Community and Whole Genome Analysis of Wastewater Bacteria

By

Daniel Rice

BSc(Hons)

A thesis submitted in total fulfilment of the requirements for the degree of Master of Science

School of Life Sciences

College of Science, Health and Engineering

La Trobe University

Victoria

Australia

February 2020

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

-1	per
°C	Degrees Celsius
µg	Microgram(s)
µl	Microlitre
µm	Micrometre
AS	Activated sludge
BLAST	Basic local alignment search tool
Bp	Base pair
C	Carbon
dH2O	Distilled water
DMSO	Dimethyl sulphoxide
DNA	Deoxyribonucleic acid
dNTPs	Deoxyribonucleotide triphosphate
EBPR	Enhanced biological phosphorous removal
EDTA	Ethylenediaminetetraacetic acid disodium salt dihydrate
et al	*Et alii* (and others)
FISH	Fluorescence *in situ* hybridisation
g	Gram(s)
gDNA	genomic DNA
GIS	Gisborne
hr	Hour(s)
kb	Kilo base pair
kPa	Kilo Pascals
L	Litre
M	Molar
mg	Milligram(s)
min	Minute(s)
ml	Millilitre(s)
mM	Millimolar
N	Nitrogen
NA	Nutrient agar
NB	Nutrient broth
NCBI	National Centre for Biotechnology Information
ng	Nanograms
nMDS	Non-metric multidimensional scaling plot
OD	Optical density
OTU	Operational taxonomic unit
P	Phosphorous
PAO	Polyphosphate accumulating organism
PCR	Polymerase Chain Reaction
PCoA	Principle coordinates analysis
PEG 8000	Polyethylene glycol 8000
RAS	Return activated sludge
RNA	Ribonucleic acid
rRNA	Ribosomal RNA
SDS	Sodium dodecyl sulphate

sec	Second(s)
spp.	Species
SVI	Sludge volume index
SUN	Sunbury
TAE	Tris-acetate-EDTA
TE	Tris-EDTA
U	Units
V	Volts
v/v	volumer per volume
w/v	Weight per volume
WAS	Queensland 2
WWTP	Wastewater treatment plant

STATEMENT OF AUTHORSHIP

Except where reference is made in the text of the thesis, this thesis contains no material published elsewhere or extracted in whole or in part from a thesis accepted for the award of any other degree or diploma.

No other person's work has been used without due acknowledgement in the main text of the thesis.

This thesis has not been submitted for the award of any degree or diploma in any other tertiary institution.

This work was supported by an Australian Government Research Training Program Scholarship

This work was supported by a La Trobe University Postgraduate Research Scholarship

Signature…………………………….

Date 19/02/2020

ACKNOWLEDGEMENTS

First and foremost, I'd like to thank my supervisor and mentor Dr. Steve Petrovski who has been a great wealth of knowledge and support. Steve has gone above and beyond to help in the writing of this thesis, and I cannot thank him enough. I'd also like to thank my co-supervisor, Prof. Robert Seviour, who has also been an amazing guide through these trying times. For this I thank both of you. This thanks extends to my colleagues who also worked in the Petrovski lab.

I'd like to thank those who helped in some way with the handling of the data. This includes Dr. Steven Batinovic, who helped with some bioinformatics and MinION sequencing, and Peter Griffiths who provided much need technical advice and information when it was required.

Without the help of the wastewater treatment plant operators from Western Water, Scott Johnson and Veena Velascas without whom, this project would never have happened. They were able to provide access to the wastewater treatment plants and much technical advice when convening with them about certain data.

This work was supported by a La Trobe University Postgraduate Research Scholarship.

ABSTRACT

Activated sludge, the most globally accepted wastewater treatment option, utilizes diverse bacterial communities to remove excess nutrients from the bulk liquid. The bacteria within these communities perform specific metabolic functions to allow this and can be studied to identify which microbes are responsible for which process. However, the system can sometimes favour the growth of filamentous bacteria allowing them to proliferate uncontrollably and cause operating issues. This study aimed to characterise three Australian wastewater treatment plants enhanced for nutrient removal over a 12-month period and to identify novel filament forming bacteria.

An amplicon sequencing survey was performed on the bacterial communities of the three treatment plants over a 12-month period. Additionally, operational data was collected so that potential trends could be identified with the bacteria. Across 102 samples the number of reads varied from 9,868-83,642 and the number of amplicon sequence variants (ASVs) varied from 73-272. Each plant was dominated by different genera and had distinctly different communities.

An *Acidovorax sp.* was isolated which exhibited a filamentous morphology and was subjected to whole genome sequencing using Illumina MiSeq and Oxford Nanopore MinION platforms. This was performed to gain a better understanding of its role within activated sludge and to identify genes involved in morphology. Based on its genome this organism has the potential ability to perform denitrification, a process well documented for this genus. It also contained genes which resemble the well documented division and cell wall gene cluster found in *Escherichia coli* which could highlight why this organism forms a filamentous morphology.

Section 1

INTRODUCTION

1.1 Activated Sludge Process

Wastewater treatment processes are crucial for the reduction of pollutants, such as microbes, organic and inorganic matter, from sewerage. This minimises the potential for both waterborne diseases and eutrophication in natural water bodies (1). The most globally accepted wastewater treatment process is the activated sludge (AS) method, first developed in 1914 by Locket and Ardern (2, 3). This system contains two phases, first a basin for aeration followed by a clarifier for separation of biomass (sludge) from the liquid phase (Figure 1.1). Raw sewage influent is introduced into the aeration basin from industrial or municipal sources consisting of faecal matter, heavy metals, surfactants and microbes. Here it encounters recycled biomass, consisting predominantly of bacteria and protozoa, and aeration is applied either mechanically or by diffusion. This promotes growth of microbes by keeping them in constant contact with metabolites and by supplying oxygen which in turn promotes floc formation. Successful formation of flocs is crucial for this process to ensure that the solid phase may properly separate from the liquid phase, so that a clear supernatant is produced.

These systems aim to remove excess nutrients from the bulk liquid, such as carbon (C), nitrogen (N) and phosphorous (P) (4). Traditional AS systems subject the wastewater to aeration to allow microbial growth which would perform nutrient removal and solids formation (Figure 1.1). Upon sufficient aeration the wastewater is then passed to a secondary clarifier where the solids phase is allowed to separate from the liquid phase. The clean water is poured off the top and either subjected to further treatment or passed into a natural water body such as a lake, river or ocean. The majority of the remaining sludge is then either disposed or placed back into aeration basins to re-inoculate the fresh influent with an already successful nutrient removing community of microbes. This is termed Return Activated Sludge (RAS) and is what separated Locket and Arderns wastewater treatment plant (WWTP) designs from the rest.

