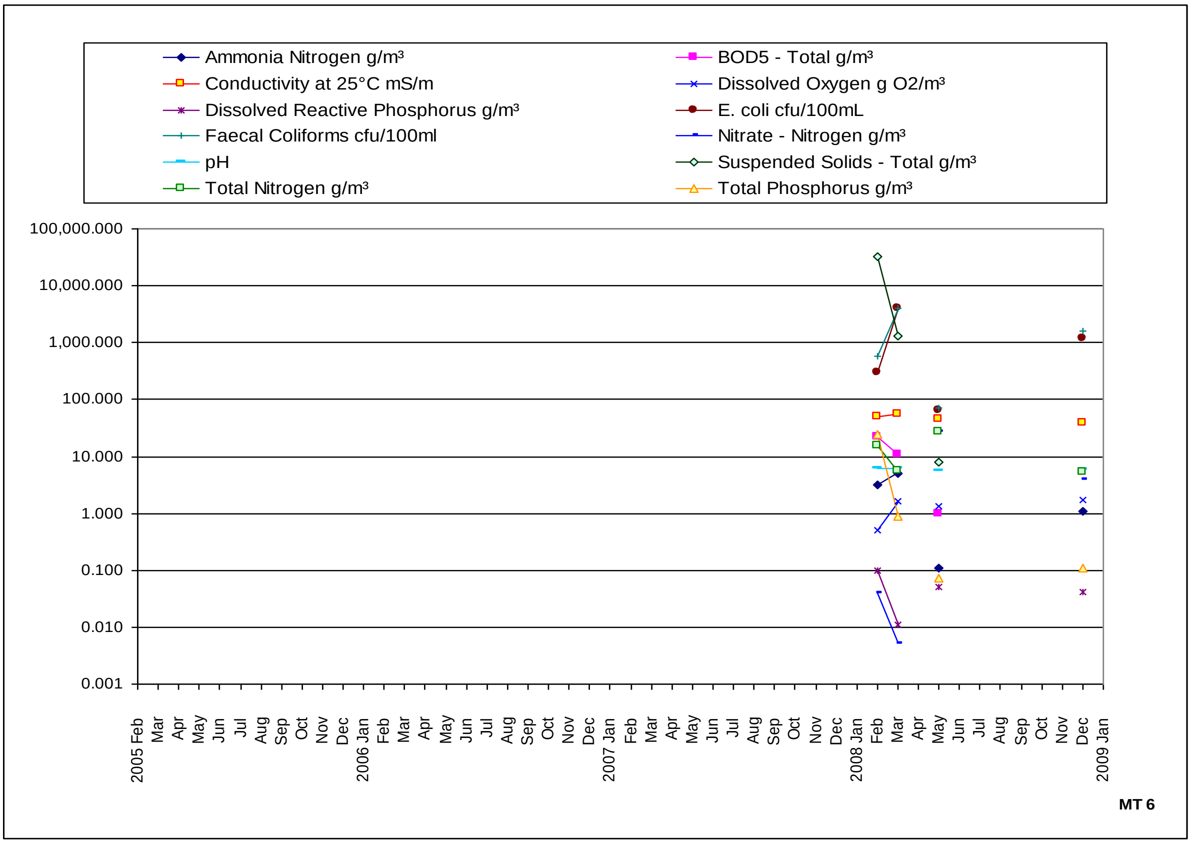


Figure 50. Bore monitoring MT6 – new bore – on boundary adjacent to ponds (limited data)

Although the new bores, (wetlands bore and MT6), have only been in for one full summer season, results show quite modest impacts on the sampled groundwater. For example, for bore MT6, located to the south and still within the council compound of ponds 2 and 3, (refer figure 30), following ”bedding in” during summer 2008, summer 2009 data shows typical values of; total phosphorus of 0.1g/m^3, total nitrogen <10g/m^3, ammonia 1g/m^3, and E coli and faecal coliforms around 1000g/m^3. For the wetlands bore, which was located further to the south than indicated in the consent due to the inability to access the chosen site with a drilling rig, summer 2009 results were similar with nitrogen species, (predominately ammonia and total nitrogen), being < 10g/m^3, (NO3 < 1g/m^3), total phosphorus <5 g/m^3, and E coli < 1000 cfu/mL.

With this data taken in concert with the results of previous attempts to measure any flow reductions, (indicative of leakage), from passing through the various plant components; ponds, wetlands, and the lack of a major measurable impact on the stream water quality, (Figures 39-41), during discharge to land periods, it appears that subsurface leakage is not a major contaminant pathway to the Mangatarere Stream.

5.4 Effects on land

Soil samples have been taken from irrigation of land areas, after a period of 3 years irrigation in both surface and subsurface irrigation areas. These have been analysed for a range of elements at varying depths and have shown an increase in nutrient levels, but no significant accumulation of elemental contaminants such as heavy metals.

Results of the sampling rounds undertaken in March / April 2007, after 3 years of summer time irrigation are given in table 13 below. Results are in % by weight, so 0.001% is 10mg/kg. The location of the holes is shown on the following plan, figure 51. The plan shows the location of auger holes, (1-8 and background), and test pits A and B.

The background sample is taken in land which, (although located between two oxidation ponds), is well remote from the land irrigation areas and does not have fertilizer applied to it.

Figure 51. Location of Soil Sample Sites in Relation to Irrigated Areas

The analyses are by x-ray diffraction which provides an elemental concentration of all elements with atomic weight above nitrogen. Of these, the constituents which might be expected to accumulate due to wastewater irrigation are:

N (not measured), P, S, Cu, and Zn. Furthermore, if there was accumulation of these constituents in the soils, this would be expected to reduce with depth, as the material in question was gradually “filtered” out in passage through the site soils. The actual processes involved in “filtration” could be physical, chemical or biological in nature – including; precipitation and co-precipitation, ad and absorption, biologically mediated transformation and ion exchange as well as physical filtration, and their impact would be expected to be soil type dependant but typically would be expected to cause the greatest removal, (and therefore concentration), in the upper layers of the soil, decreasing with depth.

The level of increase expected would be proportional to the dose applied less any natural transformation or removal processes, for example; de-nitrification for nitrogen removal or plant uptake for phosphorus removal. When the levels of these constituents in the final effluent are calculated, alone with the application rate, the theoretical increase in concentration can be determined. If this is calculated for phosphorus; at say 10g/m^3 P in the effluent applied, applied at a rate of 10mm/d for 3 years at 3 months per year, this would give 2.7m^3/m^2 effluent applied and an application rate of 30g/m^2 of P. If that 30g was removed in the top 150mm of soil, at an assumed soil dry density of 1700kg/m^3, then the increased concentration of P in that soil would be 120mg/kg, or approximately 0.01% in the same units as the values are shown in Table 13. Table 13 below gives the sample designations, hole number, sample depth, and elemental concentration.

Sa.No.>	# 01	# 02	# 03	# 04	# 05	# 06	# 07	# 08	# 09	# 10	# 11	# 12	# 13	# 14	# 15	# 16
Hole	A	B	A	B	A	A	B	6	7	5	BG	2	1	8	4	3
Depth	1.2	0	0.6	0.9	2.4	0	2	0.3	0.3	0.4	0.35	0.4	0.4	0.8	1.1	0.8
F	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Na	0.989	2.030	2.200	2.290	1.800	1.220	1.240	1.350	2.050	1.820	1.390	1.370	2.050	1.820	1.390	1.370
Mg	1.250	0.943	0.824	0.733	1.120	0.402	0.353	0.430	0.726	0.647	0.703	0.519	0.726	0.647	0.703	0.519
Al	5.910	8.442	8.697	8.555	7.003	7.960	7.137	8.442	7.299	8.167	10.230	7.274	7.299	8.167	10.230	7.274
Si	18.340	30.930	31.170	31.730	25.750	30.050	29.420	30.560	33.550	31.560	29.980	29.080	33.550	31.560	29.980	29.080
P	0.101	0.111	0.135	0.163	0.099	0.152	0.113	0.143	0.127	0.140	0.106	0.117	0.190	0.111	0.106	0.136
S	0.027	0.055	0.052	0.076	0.041	0.070	0.048	0.052	0.068	0.044	0.035	0.063	0.079	0.027	0.027	0.048
Cl	<0.001	0.012	0.011	<0.001	0.026	0.012	<0.001	0.010	0.012	0.016	<0.001	0.009	0.010	<0.001	0.011	<0.001
K	1.388	2.363	2.380	2.232	1.678	1.376	1.252	1.589	1.948	2.130	2.714	1.667	1.948	2.130	2.714	1.667
Ca	2.733	1.199	0.781	0.571	1.355	0.319	0.302	0.302	0.496	0.416	0.438	0.478	0.496	0.416	0.438	0.478
Sc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ti	0.830	0.318	0.314	0.293	0.415	0.313	0.282	0.325	0.253	0.285	0.343	0.260	0.253	0.285	0.343	0.260
V	<0.001	0.009	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cr	0.034	0.005	0.003	0.004	0.009	0.003	0.002	0.003	0.002	<0.001	<0.001	0.002	0.002	<0.001	<0.001	0.002
Mn	0.071	0.035	0.029	0.038	0.087	0.020	0.019	0.024	0.032	0.027	0.032	0.026	0.032	0.027	0.032	0.026
Fe	5.049	2.642	2.547	2.520	3.215	1.430	1.221	1.739	2.394	2.542	2.656	1.979	2.394	2.542	2.656	1.979
Co	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	0.003
Ni	0.006	0.003	<0.001	0.003	0.006	<0.001	0.002	<0.001	0.004	0.004	<0.001	0.003	0.004	0.004	<0.001	0.003
Cu	0.019	0.004	0.003	<0.001	0.016	<0.001	0.003	0.002	0.003	0.003	0.003	0.004	0.003	0.003	0.003	0.004
Zn	0.202	0.012	0.010	0.006	0.327	0.016	0.018	0.010	0.006	0.008	0.007	0.015	0.006	0.008	0.007	0.015
Ga	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ge	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
As	0.006	0.003	0.007	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	0.003	0.003	<0.001	<0.001	0.003
Se	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Br	0.005	<0.001	<0.001	0.002	0.004	0.002	0.002	0.002	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	0.004
Rb	0.005	0.009	0.010	0.008	<0.001	0.008	0.007	0.007	0.007	0.009	0.012	0.008	0.007	0.009	0.012	0.008
Sr	0.026	0.027	0.025	0.024	0.026	0.013	0.012	0.012	0.020	0.019	0.017	0.015	0.020	0.019	0.017	0.015
Y	<0.001	0.002	0.004	<0.001	0.003	0.001	0.001	0.002	0.002	0.002	0.005	0.002	0.002	0.002	0.005	0.002
Zr	0.015	<0.001	0.018	<0.001	0.017	0.030	0.027	0.028	<0.001	0.018	0.021	0.031	<0.001	0.018	0.021	0.031
Nb	0.002	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mo	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cd	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sn	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sb	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cs	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ba	0.289	<0.001	<0.001	<0.001	0.120	<0.001	<0.001	<0.001	0.055	<0.001	0.065	<0.001	0.055	<0.001	0.065	<0.001
La	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ta	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
W	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tl	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pb	0.331	0.008	<0.001	<0.001	0.122	0.011	0.011	0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bi	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Th	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
U	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
LOI	4.58	4.39	6.48	7.01	4.60	7.41	4.85	6.22	7.28	5.01	5.57	6.34	8.14	3.99	3.39	4.70

Values are weight %

Table 13. Soils Analysis of Land Irrigated Areas – March/April 2007

The levels for P from table 13 have been plotted in figure 52 below. The large green square is the background sample, and the plotted points are designated (1-16) as per their sample identification in table 13. Although this is comparing different soils with different historical backgrounds and so some of the differences could be due to this and not the impact of wastewater application, it does appear that the irrigated soils have an increase in P levels above background in the order of what would be expected, and that increase is limited to the first 800mm or so of soil depth.

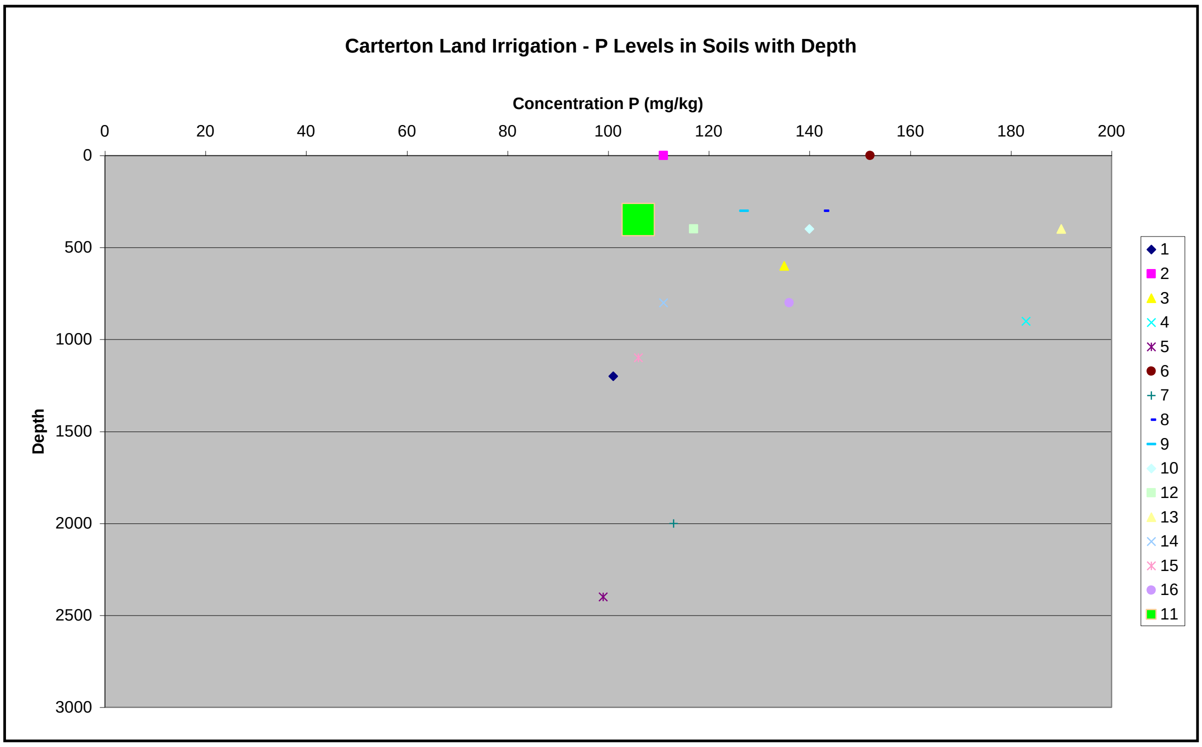


Figure 52. Variation in soil P concentrations with depth

Increases in other constituents, however, such as metals; (Cu, Zn), would not be expected to be measurable due to the low concentrations of metals in the effluent, and there are no constant trends evident from inspection of the results in table 13.

Further soil sample analysis was undertaken in April 2009 to further assess the effects of irrigation disposal since the previous sampling round in March/April 2007. The results of the analysis can be seen in Table 14 & 15 respectively. The results are shown in% by weight and soil samples were collected in the approximate locations as the previous sample locations.

Sample >	HOLE 1 100mm	HOLE 1 300mm	HOLE 4 100mm	HOLE 4 300mm	HOLE 5 100mm	HOLE 5 300mm
F	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Na	1.32	1.39	1.26	1.48	1.49	1.45
Mg	0.611	0.657	0.624	0.768	0.745	0.645
Al	7.15	7.30	7.82	7.76	7.58	7.43
Si	30.4	31.8	31.0	31.2	31.3	31.7
P	0.257	0.221	0.181	0.143	0.156	0.188
S	0.101	0.054	0.056	0.040	0.047	0.051
Cl	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
K	1.67	1.55	1.52	1.59	1.78	1.81
Ca	0.523	0.442	0.458	0.538	0.554	0.544
Sc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ti	0.307	0.333	0.355	0.383	0.359	0.340
V	<0.001	<0.001	<0.001	0.014	<0.001	<0.001
Cr	0.004	<0.001	<0.001	0.002	<0.001	0.005
Mn	0.052	0.053	0.068	0.040	0.097	0.057
Fe	2.54	2.81	2.87	3.21	2.88	2.82
Co	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ni	0.002	0.003	<0.001	0.002	0.003	0.003
Cu	0.004	0.003	0.003	0.004	0.003	0.003
Zn	0.008	0.008	0.008	0.007	0.007	0.007
Ga	0.001	0.001	0.001	0.001	0.001	0.001
Ge	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
As	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Se	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Br	0.001	0.003	0.003	0.003	0.002	0.002
Rb	0.008	0.007	0.008	0.007	0.008	0.008
Sr	0.016	0.016	0.016	0.021	0.017	0.017
Y	0.001	0.001	0.001	0.001	0.001	0.002
Zr	0.024	0.023	0.022	0.020	0.021	0.023
Nb	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mo	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cd	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sn	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sb	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cs	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ba	0.043	0.041	0.040	0.046	0.044	0.048
La	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ta	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
W	<0.001	<0.001	<0.001	<0.001	0.003	<0.001
Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tl	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pb	0.003	<0.001	<0.001	<0.001	0.001	<0.001
Bi	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Th	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
U	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
LOI	10.66	7.30	8.36	6.70	7.08	6.88

Table 14. Soils Analysis (Sheet 1) of Irrigated Land Areas – April 2009

Sample >	HOLE 6 100mm	HOLE 6 300mm	HOLE 7 100mm	HOLE 7 300mm	HOLE 8 100mm	HOLE 8 300mm	HOLE 8 500mm
F	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Na	1.10	1.22	1.21	1.10	1.41	1.35	1.34
Mg	0.609	0.548	0.606	0.656	0.566	0.633	0.647
Al	7.54	6.69	7.10	8.08	6.50	7.55	7.49
Si	29.9	29.5	32.1	30.6	31.7	31.4	30.8
P	0.173	0.240	0.158	0.155	0.176	0.148	0.171
S	0.093	0.127	0.061	0.057	0.076	0.044	0.056
Cl	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
K	1.43	1.41	1.55	1.61	1.46	1.55	1.58
Ca	0.469	0.795	0.476	0.575	0.501	0.411	0.474
Sc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ti	0.317	0.294	0.323	0.366	0.273	0.329	0.337
V	0.008	<0.001	<0.001	<0.001	0.010	<0.001	<0.001
Cr	0.007	0.008	0.004	0.004	0.003	0.005	0.005
Mn	0.045	0.039	0.042	0.040	0.068	0.065	0.080
Fe	2.50	2.49	2.53	2.80	2.24	2.72	2.75
Co	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ni	0.002	0.003	0.002	0.002	0.002	0.002	0.002
Cu	0.004	0.006	0.003	0.004	0.003	0.003	0.003
Zn	0.010	0.014	0.006	0.008	0.007	0.007	0.007
Ga	0.001	0.001	<0.001	0.001	<0.001	0.001	0.001
Ge	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
As	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001
Se	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Br	0.003	0.002	0.002	0.002	0.001	0.003	0.002
Rb	0.007	0.006	0.007	0.007	0.007	0.008	0.007
Sr	0.014	0.016	0.015	0.015	0.015	0.016	0.016
Y	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zr	0.025	0.032	0.020	0.023	0.019	0.019	0.018
Nb	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mo	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cd	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sn	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sb	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cs	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ba	0.036	0.037	0.042	0.039	0.041	0.039	0.039
La	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ta	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
W	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001
Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tl	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Pb	0.003	0.006	<0.001	<0.001	<0.001	<0.001	<0.001
Bi	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Th	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
U	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
LOI	12.08	13.82	7.90	8.62	10.11	8.05	9.17

Table 15. Soils Analysis (Sheet 2) of Irrigated Land Areas – April 2009

A comparison of these two sets of results for similar holes and depths, (holes; 1, 5 and 7 at 300-400mm), and constituents which would be expected to accumulate (Phosphorus, Copper, and Zinc), is tabulated below and shows a reasonably consistent increase in these key parameters.