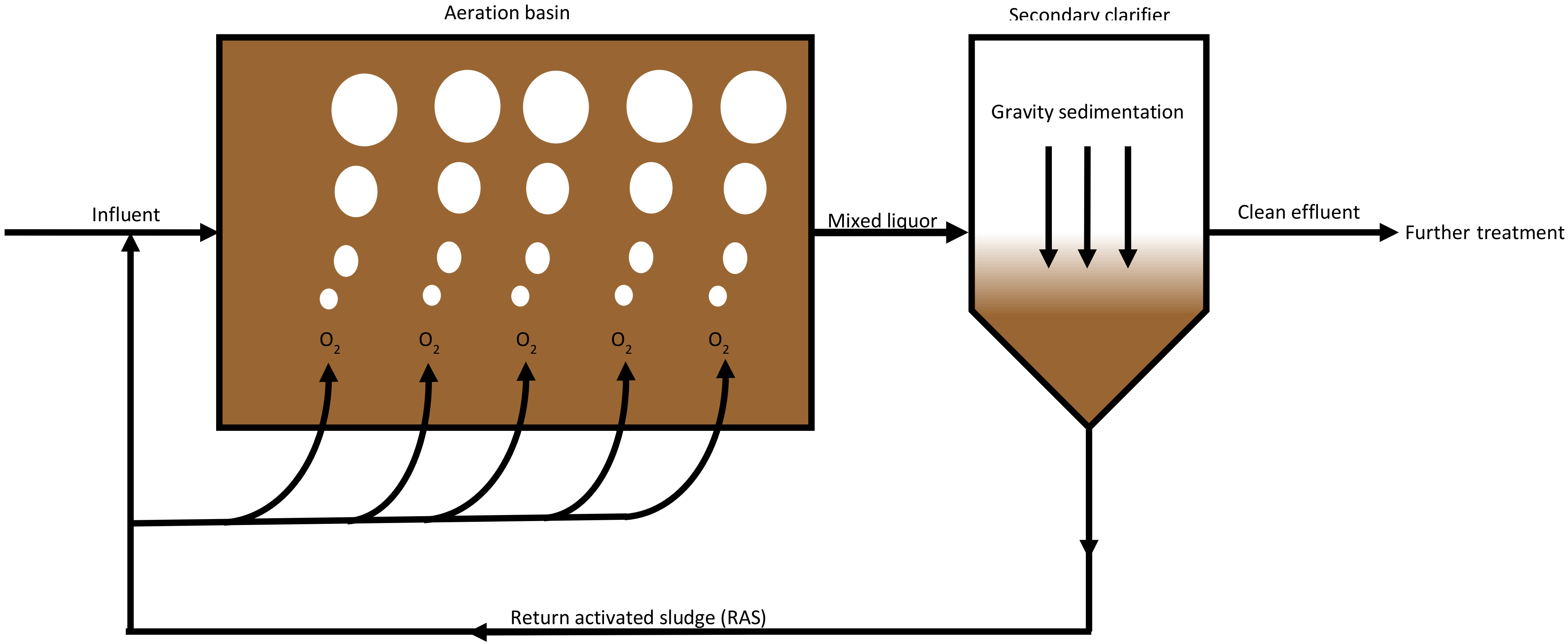


Figure 1.1 Schematic diagram of the activated sludge process. Influent is passed into the aeration basin from municipal and residential sources. Once the mixed liquor has been sufficiently aerated it is passed into the secondary clarifier where the solids are allowed to settle from the liquid phase. The clean effluent is poured from the top of the basin and passed either to a natural water body or on to downstream processes. Additionally, a portion of this sludge is passed back into the aeration to re-inoculate the fresh influent.

Despite many different microorganisms contributing to the process it is the dominating bacterial populations of these microbial communities which is predominantly responsible for the nutrient removal process (5). The other main contributor to the process is the protozoa which actively break down large molecules into smaller components. However, these organisms struggle to remove smaller compounds, such as ammonia, nitrate and phosphate, and in fact, usually produce these as by-products (6). Consequently, the bacteria are responsible for the removal of the smaller compounds removing the excess raw elements from the bulk liquid.

Bacteria are an evolutionarily diverse group of living organisms and have colonised most environments. Consequently this has added many selective pressures causing them to develop a vast array of mechanisms to utilise many different compounds in order to survive in those environments. It is these strategies that are being exploited when bacteria are utilised in artificial systems, such as wastewater treatment. As such it is important to study the mechanisms bacteria use for nutrient removal in conjunction with which bacteria are responsible for performing the respective processes.

Initial studies of wastewater bacteria were limited to culture dependent methods which provided little information of the bacterial diversity in these communities. As a result, an inherent bias towards the study of species which could be cultured has arisen, as the majority are unculturable. A misrepresentation developed of which bacteria were crucial to nutrient removal compared to those which were readily culturable but did not contribute significantly. One such example is *Acinetobacter spp*. were initially thought to be responsible for most phosphorous removal since they were readily culturable and exhibited the phosphorous removing phenotype (7-9). Eventually, this was disproven and *Acinetobacter spp.* are now considered a “laboratory weed” due to their ease of growth in pure culture but are, for the most part, functionally irrelevant in most WWTPs. Misidentifications stressed the need for the development of new techniques which could identify and characterise organisms without culture dependence.

It was advancements in molecular techniques which paved the way for a new era of wastewater research. These not only allowed for identification and characterisation of wastewater bacteria but could be performed on previously uncultured bacteria. This was due to their ability to target the DNA directly *in situ*, particularly the 16S ribosomal RNA (rRNA) gene, a highly conserved bacterial gene which contains nine variable regions (10).

The product of the 16S rRNA gene, which is approximately 1,500 base pairs long, is a crucial component of the ribosome for protein synthesis, hence it is highly conserved. Due to its importance in protein synthesis this gene is subjected to slow rates of evolution however, it does contain nine hypervariable regions. These nine regions allow this gene to be used in identifying bacterial taxonomy as some regions are more conserved than others; more conserved regions equate to higher levels of taxonomy, such as phylum and order, and the variable regions equate to lower levels of taxonomy, such as genus and species (10).

Molecular techniques were soon utilised to exploit this gene to reveal bacteria which had never been previously characterised. One such technique was fluorescent *in situ* hybridization (FISH) which used fluorescently labelled oligonucleotide probes to bind to the 16S rRNA. The probes used in these experiments could be used to target different levels of taxonomy and multiple probes with different fluorophores were often used to target multiple taxonomic levels at once. For example, three probes targeting three different levels of taxonomy, kingdom, genus and species, could be used to show the prevalence of a single species among other members of its genus compared to all bacteria in the sample.

The advantage of FISH is its ability to show varying levels of taxonomy, cell morphology and a species physical association within a community (within a floc, for example). A drawback however, is it gives no indication of species abundance or no metabolic potential of a species. New techniques were developed to overcome these draw backs including the development of qFISH, quantitative analysis of probe binding to determine species abundance, and FISH in combinations with microautoradiography (FISH-MAR), which can determine a species substrate usage. Even though these techniques are still used today, popularity of these techniques dropped greatly after the development of next generation sequencing (NGS). NGS based techniques quickly proved to be one of the most time and cost-effective methods of characterising bacterial communities, by targeting the 16S rRNA gene, and metabolic pathways of a single species, by whole genome sequencing.