Phosphorus				
Hole	Depth	2007	2009	Increase %
1	300 - 400	1900	2210	16.3
5	300-400	1400	1880	34.3
7	300	1270	1550	22.0
Copper				
1	300 - 400	30	30	0.0
5	300-400	30	30	0.0
7	300	30	40	33.3
Zinc				
1	300 - 400	60	80	33.3
5	300-400	80	70	-12.5
7	300	60	80	33.3

Table 16: Apparent changes in 3 soil constituents in CDC WW Plant irrigation area – 2007 to 2009.

These increases are with an application rate of up to 20mm/d for 90days per year, giving a total of say 3m total aerial liquid application.

By comparison, the accumulated loading on a future land irrigation area would be expected to be say 5mm/d for 200 days/yr, or 1m per year, so in 3 years, the land would have received a similar application to the current irrigation plots.

If the effluent were UF treated, the analyses performed on the pilot plant show that the metal removal would be approx 50% compared to the level in the current wetland effluent.

Maximum desirable values for these constituents are, (approximately);

- Phosphorus – no value found, unfertilized NZ soils range up to 2000mg/kg. Desirable maximum P levels are normally set based on the sodium bicarbonate extractable P, (Olsen P), with a desirable range being 20-30mg/L Olsen P. However, typical P application rates for maintenance of soil P values, (source – Ravensdown brochure), are in the range 10-60kg/ha/yr, (depending on stock type, stocking rate, and soil type), yielding approx 1 Olsen unit for every 5-10kg/ha (depending on soil type). If 1m of effluent were applied per year, at 10g/m3 P, this would give in the order of 15mg/kg annual application, much less than the tabulated values of some 150mg/kg increase given in table 16 above.
- Copper – 7800mg/kg. (NZ Timber Treatment Guidelines)
- Zinc – 200mg/kg (Canadian Guidelines – CCME 2002).

Assuming that the P would not be an issue, (due to removal during crop production), the critical level would be Zinc. Based on the measured values in table 16 above, and assuming a 15% increase per annum, and base level of 50mg/kg, this would have the guideline value of 200mg/kg being reached in approx 10 years. Realistically however, those would be unlikely to be a constraint as if the concentration increase were based on the applied zinc, (1m per year aerial application at 8mg/m3 zinc concentration, and this were mixed into the top 300mm of soil, then 10 years worth would only increase the soil values by only 0.1mg/kg, so it appears that the increased concentrations given in table 16 above are unlikely to be a true representation of the increased accumulation in the site soils, and must be simply due to the variations possible between successive samples from not exactly the same location.

5.5 Effects on air

The discharge of raw sewage from the sewer system into the treatment plant, and water surface interface discharges from the tanks, drying beds and ponds, could potentially contain a number of gases from sewage and its anaerobic decomposition. Some of the main gases likely, to be formed in the sewerage and sewage treatment systems are; hydrogen sulphide, ammonia, oxygen, carbon dioxide, methane, nitrogen and hydrogen. Some of these, and other gases, which may be present in trace amounts, have the potential to cause offensive odours. The main constituents of this odour-causing group are listed below:

Gas	**Threshold Odours Concentration ppm (vol/vol)**
Carbon disulphide	0.21
Acetaldehyde	0.21
Hydrogen Sulphide	0.00047
Nitrogen Compounds	0.00021 – 100.0
Skatoile	0.019
Mercaptans	
Ethyl	0.001 – 0.00026
Methyl	0.041 – 0.0021
Ammonia	46.8
Perchlorethylene	4.68
Phenol	0.6

Table 17. Potential Odours in Sewage Systems

These gases can potentially be produced in the sewer pipe system, or within the treatment plant and ponds. Rates of production are effected by:

- nature of raw sewage
- length of time sewage is in the pipe system
- temperature
- frequency of desludging the primary clarifier
- period of digestion in the sludge digester, and control of conditions within the digester
- aeration applied to the flow within the system, (large falls in manholes, turbulence at bends, etc),

- maintaining the pond waters aerobic, (with oxygen present)

The anecdotal evidence, monitoring results on the plant and ponds, and lack of complaints indicates that there are no associated problems in the sewers, and that the ponds maintain aerobic conditions throughout the year.

The only one of these potential gaseous contaminants which has specified concentrations in the WRC's Discharges to Air Plan, is hydrogen sulphide at maximum desirable value of 1ug/m^3 and a maximum acceptable value of 7ug/m^3.

The issue of aerosols which may occur, from both the aerated digestion, and the oxidation pond aerators, is one on which there was a significant amount of background data available from the technical literature, although these reports are not all consistent in their conclusions or necessarily relevant to the specific details at Carterton.

There is no doubt that wastewater contains pathogens, (disease causing microbes), aerating wastewater produces aerosols, and aerosols may cause a spread of disease via pathogen transfer and ingestion. What is less clear is the magnitude of risk to Plant workers and nearby residents from the aerators in the CDC ponds, (note aerators are located in ponds 1 and 3).

Shuval et al., 1989, determined that there was no obvious increased risk to workers at a wastewater treatment plant from the aerosols created during the treatment process, however, Katzenelson et al., 1976, found from a study of 77 kibbutzim, that wastewater spray irrigation with partially treated, nondisinfected oxidation pond effluent was associated with increased levels of shigellosis, salmonellosis, typhoid fever and infectious hepatitis.

Sawyer et al., 1993[9], analysed the microbial concentrations in aerosols, from a large activated sludge type wastewater treatment plant, and found that the concentrations were low compared to commonly accepted infectious dose levels. Brenner et al., 1988, also found that the levels decrease rapidly as wastewater is treated and stored, and Telsch et al., 1980, found that there was a rapid rate of microbial die off in aerosol form and that coliforms were not suitable as indicators of microbial levels in aerosols, because of their inconsistent correlation with viral and bacterial pathogen densities.

Fattal et al., 1987, concluded that under non-epidemic conditions, exposure to wastewater aerosols does not lead to enteroviral infections. Bausum et al., 1982, found that, in relation to aerosols from spray irrigation of wastewater, downwind microbial levels were higher during the nighttimes, and that, although survivors could be detected over 500m downwind, typical reductions were to a level of approx 5% of the original at 50-75m downwind.

The New Zealand Guidelines for the Utilisation of Sewage Effluent on Land, 2000[14], provide some additional information on aerosol related issues, but from the perspective of land irrigation schemes. This document concludes that the epidemiology is generally poorly understood, but risks appear to be low.

A further issue of relevance to the risk is the size and rate of aerosol generation from the specific aerators used at the Carterton WWTP. These are caged rotors made by Hamilton Precision Engineering. The caged rotor aerator is like a large reel type lawn mower, with the reel (rotor) providing the aeration by mechanical agitation of the pond liquid (refer figure 8 of the plant photographs, Appendix B).

The caged rotor type is a slow speed aerator and (although specific reports were available to substantiate this) it seems extremely likely that the aerosols produced by such a device will be larger and of lower numbers, compared to a fine droplet irrigation spray or high speed aerator, which is what most of the above literature is based around.

Therefore, it is contended that the health risk from aerosols from the plant is low.

5.6 Proposed Means of Mitigating Adverse Effects

The proposal is considered to be the most effective means of mitigating potential adverse effects. Specific measures proposed are:

- The wetlands will continue to achieve a good performance of faecal coliform reduction on a year round basis, even when discharges to the stream are required due to flows being in excess of the capacity of the membrane plant, these flows will still pass through the wetlands and these are already achieving on average a greater than 50% reduction in faecal coliform levels, reducing them to well below the previous consent requirement of 3000/100mL. Additionally this, (discharge from the wetlands – once the membrane plant is operating), will only occur at times when the receiving waters are in elevated or flood conditions with corresponding reduced quality so the impact will be minimal.

- The operation of the land treatment system as established from frequent and detailed monitoring will minimise discharge to groundwater and thence ultimately to the stream. Using the land in the immediate area means there is intensive monitoring already in place. The typical piezometric surface contours, as shown below, for example, clearly give a strong fall towards the stream.

- Continuing work on I/I control will reduce flows and therefore quantities which are able to “bypass” the proposed treatment systems. Ultimately this will result in achieving less and less frequent discharges to water even of membrane filtered effluent, until eventually the zero discharge goal is reached.

- The introduction of the trade waste bylaws and charging is having a progressively more significant impact on commercial / industrial discharges into the wastewater system. This also provides better controls on the nature of actual and potential discharges to ensure undesirable substances are eliminated and unnecessary risks are reduced.

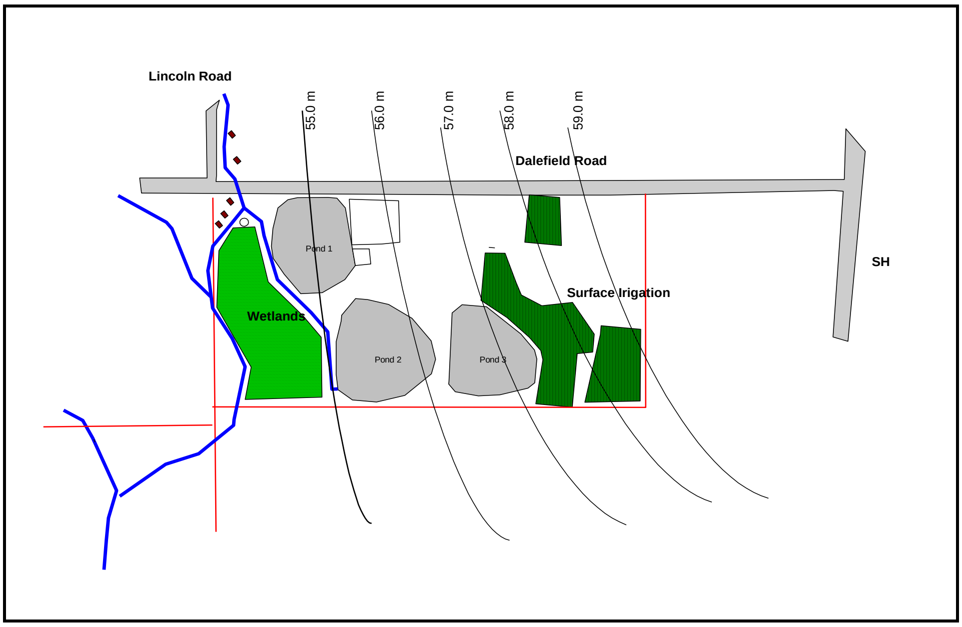


Figure 53. Piezometric Contour Plan of Plant and Treatment Area

- An additional area for land irrigation, on land owned by others is hoped to be secured during the duration of the consent. Irrigation on this land, supplemented if necessary through the existing drip line, will be the subject of a separate consent application which will detail the proposed irrigation regime, including; seasonal and weather specific variables, irrigation rates, controls on stop and start, etc.

- The use of the storage ponds to take excess flows during the summer periods will actually allow for a true zero discharge (other than pond seepage and heavy rainfall), for some of the period, if required, and using the pond storage as a buffer will allow restricted flows within the capacities of the wetlands during most times.

- The membrane plant will significantly improve the effluent quality from the existing process, ensuring that this complies with the Fonterra standards for irrigating to grazed pasture if agreements can be reached with land owners.

- The conversion of the digester to a heated cell which was completed in late 2009 after some trials and problems which created further odours in the short term, appears to have addressed one of the main sources of intermittent odours which have caused some complaints from adjoining land owners over the last 3 years.

6 Monitoring and Control

A monitoring regime is proposed which uses and enhances the existing monitoring bores and equipment in the area. The proposed monitoring regime is detailed in table 18 below.

Location	Parameter	Frequency	Purpose and Details
Plant inlet	Flows	Instantaneous with daily total	Loading on plant, monitor progress with II control programme, identify any unusual additional flows.
	Wastewater analysis - Basic parameters (pH, BOD, SS, TKN, TP, cond), plus metals.	Monthly	Identify any unusual loads or trends
	pH and conductivity	Continuous	Identify any unusual loads into the system.
Digester	Temperature	Continuous	Operation of heated cell
Ex Sedimentation Tank	BOD, SS	3 Monthly	Monitor performance of tank, trends, and loading onto ponds.
Ex facultative ponds	Filtered BOD, SS, E coli	3 Monthly	Monitor performance of ponds
Ex maturation pond	Filtered BOD, SS, E coli	3 Monthly	Monitor performance of pond
Ex wetlands	Filtered BOD, SS, E coli	3 Monthly	Monitor performance of wetland
Ex membrane plant	E coli, TC, HPC 22/35	Weekly	Performance of membrane plant
	Flow to stream, flow to irrigation ponds.	Instantaneous and daily total	Monitoring of system, checking mains for leaks, loading on stream
	Turbidity	Continuous	Identify membrane rupture, monitor membrane performance.
	Wastewater analysis - Basic parameters (pH, BOD, SS, TKN, TP, cond), plus metals.	3 monthly	Monitor membrane system performance
Ex UV	E coli, TC, HPC 22/35	Weekly	Performance of UV system
Land irrigation areas	Elemental levels in soils	Annual – 1 sample / ha	Identify any changes to soil chemistry in irrigated areas
	Soil mc	Continuous – number of sites to be based on land irrigation specifics	Identify when to start and stop irrigation
	Flows into holding pond	Daily total	Flow balancing, calculating loading
	Flows irrigated	Daily total	Flow balancing, calculating loading
Mangatarere Stream	Flow rate – direct discharge to stream	Instantaneous	Calculating impact on stream, monitoring records
	Stream flow	Instantaneous	Calculating impact on stream, monitoring records
	Water quality up and down stream	Monthly when discharging to	Impact on stream.

	BOD, SS, NH3, TN, TON, FRP, TP, E coli -	stream	
	Ecological impact – biota survey	6 monthly	Continue with 6 monthly biota survey on Mangatarere Stream. Ensure surveys do not occur within 2 weeks post a 3* median flow event. Surveys to occur Feb or March and September or October.
Bores	Monitoring bores downstream of plant. Existing parameters	6 monthly	Impact on ground water from seepage from ponds and wetlands.
	New bores in relation to land disposal areas	To be determined	Impact on ground water from land irrigation.

Table 18. Proposed Monitoring

Additionally supervision will comprise:

- Daily operator monitoring attendance,
- Telemetry monitoring of key on line parameters with call outs for critical states.

7 Alternatives to the Proposal

In selecting the treatment upgrade, council has reviewed and in some cases trialled a number of options. These are described below along with the reasons for non selection.

7.1 Lower Quality Treatment

The proposed membrane filtration presents a very high quality treatment as far as addressing particulate parameters, (solids, microbes, and even metals which tend to adsorb onto particulates). During the process of selecting this technology, however, Council has reviewed a number of alternatives. These are tabulated below, along with reasons for their rejection.

Option	**Extent of assessment**	**Reason for rejection**
Conventional secondary treatment process upstream of ponds	Desk top only	Improved performance outweighed by cost, final solution requires tertiary or advanced treatment standards.
Conventional secondary treatment process upstream of ponds, followed by UV irradiation	Desk top only	Possible to meet Fonterra standards, however, cost would be significantly higher, more extended environmental exposure - (ponds and wetlands), assessed as being a higher standard
Sand filtration	Pilot plant trails	Even with coagulant addition, performance was not very good. Phosphorus removal was not high even with high doses of coagulant. Sludge disposal was also considered to be a problem.
Nutrient removal	Desk top assessment and partial pilot trial, (with coagulation onto sand filter)	Plant complexity and cost, those processes which achieve good performance require very sophisticated controls and large amounts of power / air / high operating costs.
UV irradiation of current effluent quality.	Pilot trials (both in conjunction with sand filter upstream, and with the currently used flow train of disk filtration upstream	On straight pond effluent performance even at high irradiation doses was not good due to the particulates, with disk filters upstream to break up the larger particles; performance was better but does not reliably meet the Fonterra standards.
Larger wetlands	Desk top study	Land not readily available limited performance form wetlands even with much lower loading rates.

Table 19. Alternative treatment options considered

7.2 Land Owned by Council

Both council owned land, and land potentially available for sale have been considered for dedicated use for wastewater irrigation during the investigations. Specifically Council has historically considered:

Land area	Location	Extent of investigation	Reason for rejection
5-10Ha	Immediately adjacent to plant on same side of the Mangatarere River	Test pits, infiltration tests, test bores, property valuation.	Could not agree on price as owner was looking to ultimately subdivide to urban intensity and this was reflected in asking price.
50Ha	To east of Carterton, some 3km from WWTP	Field testing for infiltration rates, soil types, desk top study of groundwater sensitivity.	Distance, numerous bores in the area, insufficient land in total area.
24ha	Opposite WWTP across Mangatarere River	Test pits, infiltration tests, soil testing, property valuation.	Insufficient land area and proximity of water courses and flooding zones.
70Ha	To south of Carterton, close to SH1.	Infiltration testing and soils analyses.	Landowner advised not interested. May still be an option with higher level of assistance?
200Ha	Kaipatangata road –Council forestry	Desktop, site soil assessment.	Initially rejected due to low permeability soils. Alternative application methods & possible storage now being assessed.

Table 20. Land purchase options considered by Council

Council is carrying out further investigations on its forestry land in the Tararua foothills. There is potential to use this area for effluent storage and effluent irrigation. Investigations to date have not been favourable in terms of effluent irrigation.

Appendix A: Fonterra Press Releases

4th July 2005

Fonterra Co-operative Group Limited
Fonterra Centre 9 Princes Street
Private Bag 92032
Auckland
New Zealand

Phone: 09 374 9418
Fax: 09 300 3414

www.fonterra.com

The Chief Executive Officer

Dear

HUMAN EFFLUENT TO PASTURE

In 2000, the New Zealand Dairy Industry, under the New Zealand Dairy Board developed and adopted the Dairy Industry Environment and Animal Welfare Policies. One of these policies banned the spreading of human waste to pasture that was to be grazed by, or harvested for feeding to dairy animals. This position was reached after a review of our markets via feedback from our marketers around the world. At that time there was one municipal area that was spreading treated waste to pasture, with that pasture being harvested and used by a small number of dairy suppliers. This was permitted to continue while the industry investigated further the issue of acceptable levels of treatment.

There has been a growing demand from a wide range of regional authorities to utilise land application as part of their treatment process with land supporting dairy farming systems being identified. Fonterra carried out a worldwide review of treatment technology and market perceptions/requirements to identify a level of treatment that satisfied the food safety and market perception issues surrounding animals grazing pasture that has had treated human effluent applied.

We have been able to identify through, Dr Jim Barnett a level of treatment after which it is acceptable to spread the treated waste to pasture for grazing by dairy animals that supply milk to Fonterra, or pasture that is to be harvested for feeding to these animals.

Treatment equivalent to the Title 22 of the California Health Law has been adopted.