The most common method for studying microbial community composition today is amplicon sequencing targeting the 16S rRNA gene. This technique involves PCR amplification of a select few of the hypervariable regions using varying sets of universal primers which is then sequenced and analysed. This utilises varying sets of universal primers which target the variable regions, and each have their own advantages and disadvantages. A summary of the most common primers pairs used can be found in table 1.1. This may reveal both abundance and taxonomic information on which bacteria were present within the sample at the time the sample was taken. This is commonly used to survey the bacterial communities from environmental samples and, if multiple samples are taken and sequenced over time, can indicate the community's response to change.

Table 1.1 Summary of the most commonly used primer sets in amplicon studies.

Regions targeted	V1-V3[a]	V3-V4[a]	V4[a]
Forward primer	27F	314F	515F
Reverse primer	534R	806R	806R
Amplicon length	486	491	291

a= (16)

Additionally, NGS techniques also paved the way for whole genome sequencing of either pure culture isolates or of whole communities to allow for metagenomics. Ideally, whole genome sequencing is performed on pure culture isolates so whole genome data can be analysed alongside experimental data for confirmation of functional genes. However, if an organism cannot be isolated in pure culture another option is to perform metagenomics where whole community genomic DNA is extracted and sequenced potentially gaining whole genomes of every bacterial species present. This can allow for the discovery and genomic characterisation of bacteria which were previously unidentified (11, 12).

1.2 Community profiling of activated sludge bacterial communities

Amplicon sequencing using NGS has provided a valuable tool for the characterisation of bacterial communities in AS. As a result, the true diversity of bacterial communities in AS has been revealed and has given a better understanding of the bacteria and can help predict what role they may be performing within the community. The first amplicon sequencing study of AS was performed in China using 454 pyrosequencing (5). This study and many similar studies since have shown that, generally, the same phyla make up the majority of AS communities. These phyla often include the Proteobacteria, Bacteroidetes, Actinobacteria and Chloroflexi with abundances generally differing between plants however, Proteobacteria are consistently the most dominant phylum (5, 13-15).

More recently there have been reports of core bacterial communities within WWTPs which remain constant across periods of time (4, 5). These studies have predominantly been performed within a specific region (for example Denmark and China) and less than 10% of genera overlapped between them (16). Another study observing the global core community found that 12.4% of OTUs were shared between all WWTPs (16).

Though it is difficult to characterise AS communities based on the abundance of different phyla. Over the duration of most studies the abundance of most phyla will stay consistent however, abundances at genus level may be constantly changing (16). Therefore, to accurately characterise bacterial communities in (WWTPs), identification down to the genus level is essential. To increase the chances of this, choices made during the amplicon sequencing protocols may have a great impact on the study.

Amplicon sequencing has advanced greatly in the wastewater field with the development of protocols and databases developed by a Danish research group (17, 18). These protocols and databases have brought unity and consistency to wastewater researchers attempting these studies to eliminate the potential for unnecessary bias. This is important as many biases exist by consequence of amplicon sequencing, one of the most important being primer bias (18). Choice of primer pairs can greatly affect a study as different primers targeting different variable regions of 16S rRNA gene potentially over or underrepresenting certain phyla.

It was realised after the development of the activated sludge process that alterations to this system can select for specific nutrient removal. The two most popular alterations to configuration include the addition of extra basins to control oxygen levels. The first is the addition of an anaerobic zone before the aerobic zone which allows for enhanced biological phosphorous removal (EBPR). The second is the introduction of anoxic zones before and/or after aeration to select for N removal and thus these additions made the process more reliable and consistent. Changes in configurations select for microbes which are specialised at performing specific processes for nutrient removal, such as N and P removal (4).

1.2.1 Phosphorous removal

P containing compounds may have detrimental effects on water bodies if concentrations are too high. Therefore, alternate configurations of the AS process which allow for the selective removal of P containing compounds have been developed. The most effective method for removing P from the bulk sludge is by configuring WWTP for enhanced biological phosphorous removal (EBPR). This process was discovered by accident more than 50 years ago (19) and has since been studied extensively. The process encourages the intracellular accumulation of phosphorous as polyphosphate granules in polyphosphate accumulating organisms (PAOs). This group of organisms require an initial anaerobic (feast) phase followed by an aerobic (famine) phase to exploit the PAO metabolism (20).

The traditional PAO phenotype requires an initial anaerobic phase to allow for the uptake of short chain fatty acids to produce intracellular polyhydroxyalkonoate (PHA) stores (12). High amounts of P are released into the exterior environment as a result of PHA synthesis however, this is reversed during the aerobic phase. The PHAs are consumed and the PAOs uptake P from the bulk liquid to store it intracellularly as polyphosphate granules. The first, and only, organism which was identified to exhibit this phenotype was *Candidatus* Accumulibacter phosphatis (12). Since this discovery another phenotype was uncovered in members of the genus *Tetrasphaera* which most likely store high amounts of amino acids and fermentation products anaerobically to use in the subsequent aerobic phase (79).

The microbes involved in P removal have since been characterised in many WWTPs around the world, especially in the US, Australia and Denmark (12, 21, 22). It is suspected that the most proficient PAOs are *Ca.* A. phosphatis and multiple members from the genus *Tetrasphaera* (23). Amplicon sequencing data has shown that both of these PAOs are globally abundant however, the most dominant of which is seemingly dependent on geographical location and configuration (16). For many years now it has been accepted that the most globally dominant PAO is *Ca*. Accumulibacter with many studies supporting this (16, 24). The dominant PAO in Danish WWTP plants is *Tetrasphaera* and most of these WWTPs are configured for EBPR. This potentially brings into question if *Ca*. Accumulibacter was initially mis-assessed as the primary PAO (25). However, a recent global study disputes this and found that *Ca.* Accumulibacter was the core PAO in every country except for Denmark, instead being *Tetrasphaera* (16). However, it is important to note that *Tetrasphaera* and *Ca.* Accumulibacter routinely co-exist in high abundances (79). It is possible that discrepancies in known PAO abundances between studies are caused by differences in DNA extraction methods from whole communities (79).

WWTPs enhanced for P removal are also consequently enhanced for N removal. This overlap in process may select for bacteria specialised in P removal and N removal making the overall treatment process more effective than conventional or N removing configurations. Additionally, *Ca*. Accumulibacter and *Tetrasphaera* members are also capable of denitrification which would further select for this organism in EBPR plants (12, 26).

1.2.2 Nitrogen removal

Nitrogenous compounds are some of the most significant in wastewater systems and their removal is imperative. Nitrogenous compounds can cause many complications in water systems including eutrophication, oxygen imbalances and toxicity to aquatic animals. The conventional activated sludge process does not naturally allow for effective removal of Nitrogen from the bulk liquid. This process can be altered which allows for enhanced removal of Nitrogen containing compounds (27).

WWTPs enhanced for N removal pass the sludge continuously between aerobic and anoxic zones to selectively promote growth of nitrifying and denitrifying bacteria. The bacteria involved in this process are split into two groups based on their ability to perform nitrification or denitrification. The diversity of bacteria which are known to perform nitrification is narrow and limited to only a few genera from, usually, specialised phyla. Denitrifying bacteria however, are spread across many genera from many phyla indicating a higher diversity than nitrifiers and consequently are more common in the environment (28).