The standard of acceptable treatment is summarised as:

- Sewage or sewage derived material can only be applied to pasture destined for consumption by dairy cattle if it has been secondary treated and disinfected.
- Secondary treatment requires a process producing an oxidised effluent (i.e. the organic matter in the sewage has been stabilised and contains dissolved oxygen).
- The degree of disinfection required is based on the residual total coliform bacteria in the water. The median concentration of total coliform bacteria must not exceed a most probable number (MPN) of 23 per 100mL (based on a 7 day period) and the maximum number in any one sample over a 30-day period must not exceed an MPN of 240 per 100 mL.
- A management plan must be developed for where sewage is applied to a dairy farm.

This level of treatment will allow us to collect milk produced from pasture on which the treated effluent has been spread.

We continue to accept:

1. Sub surface placement of effluent not treated to the above standard.
2. Incorporation of effluent not treated to the above level, into soil, the growing of crops for harvest then sowing pasture for grazing.

Our suppliers have been updated on our position.

If you have any questions relating to our new policy please feel free to contact me on 09 374-9000

Yours truly,

Shane Lodge
Field and Technical Services Manager
Shareholder Services

Further letter promulgated mid 2010:

To Whom It May Concern

Fonterra has recently reviewed its policy relating to the use of human effluent wastewater and sludge on pasture or feed that is fed to dairy cows supplying Fonterra.

Fonterra's previous policy allowed for the application of wastewater treated to the Californian Standard Title 22 to be applied to pasture being grazed by lactating cows. Any wastewater not meeting this standard was to be sub-surface irrigated.

Additionally, stabilised sewage sludge could be incorporated into the soil, a crop could be grown, harvested and fed to lactating cows, and then the pasture could be re-sown and fed to cows.

Taking into account feedback from our customers and markets, the following policy has been approved by the Fonterra Board and applies from 1 June 2010:

- Only wastewater that meets the Californian Standard Title 22 is to be used on pasture or feed that is fed to lactating animals supplying Fonterra.
- No sewage sludge derived from the treatment of human waste may be used to grow pasture or feed that is fed to lactating animals.
- If dry stock is fed with feed that has been grown with stabilised sludge or wastewater that does not meet the Californian Standard Title 22, the stock must not be fed the material for 30 days before the start of lactation if they will be supplying Fonterra.
- Any suppliers using human sewage must meet the requirements of their local Regional Council.
- District Councils will be responsible for the production and implementation of the required management plan.

If you have any questions or comments relating to this change of policy please contact Charlotte Rutherford, Environment Programme Manager, on 021 471 045.

Yours faithfully

Andy Goodwin
Manager, Food Safety and Sustainable production

Appendix B: Raw Monitoring Data

Appendix C: Minutes of consultation meetings

Carterton Wastewater Upgrade – Steering Committee Meeting #1 – 15th February 2010 1900-2100Hrs – CDC – Council Quarters - Carterton Minutes of Meeting

Committee Members: Stu Clark, Andy Duncan, Ian Gun, Andrew, Emily Greenburg, Rebecca Fox.

Council Officers: Colin Wright

Invited attendees:

Apologies: Stephen Thawley, Ra Smith

Minutes

The meeting was opened by Andy at 7:15pm. As this was the first meeting no previous minutes were reviewed.

Introduction

Andy had prepared a power point in which he worked through for the meeting; he introduced Stu's and his idea, the concept of a paradigm shift in using wastewater as a resource, and aiming for a long term goal of "zero discharge''. He saw it as a collective duty for a proposed working party to try and accomplish.

Andy asked if everyone was happy with the AEE, questions and issues arising regarding the AEE:

Emily asked whether the reticulation system was part of the plan. Andy answered yes it was.

Ian questioned issues related to signing up the land owners for irrigation. Emily said it is a partnership between Greater Wellington Regional Council and the District Councils. Ian replied in saying land owners would need to be a part of this as well.

Andy brought up the topic of Fonterra standards and explained that when he had been in touch with Fonterra they had over ten other councils considering dairy land irrigation. Stu added that even if the wastewater did comply with Fonterra's standards a restriction could crop up in the overseas market resulting in products from effluent treated farm being not accepted; this could cause a change in the standards or a complete ban.

Design and Construction

Andy then discussed the proposed system design and construction.

Andy showed a graph of flow prediction and water balance. Stu raised the point that the rainfall data for actual town catchment might not necessarily be the same as at the sewage plant (where the records are taken) which was why there was variance between the predicted and actual flow and that the predicted flow is probably a better model. Andrew asked Andy what the graph is going to be used for. Andy answered it would help with the design of the system; he explained how it would allow them to see how much and when you can irrigate.

On the next slide a table was shown and described by Andy. It showed percentiles on flow prediction and water balance. Ian asked how much land you would need to just irrigate with no discharge to the Mangatarere Stream. Andy replied 150Ha, as an estimate. Andrew asked about infiltration. Andy said that the graph of flow prediction and water balance included infiltration and inflow and if the system was remediated the peaks around winter would disappear. Colin said he remembers when there was a 50 year flood event and there was water coming out the man holes and they could not even pump the wastewater. Andy said it was an extreme case, and Stu added it was also because more stormwater was linked with sewage then. Ian conversely asked Andy, can you work out how much extra storage you would need. He replied that you could use formulas to calculate it, so yes.

Consents

Andy went on to introduce the topic of consents and presented the question of how they were going to get what they wanted as a group. He explained how he thought a working party of representatives could agree on milestones which would be documented in the consent and be signed off by each representative once achieved. Once the first three mile stones were achieved the consent could be extended to 2020. Emily explained she had seen a similar consent with one of Wellington City's consents for excess water in an emergency, such as a large flood event. However she said the consent conditions were not easy to develop and a lot of effort is required.

Andy explained the various consent guidelines and terms he thought appropriate. Ian asked Colin, being a representative of the Carterton District Council, what his views on this were. Colin explained his main view was he did not want a repeat of what Masterton did and supported Andy and Stu's idea. Rebecca said we might be able to get some relatively easy consent conditions to deal with and thought as a group we will need real commitment.

Ian gave his views on the working party he wanted to know how it was going to work, and thought that Stephen Thawley is needed here so they can present the idea from the working party to Greater Wellington Regional Council.

Andy said the message we were getting from Greater Wellington Regional Council was that the consent term should be five years. However he thinks they needed a long term goal as well as short term so we are actually moving towards a final solution. Andrew agreed and asked when the current consent expired; Stu replied it had already expired. Andy said as a group they would come up with the defined final milestones. Andrew brought to attention there was some degree of risk involved, they could get 3 years down the track and then someone just says no. Andy re-enforced the point that we must incorporate a long term goal into consent even though that risk is involved. Rebecca strongly agreed and said they need to present the idea of "zero discharge" to the public and other organisations, Ian added that they would have strong public support and the only alternative is expensive.

General

Andy moved back to the issue of irrigation, he explained it would not necessarily matter whether Fonterra changed their standards as it would not mean they cannot irrigate. There was still; council owned land, the golf course, a non-food crop grower, and others in which the standards are irrelevant to. Ian replied, this may be the case but when the grower goes to sell his land it could be classified as a contaminated site. Andy made the point that they have 250Ha of land owners interested so far and only 150Ha are needed so even with the issues they should still be safe as they potentially have more than enough land.

Ian suggested the land owners could nominate a representative to have on the working party. This would allow for the land owners to have a part in the process and be informed of what is happening. Adding to this idea Andy suggested also having a place on the council website so ideas are shared among the group.

Andy explained how Stu and he had been thinking about the consent conditions and what they were trying to achieve with regards to the phosphorus content of the Mangatarere Stream. Ian made the point that the Mangatarere Stream was complicated and recommended to get closer to Greater Wellington Regional Council for a contribution to the project. Andrew recommended they could obtain further sampling information on the Mangatarere Stream by presenting the idea to Julia, at Greater Wellington Regional Council. Ian said Greater Wellington's information might conflict with ours. Andrew replied the extra information would still be of some assistance. Emily asked why we would need the information from Julia, have not we been sampling the stream ourselves. Stu explained that our sampling was not as relevant or as extensive as Greater Wellington's. The sampling points we sample are outlined in the consent and are not all in the correct place to determine everything. Stu explained a big ticket item was reducing flows and was more important than removing nutrients. We just need to live with high phosphorus discharge for awhile to reach the long term goal of zero discharge. Emily replied she understood this and agreed with it. Back to the topic of Fonterra standards Emily stated she did not want to be reliant on Fonterra standards. Andy explained we could acquire core places where you could discharge without reliance on Fonterra standards. Emily said she agreed that discharges of high phosphorus could be dealt with for awhile.

Ian stated that phosphorus has the highest impact when the water is warmer. Andy said this is true however they would need to definitely discharge to water in winter in the short to medium term but could irrigate in summer and it could work with a consent. Ian replied there was no one from Greater Wellington Regional Council to review this idea, Andy agreed.

Andy showed a graph that explained how much phosphorus they could remove from the river by removing the peak flows in winter. Andrew said he can not see how this would make much difference to the discharge and thought the removal of phosphorus was needed at extreme times.

Andy showed his proposed milestones but said they were not set in stone. Stu asked about the phosphorus. Andy said it was just a suggestion as a milestone. Rebecca spoke about the issue of costs required (for different options) and they would have to be considered. Andy explained that costs were Carterton District Council's issue (best use of funds), Andrew clarified this. Emily asked why they were not to make any progress until the third milestone. Andy explained upgrades would still be taking place during the first and second milestone. Emily said they would need some sort of guarantee for irrigation so it was permanent, a core area of land. Stu said he thought that the Council purchasing dedicated land for irrigation does not make sense but using it as a resource, irrigating on farmers land, makes sense however we would need to upgrade treatment to comply with Fonterra standards. He explained purchasing land was not a solution either as something has to give and that would be the remediation of the inflow and infiltration, it would be better to create a cleaner effluent so when land was sold questions were not raised. The idea for presenting a standard for the land irrigation was then discussed. Emily said it was a vision and she needed something solid, and explained how Rotorua was an example of something solid. Stu explained 32 million dollars was spent by the government on the Rotorua Treatment Plant, and we do not have that sort of government funding.

Limitations

Rebecca stated to discuss these ideas we need the rest of the group here. It was discussed by everyone that Stu and Andy had had more time to come to terms with the idea than everyone else. Stu said maybe we should go to GW and ask if the deadline is flexible. Ian and Rebecca said we need a group of people to go to GW as ammunition.

Stu raised issue of the mechanics of the group and how they were going to get them together. Sending an email to all members was proposed and the next meeting day to be moved from Monday. Stu then introduced Brett Stansfield as another person who would be helping evaluate the existing and proposed systems.

Stu Clark CP Eng
NZET Ltd
16/02/2010

Carterton Wastewater Upgrade – Steering Committee Meeting #2 – 1st March 2010 1900-2145Hrs – CDC – Marquis of Normandy Hotel – Carterton Minutes of Meeting

Committee Members: Stu, Ian Gun, Andrew Stewart, Emily Greenburg, Rebecca Fox, Alex Webster, Bill Knowles, Dane Rimene, Chris Engel, Ra Smith.

Council Officers: Clark, Andy Duncan.

Invited attendees: Hugh Dixon-Paver

Apologies: Colin Wright, Corina Jordan

Minutes

The meeting was opened by Andy at 7:00pm.

Introduction

Andy briefly explained to the working party where Carterton District Council is at in terms of: reticulation repairs, treatment upgrade, irrigation proposal, and the long term goal, zero discharge to the Mangatarere Stream. Andy then explained the agenda for the meeting.

Andy described his view of the purpose of the consultation as being a three step process; to gain a broader community input into the long term solution, to ask the group for a collective comment of support for the application, for the group to define milestones which, if achieved, lead to an automatic 5 year rollover of the consent. Andy also advised that Carterton District Council would prefer to avoid the option of obtaining another resource consent just for compliance and instead would rather work towards something that all parties want to achieve; zero discharge to the stream.

AEE

Andy introduced information from the AEE and the effect of discharge on the Mangatarere Stream was discussed amongst the group. Andy explained that a high level of phosphorus was present in the stream partly due to the wastewater discharge. Inflow and infiltration works were also discussed. Andy and Stu explained to the group the extent of the repairs on the reticulation system carried out during 2009.

Alex Webster asked what the upgraded treatment is to be. Andy explained that the membrane filtration technology is likely to be used as it will treat effluent substantially better than the current Fonterra standards.

Emily asked whether Premier Bacon's plans to treat their own effluent would have a significant effect on the discharge of the Carterton Treatment Plant. Stu explained that the removal of flow from Premier Bacon would create significant decrease on the current levels of nutrients present in the discharge. Premier Bacon's progress towards their own treatment and/or disposal was discussed and Andy suggested that

Premier Bacon's plant could still possibly work in conjunction with Carterton's. Ian made the point that dividing the two systems could just be moving a problem from one place to another. Ra suggested that faming and industry should have a representative in the working party as they are going to be a large part of the proposal. Andy agreed that farming is a large part but thought that other than Premier Bacon there was not a great impact for industry involvement.

Consent and Works Status

Andy first explained for the proposed works to go ahead, discharge to the Mangatarere would still need to occur in the short to medium term and because Carterton District Council cannot afford both land and advanced treatment, co-operative land use with land owners is desired.

Emily inquired how much land would cost and how much they were spending on reticulation repairs. Alex Webster answered he had brought 75Ha of land for 1.25 million. Andy explained the reticulation repairs will lower the flow and therefore the amount of land needed will decrease. Andy also explained not all land is suitable for irrigation and that it is better for land owners to evaluate how irrigation could enhance their current operations than for the Carterton District Council to do so. Ian highlighted that not purchasing land was a constraint and nothing should be said for sure. Andy agreed with Ian and also thought that there are still other possibilities to consider. Alex pointed out that the longer you leave buying land the more expensive land will become so it is an important decision to make early on. Andy agreed that it is important but more information and calculations are required to decide on the most suitable land before issues of purchase versus leasing can be resolved.

Consent Issues

Andy explained that because of what was proposed gaining consent for discharging to land will be difficult. Ra explained what he was trying to do was encourage Greater Wellington to conform to their own RPS. Andy said he had talked to Stephen Thawley of Greater Wellington and his opinion was that the proposed methodology was possible. Andrew asked whether there have been any indications on the likely consent conditions. Andy replied a trial irrigation plot was one possible option in which consent conditions could be established, and depending on when they do this they could use UV treated or membrane treated effluent.

Andy went on to describe the current application; reticulation system repairs, irrigation scheme and discharging treated effluent, he explained how he thinks they could fit some of it into a 5 year short term consent, that planning towards zero discharge is more important than expending huge sums on analysing the short term effects of the discharge on the Mangatarere Stream and that as a group they could achieve this. Andrew asked why 5 years was the proposed timeframe. Stu explained it was a good amount of time as 5 years is short enough so if something did go wrong not too much time was wasted and long enough to be able to achieve some significant steps and analyse the impact these will had. Chris added if things did go wrong discharge might have to continue for longer than proposed.

Ian pointed out that Carterton District Council and Greater Wellington should have had this thinking 5 years ago. Hugh (as a representative of GW) explained time was needed to work the issues out, he thought this discussion was very useful as the different parties were co-operatively working together and even though this was not done 5 years ago at least they are doing it now. Andrew asked Hugh if he thought irrigation all year round and zero discharge to river is plausible. Hugh explained that a lot of effort and commitment will be needed, a plan of exactly what they are proposing to do will have to be presented and results will have to be achieved and reported on.

Background Work

Andy explained how the evaluation of land would be undertaken and that he had prepared and sent out letters to land owners of appropriately sized and located land to gauge their interests in receiving wastewater for irrigation. He added that not only had farmers been sent applications but others had as well. Emily asked whether any additional information had been found on Hawkes Bay Regional Council purchasing land. Ian said he had done a bit of research on what was happening there and that Hawkes Bay Regional Council was setting up agreements with farmers for irrigating effluent. Stu pointed out that with our approach you cannot irrigate all year round and surplus storage will be needed.

Emily suggested a possible milestone could be a certain percentage reduction in inflow and infiltration, Stu and Andy agreed this could be a possibility. Alex Webster asked how the milestones are going to work in conjunction with the 5 year consent. Andy answered that the mile stones would be present with the 5 year consent but would apply more to the following consent, in that meeting the milestones would allow a consent roll over. Ian said there is a history of people not meeting milestones and that you would need to proceed efficiently in doing so.

Ra presented a milestone in which technological advances are considered. He thought that options such as high rate pond systems and reverse osmosis may become cheaper and better accepted in five years time, and therefore a review of technology should be done and the plan should be subject to change, if the review offered a better solution. Emily agreed it was a very good idea and added that a review of the consent should be required after each milestone as it would give Carterton District Council and the group more options to better the system.

Ian raised the concern of a large industry opening in Carterton causing an increased flow/loading and asked how this could be taken into consideration. Andy and Stu acknowledged that this could happen and depending on the magnitude of increase the plan would change accordingly.

Hugh noted that different quality effluents could be used for irrigation as not all land owners would need effluent treated to the same level. Andy said the model has not been fully developed yet and would change as more aspects are accounted for. Andy thought that what Hugh suggested was a good idea and would be incorporated into the design process.

With regards to the irrigation scheme Andrew asked what exactly the human health and Fonterra standards are. Rebecca answered Public Health was more concerned with the proximity of aerosols to, water supplies, waterbodies and residential areas but there are specific standards that were written up in 1975 which are still used as guidelines today however there are many different factors than just these standards which have to be investigated and accounted for. Stu pointed out that currently during summer when the plant is irrigating, on a good day the plant produces Fonterra standard effluent with just disc filtration and UV treatment.

Ian asked if there are any high levels of heavy metals present in the Mangatarere Stream because of Tower Gates discharge. Stu answered Tower Gates no longer discharge to the sewage system and the heavy metals recorded in the effluent are relatively low and should not be of concern especially following membrane filtration.

Ra asked about the presence of other pathogens in the waste stream and if any other contaminants were particularly high. Stu explained that they had tested for other viruses and bacteria and that copper and zinc levels were elevated as is normal in municipal wastewater. Hugh informed the group that there would be strict monitoring in the consent but not as to burden Carterton District Council, just what is required. Ra suggested that good analysis results should be shown to the public as this would show them what their rates are paying for and increase public support. Stu explained he was happy with the existing plant as it is a good pre-treatment, especially the wetlands which are excellent for breaking down some potentially harmful contaminants including those for which testing is not possible/viable i.e. hormone compounds and other pharmaceuticals.

Emily expressed the view that milestones need to keep relating back to the vision of zero discharge. Andrew asked if there was a planed date for achieving zero discharge. Andy answered 2030 is a good target at the moment, Stu added as more research and work is completed the model can develop and a finalization date will become clearer. Hugh suggested rather than looking at the vision as one long term goal it is probably better to see it as small short term goals which build towards the long term goal.

Chris pointed out that farmers see wastewater as a resource because fertilizer has become more expensive and the wastewater is an excellent substitute. Alex Webster added that there is also good money for farmers to be made from irrigating effluent.

Andy asked whether they should put something back to the Carterton District Council on the vision to see if they come up with something that meets the expectations of the working party. Andrew added it is an important vision to share with the Carterton Community. Councillors Bill Knowles and Chris Engle agreed Council would confirm its vision.