The aerobic zones allow for nitrification where ammonia is first oxidized to nitrite and then nitrate by nitrifying bacteria. Traditionally, it was always thought that this process was performed by two separate populations; the ammonia oxidizing bacteria (AOB) and the nitrite oxidizing bacteria (NOB). The AOB portion of the community most commonly consists of the genus *Nitrosomonas* however, members from other genera are known to perform this role, for example, the genus *Nitrotoga*. The NOB portion is far more restrictive consisting mostly of members from the genus *Nitrospira* (16).

Recently bacteria that belong to the genus *Nitrospira,* have been shown to perform the entire nitrification process (29, 30). The process, now termed Comammox, occurs when a single species is able to perform the complete oxidation of ammonia to nitrate without the requirement another species. Comammox was first observed in a bioreactor containing an enriched community which was efficient at removing ammonium and nitrate (31). Further studies have revealed that it was members from the genus *Nitrospira* which were performing this process. *Nitrospira* members fall into one of six sublineages, members from sublineage ll are the only organisms known to be capable of comammox (32). This has had major implications within the field of microbial ecology and understanding the true diversity of these bacteria is crucial to future studies.

The anoxic zones allow denitrification to take place where N is removed from the bulk liquid by the sequential reduction of nitrite into N_2 gas. These specialised nitrifying bacteria which perform this process require anoxic conditions as they use compounds such as nitrate and nitrite as a substitute for oxygen as the terminal electron acceptor. This requires the presence of many different proteins to perform this process in full, most of which require multiple genes (Figure 1.2).

In contrast to nitrification, the diversity of bacteria capable of denitrification is far greater and characterisation of these bacteria has been difficult due to their diversity (33). Denitrifying bacteria have been identified in AS using *in situ* techniques, such as FISH, which revealed that *Aquaspirilum, Azoarcus, Thaurea* and *Rhodocylcus* were all abundant (34). Once sequencing techniques became available Yu & Zhang (14) revealed that more than 20 different common genera found in AS contain genes for denitrification. A study in Denmark later identified bacteria which were actively performing denitrification concluding that members of the genera *Rhodoferax*, *Dechloromonas*, *Sulfuritalea*, *Thermomonas* and *Haliangium* were all likely core denitrifiers in the WWTPs that were tested (35). Bacteria involved in this process have received very little attention since.

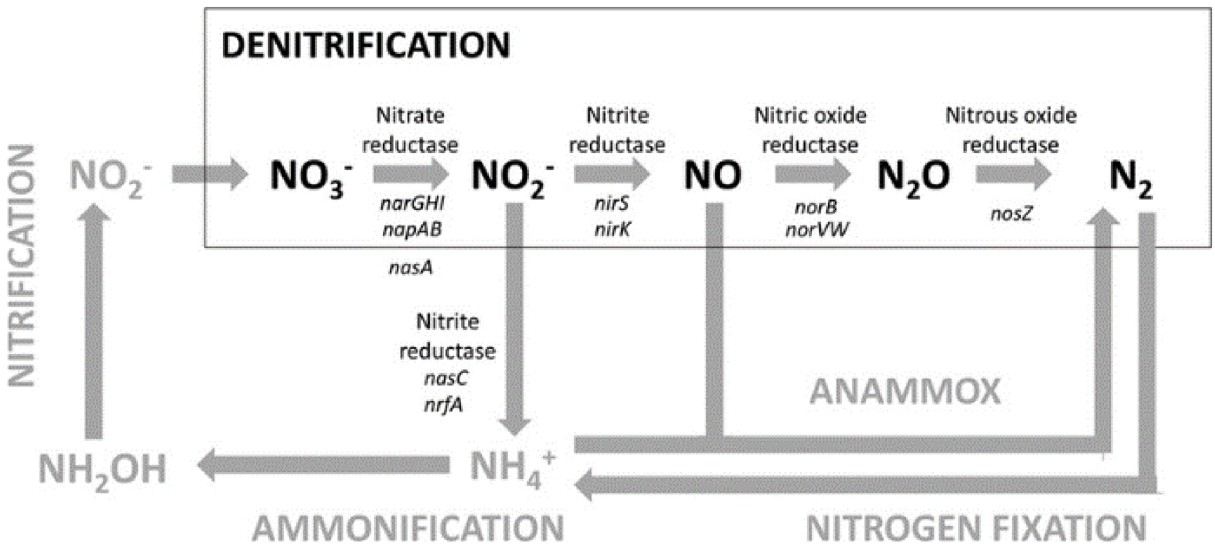


Figure 1.2 The different stages of the nitrogen cycle with a particular focus on the denitrification process and the genes involved and their products. Figure adapted from (36)

1.2.3 Flocs and filamentous bacteria

In addition to nutrient removal, an equally important process is biological floc formation which relies on bacteria with physical and metabolic importance. This includes bacteria which have hydrophobic cell walls, filamentous morphology or the ability to excrete important compounds such as extracellular polysaccharides (EPS). All of these factors are important in the production of biological flocs (2).

The formation of biological flocs is crucial to the successful completion of the AS process as they make up the solids phase. This solids phase will eventually separate from the liquid phase, via gravity sedimentation, allowing the treated effluent to be poured off and passed on for downstream processes. Flocs consist of bacteria, organic and inorganic particles, organic fibres and extracellular polymeric substances (23). Together these form a niche to allow bacteria to undergo their respective metabolic processes to remove excess nutrients from the sludge.

Many different bacteria may contribute to floc formation by providing a scaffold or EPSs to act as a “glue”. The bacteria most well-known for this are those which exhibit filamentous morphologies, these are known as filamentous bacteria. They form a “back bone” providing a structure for floc formation to occur. Before advancements in molecular techniques filamentous bacteria were initially identified based on morphology and assigned a type number (37). It was soon realised however, that this is an ineffective and unreliable method as more than one species may exhibit the same filamentous morphotype (38).

It is now known that the diversity of filamentous bacteria covers multiple phyla with many different species capable of exhibiting such morphotypes. In addition to more bacteria capable of floc formation, a higher diversity of filamentous bacteria also allows for a greater potential of metabolic activity by these bacteria. Many filamentous bacteria may serve a greater benefit to the process beyond floc formation, one such process these bacteria are well known for is fermentation. The ability to perform fermentation not only allows for breakdown of nutrients from the bulk liquid but also allows these bacteria to grow anaerobically (39).

Although filamentous bacteria are both metabolically and morphologically important for the AS process, they are also notorious for causing operational problems. The two main operational problems caused by filamentous bacteria are foaming and bulking.

1.2.3.1 Foaming

Foaming is the formation of a scum layer on the top of the AS basins which can become stabilised, preventing degradation and can cause major problems for WWTPs. These problems include the foam overflowing over the basin onto pathways and potentially allowing for the dissemination of potential pathogens. Foaming also costs the wastewater industry billions of dollars every year as it has very few effective, long-term treatment options. Forms of treatment are limited to physical removal, often involving breakdown with water sprays or extra aeration.