Possible Milestones

Andy recapped on the previous section and moved onto “Possible Milestones”, firstly he explained how an adjoining land parcel could be used as trial plot for the irrigation scheme. It seems likely that a base allocation of water during irrigation would be determined and given to land owners for the full scheme. Ian replied a land owner would need to evaluate their land and provide irrigating information on what they want opposed to Carterton District Council evaluating land for the required information, as irrigating effluent can have long term effects on the quality of land. Andy explained that this is not a big issue as dry land irrigation does not have a devastating effect on land. Andrew asked how much land would be required for irrigation. Andy estimated 150Ha of land is required and estimated that they have over 300Ha of possible land for irrigation where the land owners have expressed interest. Chris said farmers will need to know what volumes of water and nutrients they are to be receiving. Andy replied farmers are already indicating how much water they require.

Andy asked how they are going to agree on milestones. Emily asked how the consent conditions were going to work with a third party being involved as she did not think it would work. Stu replied first explaining the Riversdale Treatment Plant which was consented to irrigate with oxidation pond effluent under the permitted baseline rules and then asked Emily why we can not do this with a higher quality effluent. Emily explained that was not her problem her problem was that you would need third party permission from the land owners to irrigate. Andy agreed that there would be some degree of risk involved. Stu replied it was the only way unless Council buys land which will mean no reticulation repairs and no upgraded treatment. Stu then asked could the agreement be a milestone. Emily said it could but it would be hard to obtain and explained that it would be better just to be a step towards a milestone.

Ra stated that community consultation is an important milestone. Hugh said the consent conditions could be part of an irrigation milestone for the community aspirations

Emily said she thinks a potential consent condition could be or something similar to, inflow and infiltration will be reduced by a percentage by a certain time. Andy said that removing the high-rate infiltration problems is almost always a good option, but committing to further reductions should wait until the cost-benefit has been better defined.

Ra said the consent conditions could be established from milestones and community conditions because things that we are looking at now might not be all there is and if something does go wrong, this way we can be open about it rather than trying to hide it from the community.

Andrew suggested there might need to be some base line environmental conditions.

Emily asked why the milestones could not be part of the consent. Andy explained that there was not enough information to incorporate the milestones into the consent as things can change and we want to be able to change what we are doing accordingly. Andy gave an example that a cap for phosphorus could be chosen as a consent condition so that they would not discharge to the river phosphorus of a higher level than the cap and a milestone could be to reduce this phosphorus cap. Ian said what Emily was trying to say is that there are things that we know for sure and from this we can determine consent conditions. Andy explained again that information was not available to do this at this time. Andy then asked the group whether it would be of assistance if the current and future information was made available on the internet so they could gain further understanding of practicable milestones and consent conditions. The group agreed that this would be required.

Andy explained that there would need to be milestones that we can flesh out. Emily said she did not understand some of them especially the inflow and infiltration she believed this should be a consent condition. Stu agreed that it would be a good consent condition. Hugh suggested that the consent condition could be based on peak flows not a percentage reduction in flow. Stu explained if you were to have a consent condition on peak flows then you could have the wettest year in 100 years so a percentage reduction would work better. Emily agreed with the reviewing of technology milestone and believed that the consent conditions could require reporting on this milestone and on all other milestones once they are achieved. Hugh included that the community could be reported to as well when each milestone is completed.

Andy then asked if anyone would like to add any milestones. It was then agreed that more time was needed to think about milestones and everybody would send their suggestions to Andy. Ra said one of the things he would like to see would be pumps and pipes so water is actually being taken away from the Mangatarere. Stu replied there are already pumps and half a pipe in place which can be extended onto other farm land.

Stu suggested smoke testing is probably the most efficacious way to investigate inflow and infiltration issues. Andy added it would be good to report progress as well. Andrew suggested instead of increasing rates they could have people individually pay for repairs themselves. Ian suggested that there could be a milestone to enforce a condition in which new subdivisions to have a water strategy for using and disposing of water. Stu enquired is there not already a rainwater storage request in place for new dwellings. Bill explain that in time a condition for compulsory tanks could be part of the building requests but for now it is not. A possible milestone was then discussed for a water strategy to be in place by year five.

Ian made the point that farmers need to take responsibility of taking a base allocation of water away and not just when they want to irrigate. Hugh asked what the total phosphorus produced in the waste water amounts to annually as it is a resource to the farmers and it would show how much fertilizer would not be needed, Stu answered later to this giving an estimate of 10 tonnes.

Stu presented a potential milestone for engaging the community and gaining feed back from the wider community.

Ian asked Bill if Carterton's vision was obtainable within the month Bill explained it might not be possible but they would try.

Schedule for March

- Milestones sent in within a week from the meeting
- Refined milestones proposed by Council representatives
- 23rd March 2010 for meeting #3

Phineas Burke
NZET Ltd
02/03/2010

Carterton Wastewater Upgrade – Steering Committee Meeting #3 – 23rd March 2010 1900-2200Hrs – CDC – Marquis Hotel Of Normandy - Carterton Minutes of Meeting

Committee Members: Ian Gun (Sustainable Wairarapa), Andrew Stewart (Sustainable Wairarapa), Rebecca Fox (Public Health), Alex Webster (Kahungunu), Bill Knowles (CDC), Chris Engel (CDC), Corina Jordon (Fish & Game), Colin Wright (CDC).

Council Officers: Stu Clark (NZET), Andy Duncan (EQONZ).

Invited attendees: Hugh Dixon-Paver (GW)

Apologies: Emily Greenburg (DOC), Dane Rimene (Rangitane).

Late: Ra Smith (Kahungunu)

Minutes

The meeting was opened by Andy at 7:00pm.

Introduction

Andy had prepared a draft document for this meeting titled Carterton District Council wastewater consent, a discussion document on community milestones; he worked through the document as the meeting progressed.

Conditions, Milestones and Recommendations

Andy described the list of collectively collaborated milestones proposed by the group and suggested it was a good number of milestones to have. He suggested that the group adopt *recommendations*, milestones and consent conditions, and that the recommendations would reduce the number of milestones whilst ensuring that aspects of importance to the group are investigated during the consent term.

Andy then explained the consent conditions would have to refer to particular aspects as Greater Wellington Regional Council (GW) can not consent something of uncertainty. Corina asked how long the short term consent is to be, Andy answered five years. Corina said she could write up a possible consent condition for the group to be sent out by email and reviewed by the end of the week. Hugh presented GW’s view, they would not want to set unrealistic conditions for Carterton that would fail, and would prefer to have progressive but probable conditions. Andy explained to Corina that they are trying to plan what to do and there is not enough information within their plan to detail absolute consent conditions in regard to farm irrigation.

Andy asked the group whether they had any comments on the recommendations, milestones or conditions. Rebecca thought the plan was very clear and well set out.

Long Term Council Community Plan

Corina asked how is this plan tied into the Long Term Council Community Plan (LTCCP) for Carterton in regards to the budget. Andy answered that he has not developed a detailed enough plan for implementing cost into the LTCCP. Colin explained CDC's view; they did not know what was to come from these meetings and wanted to build their decisions around the discussion and ideas of the meetings.

Corina asked what sorts of upgrades are proposed and what the available funds are. Stu explained that the group is proposing membrane filtration treatment and then irrigating effluent to land. Inflow and Infiltration control is to be an ongoing process and larger storage is proposed in the long term. Colin explained that CDC has 1.5 – 2 million available for the membrane filtration treatment and there is more money for the other works but costs have not been detailed.

Colin asked if they have had any more feed back from GW about the idea of the proposed milestones rolling over into the long term consent. Hugh answered that he had spoken to Stephen Thawley of GW who had said it was practicable but he was not 100% sure and that their consent conditions would have to be set on definite parameters so you would need to make realistic and inexpensive milestones. Hugh commented and thought that the group had moved the milestones in the direction of minimising risks.

Premier Bacon

Alex introduced the topic of Premier Bacon to Corina, explaining that they contribute a high level of nutrients and flow to Carterton's Treatment Plant (CTP) and that Premier are indecision at the moment whether to continue discharging to CTP or an alternative solution, managing their own effluent. Colin informed the group on Premier's progress, they are preparing a report to CDC which could include their decision but he did not know when this will be completed. Bill added that Premier want to discuss the matter with CDC before making a decision. Corina explained if Premier's discharge is removed, they could have a consent condition incorporating that factor of removal for Carterton's nutrient levels. Andy explained that there is no certainty about what may happen in this regard and that the proposed works do not assume this benefit. Any reduction in loads will therefore be a bonus.

Corina asked Colin whether trade waste charges are expiring this year. Colin explained that Premier could not pay and did not have to pay trade waste charges for the first financial year but Council is trying to work on an agreement with Premier for trade waste nutrient charges.

Irrigation Options

Andy moved the meeting forward to irrigation options; he provided another hand out which was a summary of suitable irrigation areas, displayed on an aerial photograph, produced from information supplied by interested land owners. Andy suggested 'group' 2 to be used for establishing the irrigation scheme as it is, the area in which the most information has been provided by land owners, and it is located 2.5 – 3Km from the treatment plant. Andy stated that if this is established we could achieve annual flow reductions of 6 – 20%. Stu added, the current reduction they are achieving with irrigating is 2% but that is because they have limited land, their expired consent only allows three months of irrigation, and rainfall is substantially larger in winter than in summer which results in higher flows. Andy included that there would also be a limit to flow reductions due to the capacity of processing for the membrane filtration plant but there are other places such as the golf course which would not require this level of treatment.

Alex asked if 2 or more people signed up for irrigation would installation works commence. Andy answered that he needs further discussion with Council to answer that question completely but the next step is to ask farmers to provide some additional storage for the water and creating some sort of security for CDC with the land they are to irrigate. The question then arose, how have the landowners expressed an interest. Andy explained that he had consulted many land owners and some had simply signed up with their name others he had had detailed discussions with.

Ian asked what types of costs CDC would be looking at for irrigation installation works and could he have more clarification on the flow reduction %. Andy answered pipe costs are relatively inexpensive and there is already a section of existing pipe in the direction of irrigation area ‘Group 2’ (Dalefield). Stu explained the flow (discharge to water) reduction of 6 – 20% given is a realistic view for what Andy has suggested. Andrew asked, why did works not continue when the now existing pipe was laid, could this happen again. Stu explained that certain issues had arisen at the time.