A foam has three main constituents; air bubbles, surfactants and hydrophobic particles. Air bubbles are caused by consequence of the aeration process. Surfactants are a result of detergents entering the treatment plant or some bacteria have been shown to generate potent surfactants that can contribute to foam formation (40). Hydrophobic particles in AS are generally filamentous bacteria which contain hydrophobic cell wall constituents (40). The filamentous bacteria will associate themselves within the foam and stabilise it, meaning it does not naturally dissipate.

The filamentous bacteria which have been implicated in stabilisation of foams are the Actinobacteria. These bacteria are often referred to as the Mycolata as they contain a large amount of mycolic acids within their cell walls. This allows them to exhibit the hydrophobic characteristic that makes them capable of stabilising a foam. Filamentous bacteria which are most commonly associated with foaming include *Gordonia spp.*, and *Candidatus* Microthrix parvicella (41). Although these two are most associated with foaming on a global scale, there are some species which can cause foaming in specific countries, for example *Skermania piniformis* is commonly associated with foaming in Australian WWTPs (42).

1.2.3.2 Bulking

Bulking is caused by the over proliferation of filamentous bacteria within bacterial flocs which eventually causes interfloc bridging. When this occurs, it prevents settling of flocs in the secondary clarifier and greatly reduces the quality of the final effluent. There are very few treatment methods which are effective enough to reliably reduce or prevent bulking and so the water generally must be retreated (2).

Filamentous bacteria capable of causing bulking are much more diverse than those capable of causing foaming. However, bacteria capable stabilising foams may cause bulking, but not all bacteria capable of causing bulking are not all implicated in foam stabilisation (40).

It has been shown that in some instances bulking events due to non-filamentous bacteria can occur, this is known as non-filament bulking. This is most commonly caused by bacteria capable of producing potent exopolysaccharides (EPS). Most commonly associated with this is members of the genus *Zoogloea* which facilitate in floc formation (43, 44).

Table 1.2 Bacterial species associated with foaming and bulking.

Phylum	Bacteria	Morphotype	Operational problem	Contribution	Reference(s)
Actinobacteria	*Candidatus* Microthrix parvicella	Microthrix parvicella	Foaming and bulking	Filamentous structure	Hwang *et al*. (1998)
	Gordonia spp.	*Gordonia amarae*-like organisms	Foaming and bulking	Filamentous structure	Guo & Zhang (2012)
	Skermania piniformis	Pine tree-like organism	Foaming and bulking	Filamentous structure	Seviour *et al*. (2008)
Proteobacteria	*Acinetobacter johnsonii*	Type 1863	Bulking	Filamentous structure	Seviour *et al*. (1997)
	Moraxella osloensis	Type 1863	Bulking	Filamentous structure	Seviour *et al*. (1997)
	Thiothrix spp.	Type 021N	Bulking	Filamentous structure	Kanagawa *et al*. (2000)
Chloroflexi	*Bellilinea* spp.	Type 0092	Bulking	Filamentous structure	Guo & Zhang (2012)
	Caldilinea spp.	Type 0914 & 0803	Bulking	Filamentous structure	McIlroy *et al*. (2016); Speirs *et al*. (2015)
Bacteroidetes	*Chryseobacteria* spp.	Type 1863	Bulking	Filamentous structure	Seviour *et al*. (1997)
	Flavobacterium spp.	Type 0092	Bulking	Filamentous structure	Schade & Lemmer (2006)
Firmicutes	*Bacillus* spp.	Not applicable	Foaming	Surfactant production	Petrovski *et al*. (2011)

1.3 Isolation and genomic characterisation of filamentous bacteria

Due to the ability of filamentous bacteria to be the causative organisms in WWTP operational problems, much research has been conducted to better understand their characteristics and physiology. The main problem lies in the inability to readily culture most of these organisms, making them difficult to study. The historical evidence of this is made obvious when these organisms were first identified as they were given type numbers based on morphology as opposed to species names based on techniques which were only possible on culturable bacteria (37).

As mentioned previously, this problem can now be overcome with advanced molecular techniques which allow for the study of organisms without having to culture them. These techniques, specifically FISH and NGS, have allowed for the study of unculturable organisms to be significantly easier. FISH has provided a tool for the identification and the morphological characterisation of filamentous bacteria knowing the sequence of the 16S rRNA gene. This technique has helped identify organisms of interest which have a filamentous morphotypes (108).

NGS has provided a tool for whole genome sequencing of these organisms to better understand their metabolic potential and what functional role they may fulfil within the AS process. Additionally, it can even give an understanding as to what may allow these bacteria to proliferate in the first place based on knowing what substrates they can utilise (15).

NGS has already been performed with many bacteria both filamentous and non-filamentous. The filamentous portion of these studies has helped characterise bacteria notorious for foaming and bulking (45) and filamentous bacteria which had previously not been characterised (11, 46). One genetic property of these bacteria which is poorly characterised is their ability to form filamentous morphotypes. Understanding this could give insights into evolutionary significance as to why these bacteria are so abundant in wastewater systems. The identification of genes involved in this process may even allow for the identification of a conserved marker which could be PCR amplified to easily identify filamentous bacteria.

1.4 Aims

Wastewater treatment is a globally important process. The lack of such processes can cause disease and eutrophication. The AS process is performed by diverse and abundant bacterial communities which aim to principally remove excess nutrients such as C, N and P. Characterisation of these communities is vital to understanding which bacterial genera are contributing to the process. This may allow for increased knowledge of how to select for functionally important bacteria so that such methods can be applied to plants around the world to optimise wastewater treatment.

Despite the importance of bacteria within these communities they are also responsible for the two biggest problems known to hinder this process; bulking and foaming. The most notable cause of these problems is the uncontrolled proliferation of filamentous morphologies and treatment options for these bacteria are often ineffective. Finding alternate treatment methods to alleviate these problems are essential but in order to do this understanding what allows the bacteria to proliferate in the first place is important. This can be achieved by analysing the whole genome sequences of filamentous bacteria and determining metabolic pathways.

The aims of this study was to characterise bacterial communities in three Australian WWTPs, all three of which were enhanced for N removal. AS communities in Australian WWTPs are poorly characterised and doing so could give further insights into which bacteria are functionally important for the AS process around the world. Additionally, very few community analyses studies have focused on N removing plants over a 12-month period with weekly sampling. The second aim of this study was to isolate and characterise a filamentous bacterium which may be associated with causing operational problems in AS.

Section 2

MATERIALS AND METHODS

2.1 General protocols

2.1.1 Media, buffers and solutions

The media used in this study and their composition are listed in table 2.1. All media were autoclaved at 121 kPa and 121 °C for 20 min. Unless otherwise stated, dH_2O was used as the solvent.

Table 2.1 Media composition

Medium	Composition
R2A broth	0.05% (w/v) Bacto yeast extract; 0.05% (w/v) Bacto proteose peptone; 0.05% (w/v) Sigma hydrolysed casein; 0.05% (w/v) starch; 0.03% (w/v) K_2HPO_4; 0.005% (w/v) $MgSO_4$; 0.03% (w/v) sodium pyruvate
R2A agar	Same as above with the addition of 1.2% (w/v) agar technical
Nutrient agar (NA)	0.5% (w/v) Bacto yeast extract; 3.5% (w/v) Oxoid blood agar base
Nutrient broth (NB)	0.5% (w/v) Bacto yeast extract; 2.5% (w/v) Oxoid nutrient broth

2.1.2 Bacterial strains

Bacterial strains used in this study are listed in Table 2.2. *Escherichia coli* was routinely incubated at 37 °C overnight on NA or in NB. *Acidovorax* strains were incubated at 28 °C for 2-7 d on R2A or GS media agar plates or in R2A broth. All cultures were grown aerobically and were inoculated with a single colony. Liquid cultures were incubated with shaking.

Table 2.2 Bacteria used in this study

Strains	Relevant characteristics	Reference/source
Laboratory strains		
Escherichia coli DH5α	Positive control for PCR	Hanahan (1983)
Bacterial strains		
Acidovorax sp.	Wastewater isolate	This study (Section 3.2)

2.1.3 Wastewater treatment plants and sampling

Three wastewater treatments plants were used in this study, Woodend, Gisborne and Melton, and relevant characteristics are summarised in table 2.3. Weekly samples were taken from the aeration basin of each plant for a 12-month period starting 26/04/2017 and concluded 18/04/2018. Samples were consecutively taken from the same place in each basin at a depth of at least 1 m. Samples were transferred to La Trobe University, on ice, where they were processed for storage, whole community DNA extraction (section 2.4.1.2) and for phage screening (section 2.2.3.1). Operational data was collected at varying time points for the three plants. All operational data can be found in appendix 2.

Table 2.3 Summary of the three wastewater treatment plants used in this study

Plant	Configuration	Capacity (L)	Source – Municipal/Industrial (%)
Woodend	Intermittently decanted aeration lagoon (IDAL) with N removal	1,000	96.8%/3.2%
Gisborne	Activated sludge with N removal	2,000	96.5%/3.5%
Melton	Activated sludge with N removal	13,000	90%/10%

2.2 Microbiology procedures

2.2.1 Micromanipulation and culturing

To cultivate filamentous bacteria, 100 µl of wastewater sample was streaked down the middle of an R2A or GS medium agar. A Skerman micromanipulator was used to isolate single bacterial cells with a glass hook and moved to the outer perimeter of the agar plate (47). Upon completion of micromanipulation, the wastewater streak was excised with a sterile scalpel. Plates were incubated at 21 °C in either aerobic or microaerophilic conditions (5% CO_2) and checked daily for single colony formation.

2.2.2. Gram staining

To visualise bacterial cells based on Gram reaction, cells from a plate culture were smeared across a microscope slide in dH_2O and allowed to air dry. Once dried, cells were heat fixed by passing through a flame four times. Cells were treated with: crystal violet for 30 sec; Iodine for 30 sec; alcohol wash for 10 sec; and safranin red for 25 sec. All steps were followed by a 5 sec wash step with dH_2O. Slides were dried and visualised under a light microscope.

2.3 Genetic procedures

All buffers and reagents used in this study can be found in table 2.3

Table 2.3 Buffers and reagents

Buffer/reagent	Components	Concentration
Agarose gel electrophoresis		
50 x TAE buffer	Tris	24.2 % (w/v)
	Glacial acetic acid	5.71 % (v/v)
	Na_2EDTA (pH 8.5)	3.72 % (w/v)
1 x TAE	50 x TAE	2 % (v/v)
	sdH_2O	-
6 x DNA loading buffer	Tris-HCl	10 mM
	Bromophenol blue	0.03 % (w/v)
	Xylene cyanol FF	0.03 % (w/v)
	Glycerol	60 % (v/v)
	EDTA	60 mM
1 x DNA loading buffer	6 x DNA loading buffer	16.67 % (v/v)
	sdH_2O	83.33 % (v/v)
1 kb DNA ladder	DNA	0.5 µg $µl^{1}$
	Tris-HCl (pH 7.6)	10 mM
	EDTA	1 mM
	6 x loading dye	80 % (v/v)
Agarose gel	Agarose	1 % (w/v)
	1 x TAE buffer	97.5-98.5 % (v/v
	Ethidium bromide (10 mg ml^{-1})	1.5%

GF-1 bacterial DNA extraction kit (Vivantis)	
Buffer R1	As per manufacturer’s instructions
Genomic binding buffer	As per manufacturer’s instructions
Elution buffer	As per manufacturer’s instructions
Powersoil DNA isolation kit (MoBio Laboratories Inc.)	
C1	As per manufacturer’s instructions
C2	As per manufacturer’s instructions
C3	As per manufacturer’s instructions
C4	As per manufacturer’s instructions
C5	As per manufacturer’s instructions
C6	As per manufacturer’s instructions
Qubit DNA quantification (Life technologies)	
Qubit reagent	As per manufacturer’s instructions
Qubit buffer	As per manufacturer’s instructions

2.3.1 DNA extraction

2.3.1.1 Bacterial genomic DNA extraction

The Wizard® Genomic DNA purification kit (Promega) was used for genomic DNA (gDNA) extraction from bacterial pure cultures. This method is commonly used in microbial ecology studies. All centrifugations were carried out at 16,000 x *g*. Stationary phase culture (1 mL) was pelleted via centrifugation for 2 min and supernatant discarded. The pellet was resuspended (600 µl of Nuclei Lysis Solution) and incubated for 5 min at 80 ˚C then subsequently allowed to cool to room temperature. 3 µl of RNase solution was added to mixture and incubated at 37 ˚C for 60 min and then allowed to cool to room temperature. Protein Precipitation Solution (200 µl) was added, vortexed and incubated on ice for 5 min before centrifugation for 3 min. Supernatant was transferred to a new microcentrifuge tube containing 600 µl of isopropanol and mixed. Mixture was subjected to centrifugation for 3 min, supernatant discarded and 600 µl of 70% ethanol were added; mixture was again centrifuged for 3 min. Supernatant was removed and the tube was dried in a Savant DNA 120 speedvac concentrator (Thermo scientific) for 5 min. The pellet was resuspended in 100 µl Rehydration Solution and stored at 4 °C.