Andy pointed out that the Group 2 irrigation area covers a large area and before irrigating an evaluation covering aspects such as soil types and ground water tables of the land would be part of the works carried out.

Cultural Health Indexing

Rebecca asked how health issues will relate to the irrigation works and explained that the Health Inspection Assessment (HIA) would be of a much broader range, involving the impact on the community and the inspection would have a large impact on the irrigation works. She said she would provide further information to clarify and explain exactly what she means. She also suggested a consultant may not be best for the HIA and somebody else within the group would be.

Andy asked Ra if he could describe his views on Cultural Health Indexing (CHI). Ra explained that Maori would want to know how the discharge is affecting the waterways, physically and biologically, they would also like to see at what quantity the waterways are being affected. He thought an ecological assessment would be necessary to see the on going effects to fish, fauna and wildlife and the CHI would have to be on going and reported every 6 months or something similar. Ra explained their progress; we have a set of base line values and would be looking at a broad CHI accounting for different factors such as seasonal variation and other potential sources of contaminant towards the waterways, not just CTP. He suggested the CHI could intertwine with consent conditions. Corina explained that the broad CHI could not co-operate with consent conditions but the small part of the CHI relating to Carterton’s Treatment Plant could.

Flow Reduction

Ian asked what the actual expected figure for flow reduction would be from irrigation. Andy replied a good figure would be 10%. Hugh asked how will Premier Bacon and I&I control reduce flows. Andy and Stu explained that Premier is unpredictable as they could reduce their flows to the Carterton's Treatment Plant anywhere between 0 – 100% and for I&I control more time was needed in predicting a model to show what level of flow reduction can be expected.

Ian asked how long the period of irrigation is. Stu answered, it is three months as written in the current expired consent. The group then agreed greater flexibility is needed for the irrigation period. Stu explained that it would be a possibility in the new consent but CDC are not able to develop this flexibility with the current expired consent, Ra clarified; you legally can not oppose a condition that you have signed for. Colin explained that CDC had asked GW previously if they could continue discharging to land out of the irrigation period and GW did not allowed it. The group then agreed that the new consent would have a more flexible irrigation period and they would investigate this week for whether it is possible.

Andy asked if they could now move focus to the proposed milestones. Andy explained a plan would be developed for achieving the milestones, put to CDC for evaluation and if accepted would become the strategy i.e. when, how, why, what.

Trade Waste Charges

Ra asked how trade waste was going to be incorporated in the plan. Colin and Chris explained that CDC are planning to charge for trade waste nutrient loads soon and at the moment are coming to an agreement with the trade waste industries. Ra said he understands but we need a time and date. Andrew asked what affect Premier's discharge is going to have on the flow reduction milestone. Stu explained that the flows from Premier are not the main concern, the nutrient loading is significant but a 5% reduction could be expected in flows. Ra said his main concern was of the nutrients. Rebecca suggested putting the aspect of trade wastes on hold and to wait for CDC to meet with Premier so their decision/plan can be acknowledged, as it appears we need that piece for detail to discuss trade wastes. Stu addressed the approximate costs determined for trade waste nutrient loads, $10.00 per Kg each for nitrogen and phosphorus. Ra point out that these charges would need to be factored into the plan if considerable savings are to be made.

Proposed Milestones

Andrew brought the discussion back to the milestones asking how the "irrigation scenario analysis & strategy" milestone is going to be approved. Andy and Stu explained they had not thought into that yet but the first step is to present the plan to CDC. Ian clarified that the only concrete milestone is the 1st, "% reduction in discharge to water" and the 3rd, "formal response from CDC on recommendations." Andy added no milestones will be official until written into the new short term consent.

Ra asked how long the third milestone would take. Andy said two years would be expected and the first step is to put the ideas to CDC for approval and explained to the group that they need to design milestones which are progressive, probable and free of risk.

Ian requested clarification on the recommendations. Andy suggested the "% I&I reduction target", could possibly relate to the % reduction milestone in discharging to water.
Ra explained that the community reporting recommendation was to stay out of the consent and that it is there just make people aware of the planning, strategy, works and results. Andy added, it has already commenced with the forum on the internet. Ian thought that some of the recommendations could come under each other; he believed community reporting and community engagement are very similar. Andy explained both are different from each other because community reporting is reporting to the community and community engagement is the community's feed back, their thoughts and ideas towards the overall goal; however he did see what Ian was alluding to. Ra suggested defining the recommendations as to elucidate them and eliminate misinterpretation. Rebecca added that the definitions could be made available on the internet so they can be discussed and altered by the group. Andy said he would work towards that.

Ian clarified that the 1st milestone "% reduction in discharge to water" applies to the first five years, for the period of the short term consent, but the other two are more ongoing and apply to the long term goal of zero discharge.

The group discussed and proposed that the strategy could be planned now and the LTCCP could be consulted in 2012. Colin said only a proportion of the strategy could be implemented into the LTCCP.

Ra said he would like to flesh some things out but at the moment we have just started building momentum and thought particular aspects such as the 6 – 20 % flow reduction could change and become more exact as momentum increases and therefore nothing should be taken for certain. Andrew explained that he saw the % flow reduction milestone as a trust building process for the community. Stu agreed; it is a validation to the community to help gain support. Ra suggested the milestones following the consent rollover could tighten. Hugh explained that the group would need to show assurance in that achieving milestones would result in progress towards the long term goal of zero discharge, otherwise stricter conditions could be inferred and would make things more difficult and expensive.

Andy asked if everyone could give there personal opinions on the milestones. Ra said he would not mind seeing a timeline for reviewing of the milestones at appropriate yearly intervals within the five year short term consent period, for example: 1st milestone "% reduction in discharge to water", after 4 years it is reviewed; 2nd milestone irrigation scenario analysis and strategy, 3 years; and 3rd milestone "formal response from CDC on recommendations" 2 years. Stu asked for clarification of the reviewing process. Hugh explained it would probably be a standard consent condition to review and report milestones.

Corina asked if the milestones would be incorporated into the consent conditions. Ra explained that the recommendations and the milestones are separate from the consent but they would indirectly relate to the short term consent and issues which arise from the milestones over the next five years could be included in the next consent.

Ian suggested a timeline to be designed for the 2nd milestone, "irrigation scenario analysis and strategy”. Andy explained that they had a lot of time available for designing a timeline but at the moment it was not feasible as more information was required. Ian asked Andy how can you guarantee in 2030 you will be able to achieve zero discharge. Andy explained it was a goal not a guarantee. Andy and Stu further explained that they could not create a timeline as they did not know all the aspects such as how much storage is needed or how much they are going to discharge, but within the 5 year short term consent period they can develop this information and thus a timeline. Ian detailed that what he meant was a timeline for the gathering of this information towards the 2nd milestone.

Rebecca said she was happy with what is happening but wants a recommendation of or to include the HIA and also to create a liaison group for the community which would communicate with the steering committee and for this liaison group to be left out of consent conditions.

Andy said they would prefer not to go through a hearing and asked Hugh how the group can ease the consent process. Hugh answered; they must have a hearing if a submitter wishes to be heard. The group agreed that if this is the case then the community will have to be well informed, so when they apply for a resource consent a submission is not submitted which wishes to be heard. Ra suggested to CDC that they would need to take care in the way they inform the public about the health of the river. Ian asked if people do not wish to be heard how can they participate with the consent process. Andy answered, the group would evaluate community ideas and thoughts then alter the plan accordingly before requesting submissions.
Andy asked if, based on the format and milestones agreed to date, if the group would be willing to enter submissions stating “do not wish to be heard” to avoid a hearing. Each member of the group agreed. Ra and Corina noted that this was subject to agreement on the consent conditions.

Flow Basis

Hugh asked if the weather data used for the flow calculation data is a reliable model and pointed out that July to July is not a good hydrological year. Stu explained the model predictions are of flow calculated from rainfall and the period used has reliable actual rainfall and flow data. Andy added that the model was based on two full years of data.

Andrew asked if Andy and Stu had found anymore information on how the reticulation repairs last year affected the sewer flows. Andy and Stu explained they are currently still collaborating data to determine its affects. Andrew then asked what the expected flow reduction from reticulation repairs would be. Andy said that they don’t have enough data at the moment, but should be able to supply an estimate soon.

Draft Vision Statement

A draft vision statement was provided by CDC:

“The Carterton District Council’s long-term vision for the Dalefield Road Wastewater Treatment Plant is to be discharging all treated effluent to land except in extreme weather events. The Council is aiming to achieve this in partnership with farmers in the area rather than the Council having to own land. The progress towards achieving

this vision will be governed by practical realities of achieving suitable arrangements and the ability of the Carterton community to pay for the improvements."

The group discussed the amount of information to be included in the vision. Ra suggested including two partnerships, one with the community as we want to encourage fixing direct inflow and using phosphorus free soaps and the other with the farmers, who have a huge impact on the irrigation scheme. Andrew suggested more information could be included for how they are going to work towards the vision. Ra said he would like an extended amount of information in the vision so that he could present it to the Marae. Stu explained that the purpose of a vision statement is to be brief and present a general idea. Andy added, if people are interested in knowing more they can check out the forum on the internet.

Schedule

- No future meeting was decided but communication of the group via the internet forum was encouraged.
- Hugh to provide proposed consent conditions by late April.
- Defining and fleshing out recommendations, and finalising milestones by late April.
- Rebecca said she would work on defining the *recommendations* for rainwater storage, long-term reductions targets, and community engagement. Ra said he would work on defining the *recommendations* on cultural health indexing, technology review, and community reporting.

Phineas Burke
NZET Ltd
24/03/2010

Appendix D: Public Information Brochure

Appendix E: Biota Monitoring Reports for the Mangatarere Stream

Appendix F: Photographs of Existing System