2.3.1.2 Genomic DNA extraction of whole community wastewater samples

The DNeasy powersoil kit (Qiagen) was used for whole community gDNA extraction of wastewater samples following the manufacturer's instructions. All centrifugations were carried out at 10,000 x *g*. Aliquots (250 µl) of wastewater sample was added to a power bead tube and vortexed briefly. Solution C1 (60 µl) was added to the mixture and vortexed briefly followed by 10 min on a flat-bed vortex pad on maximum speed. The mixture was centrifuged for 30 sec and supernatant was transferred to a clean microcentrifuge tube. Solution C2 (250 µl) was added to the mixture and vortexed for 5 sec; tubes were then incubated at 4 ˚C for 5 min. All subsequent centrifugation steps were carried out for 1 min unless otherwise stated. The mixture was centrifuged and 600 µl of supernatant was transferred to a clean microcentrifuge tube. Solution C3 (200 µl) was added to the mixture, vortexed and then incubated at 4 ˚C for min. The mixture was centrifuged and 750 µl of supernatant was transferred to a clean microcentrifuge tube with 1200 µl of solution C4 and vortexed for 5 sec. An aliquot (675 µl) of the mixture was transferred to a spin filter and centrifuged. Solution C5 (500 µl) was placed in spin column and centrifuged for 30 sec to wash the gDNA, supernatant was discarded and the column was centrifuged again to dry. The spin column was transferred to a clean microcentrifuge tube and 100 µl of solution C6 was added to spin column and centrifuged for 30 sec to elute DNA. DNA sample were stored at 4 ˚C.

2.3.2 Determination of DNA concentration

DNA concentration was determined using a Qubit (life technologies)(broad range kit) as per manufacturer's instructions. Qubit reagent and Qubit buffer were added to a 1:200 ratio, respectively. DNA (2 µl) of each sample was mixed with 198 µl of Qubit solution, vortexed and incubated at room temperature for 2 min. Samples were then analysed in a Qubit fluorometer.

2.3.3 Polymerase chain reaction procedure and purification of products

DNA for amplification was prepared in two ways: i) For colony PCR (using Less than 10 colonies of bacterial culture), colonies were suspended in 100 µl of 1% (v/v) Tween-20, vortexed to mix and incubated in a water bath at 55 °C. ii) gDNA extraction (see Sections 1.4.1.1 and 1.4.1.2). Amplification targeted either the whole or varying regions of the 16S rRNA gene using primers listed in Table 2.3. Unless otherwise stated, PCR mixture, with a final volume of 25 µl or 50 µl, contained the following: 10% (v/v) DMSO, 5 mM MgCl, 10 X PCR buffer, 0.2 mM dNTPs, 0.5 µM of each oligonucleotide and 2.5 U *Taq* DNA polymerase (for whole 16S rRNA amplification)(Promega) or Platinum *Taq* DNA polymerase (for amplicon sequencing)(Promega). Unless otherwise stated mixture was subjected to 40 thermal cycles in a Professional Trio thermocycler (Biometra) as follows: 94 °C, 4 min (first cycle only); 94 °C, 1 min; 55 °C, 1 min; 72 °C, 1.5 min; 72 °C, 11 min (last cycle only). PCR products were visualised by agarose gel electrophoresis (Section 2.4.5).

Table 2.4 Oligonucleotides used in this study

Name	Sequence 5' → 3'	*E. coli* position	Comments	Use
27F	AGAGTTTGATCMTGGCTCAG	27-46[a]	5' end of 16S rRNA gene	PCR, Sanger & amplicon sequencing
1492R	GGTTACCTTGTTACGACTT	1492-1473[a]	3' end of 16S rRNA gene	PCR & Sanger sequencing
515F	GTGCCAGCMGCCGCGGTAA	515-534[a]	5' end of 16S rRNA gene	Sanger sequencing
519R	GWATTACCGCGGCKGCTG	501-519[a]	3' end of 16S rRNA gene	Amplicon & Sanger sequencing

[a] = Lane (1991)

2.3.4 Bead clean-up of DNA

To prepare DNA for sequencing, the DNA was cleaned with AMpure XP beads to remove excess primers and salts. AMpure XP beads were added to DNA in a 0.6:1 ratio and mixed gently using a shaker at 1800 rpm for 2 min and then allowed to incubate at room temperature for 5 min. Samples were then placed on a magnetic stand for 2 min until supernatant had cleared, supernatant was then removed. 200 µl of freshly prepared 80% ethanol was then added to sample and allowed to incubate for 30 sec before supernatant was removed; this step was repeated. Samples were then allowed to air dry for 10 min to ensure all ethanol had evaporated. Samples were then removed from the magnetic stand and 52.5 µl of 10 mM Tris (pH 8.5) was added and mixed using a shaker at 1800 rpm for 2 min and then allowed to incubate for 2 min. Samples were placed on a magnetic for 2 min until supernatant had cleared, 50 µl of supernatant was then transferred to a fresh tube.

2.3.5 Agarose gel electrophoresis

To visualise presence of DNA a horizontal gel apparatus was used for electrophoresis. 1% (w/v) agarose gels were prepared with 1 X TAE buffer and were supplemented with ethidium bromide (10 mg ml^{-1}). The gels were submerged in TAE and run at 100 V for 1-2 h. The GeneRuler 1 kb DNA ladder (Thermo Scientific) was used as a molecular marker. Gels were visualised and photographed with an enduro GDS gel documentation system (Labnet).

2.3.6 Sequencing

2.3.6.1 Amplicon sequencing library prep

2.3.6.1.1 PCR amplification of amplicon libraries

DNA for amplification was prepared by gDNA extraction (see section 2.4.1.2) and normalised to 5 ng/ µl. Amplifications targeted the V1-3 variable regions (table 2.3) of the 16S rRNA gene with Illumina barcoded primers. This region was targeted as recommended by Albertsen *et al*.[18] for amplicon sequencing of activated sludge samples. The overhang barcode sequences are as follows: Forward overhang: 5' TCGTCGGCAGCGTCAGATGTGTATAAGAGACAG-[locus-specific sequence]; reverse overhand: 5' GTCTCGTGGGCTCGGAGATGTGTATAAGAGACAG-[locus-specific sequence]. PCR mixture was mixed with PCR reagents as outlined in Section 2.4.3.1 however, Platinum *Taq* (Thermo fisher) was used and 5 µl of each primer was added. Mixture was subjected to an altered PCR protocol with 25 thermal cycles in a Professional Trio thermocycler (Biometra) as follows: 95 ˚C, 3 min (first cycle only); 95 ˚C, 30 sec; 55 ˚C, 30 sec; 72 ˚C, 30 sec; 72 ˚C, 5 min (last cycle only). Samples were then subjected to an AMpure XP bead clean up (see Section 2.4.4).

Amplified DNA of the V1-3 regions were then subjected to an additional PCR using Nextera XT index primers. PCR mixture, with a final volume of 50 µl contained the following: 5 µl of DNA, 10% (v/v) DMSO, 5 mM MgCl, 10 X PCR buffer, 0.2 mM dNTPs, 5 µl of unique mixture of Nextera XT index primers and 2.5 U Platinum *Taq* DNA polymerase. Mixture was subjected to eight thermal cycles in a Professional Trio thermocycler (Biometra) as follows: 95 ˚C, 3 min (first cycle only); 95 ˚C, 30 sec; 55 ˚C, 30 sec; 72 ˚C, 30 sec; 72 ˚C, 5 min (last cycle only). Samples were then subjected to an additional bead clean-up (see Section 2.4.4) and then normalised to 4 nM in 10 mM Tris (pH 8.5).

2.3.6.1.2 Library pooling and denaturation

Prior to next generation sequencing the DNA must first be pooled and denatured. PCR amplicons were normalised to 4 nM in 10 mM Tris (pH 8.5) and then pooled by placing 5 µl of all samples into the same tube. An aliquot (5 µl) of pooled DNA library was then mixed into a tube with 5 µl of 0.2 M NaOH, vortexed to mix mixture was then centrifuged at 280 X *g* at 20 ˚C for 1 min and then incubated at room temperature for 5 min to allow DNA to denature. The 10 µl of denatured DNA was added to 990 µl of pre-chilled Hybridisation buffer and then diluted to 20 pM. Diluted and denatured DNA sample was then loaded into the MiSeq using a V3 600 cycle kit. PhiX was added to the run to provide diversity.

2.3.6.2 Whole genome library prep and sequencing

2.3.6.2.1 Illumina library prep and sequencing

Library preparations were carried out as per NextEra XT DNA library prep (Illumina) reference guide and sequenced on a MiSeq sequencing system (Illumina). DNA was normalised to 1 ng μl^{-1}; any samples with lower DNA concentrations were removed. To fragment and tag libraries 10 µl of Tagment DNA buffer was mixed with 5 µl of normalised DNA and 5 µl of Amplicon Tagment Mix by pipetting. Samples were centrifuged at 280 x *g* at 20 °C for 1 min and incubated at room temperature for 1 min.

To amplify libraries, each sample was mixed with 5 µl of two different adapter primers, giving each sample a unique code in a 96 well PCR plate. Nextera PCR master mix was added (15 µL) to solution, mixed via pipetting and centrifuged at 280 x *g* at 20 °C for 1 min. PCR mixture was then placed in a thermocycler for 12 cycles as follows: 72 °C, 3 min (first cycle only); 95 °C, 30 seconds (first cycle only); 95 °C, 10 seconds; 55 °C, 30 seconds; 72 °C, 30 seconds; 72 °C, 5 min (last cycle only).

To remove small DNA fragments (<300 bp) samples were centrifuged at 280 x *g* at 20 °C for 1 min followed by the transfer of 50 µl of PCR product to a midi plate. 30 µl of AMPure XP beads was added to each well as per recommendation of 0.6 X beads for fragments greater than 500bp. The mixture was shaken at 1,800 rpm for 2 min and incubated at room temperature for 5 min. A midi plate containing samples was placed on a magnetic stand until liquid turned clear and supernatant was discarded. To wash, 200 µl of fresh 80% ethanol was added and allowed to incubate on magnetic stand for 30 seconds; supernatant was discarded. Residual ethanol was removed via pipetting and the plate was allowed to air dry on the magnetic stand for 15 min. 52.5 µl of resuspension buffer was added and plate was shaken at 1,800 rpm for 2 min and then incubated at room temperature for 2 min. The midi plate was placed on magnetic stand until liquid was clear and 50 µl of supernatant was transferred to a fresh TCY plate. 5 µl of each sample was visualised with agarose gel electrophoresis to ensure DNA amplification.

To denature libraries, 5 µl of sample was combined with 5 µl of 0.2 M NaOH, vortexed briefly and centrifuged at 280 x *g* for 1 min. After a 5 min incubation period at room temperature, 990 µl of HT1 was added to samples.

Samples were centrifuged at 1,000 x *g* at 20 °C for 1 min and 5 µl of sample was transferred to a PCR 8-tube strip. Samples were then pooled together into a single microcentrifuge tube and inverted to mix. Sample was loaded into MiSeq and run for 36 h.

2.3.6.2.2 Oxford nanopore library prep and sequencing

Genomic DNA was extracted using the Wizard® Genomic DNA Purification Kit (Promega) and sequenced by Oxford Nanopore long read sequencing technologies. Long read libraries for Oxford Nanopore sequencing were prepared using the Ligation Sequencing Kit (LSK108) with Native Barcoding Expansion (NBD104) and sequencing was performed on an Oxford Nanopore MinION (R9.4.1 Spot-on Flow Cell). The genome was hybrid assembled using Unicycler (0.4.8) (7).

2.3.6.3 DNA sequence analysis

2.3.6.3.1 Analysis of amplicons

Upon completion of sequencing, amplicon data must first undergo quality control followed by taxonomy assignment. Amplicon sequence pairs were trimmed to remove primers, truncated to ensure at least 50 bp overlap and merged using Dada2 (48). QIIME2 (49) was then used to assign taxonomy based on the MiDAS taxonomic database (50).

Quality control and paired end read merging was achieved using dada2 however, poor reverse read quality resulted in large quantities of data being discarded and thus only the forward reads were used for further analysis. A total of eight samples were removed due to poor read quality and abundance. Unique reads observed less than 2 times were discarded. Each unique read which becomes a potential representative sequence for a genus are known as amplicon sequence variants. ASVs were determined and taxonomy was assigned using QIIME the MiDAS reference database V2.1.3 (17). Analysis was performed using R packages Ampvis2 (51) for amplicon data and Hmisc (43), qgraph (52) and ggcorplot2 were used for correlation analysis. All scripts can be found in appendix 3. Upon assignment of taxonomy, the data can then be analysed into graphs and figures to make the data visually appealing; the R programming language was used to do this. The ampvis package was used to generate heat maps and box plots

To determine relationships between relative abundance of select OTUs and plant operation variables, OTUs were selected based on high abundance and/or known metabolic importance.

Operational parameters were chosen based on what was available, as supplied by the plant operators. Due to limited operational data for the Gisborne plant only three operational parameters were chosen; nitrate, ammonia and pH. Of the 48 time points taken for the Gisborne plant amplicon sequencing, only 35 were used for correlation analysis as they fell within the same week as sampling. The Melton plant however, had operational data corresponding to all sampling points that were taken within the same week. Additionally, there is a greater availability for operational data including those mentioned above, VSS, VS, suspended solids and settled solids. Correlations analysis was performed using R packages Hmisc (53), for analysis, and ggplot (54), for visualisation of correlations. Pearson correlation analysis was used with significance of $p < 0.05$.

2.3.6.3.2 Whole genome analysis

Whole bacterial genomes were assembled using short read sequences from the Illumina MiSeq and long read sequences using the Oxford Nanopore MinION with Unicycler (Wick *et al*., 2017). Whole genome assemblies were then analysed through Prokka (Seemann, 2014) to assign putative proteins to ORFs. Genomes were then annotated on Geneious and the plugin Mauve (55) was used to perform multiple genome alignment.

Section 3

Changes in the community compositions of three nitrogen removal wastewater treatment plants of different configurations in Victoria, Australia over a 12-month operational period.

3.1 Introduction

There is no doubt that the application of molecular methods has changed considerably our understanding of the microbiology of wastewater treatment plants (WWTP) (56). Plants of different configurations designed to remove nitrogen (N) are in operation around the world, but they have one feature in common. All are designed to ensure the coupling of the aerobic oxidation of ammonia (NH_3) by the chemolithoautotrophic, ammonia oxidizing bacteria (AOB) to nitrite (NO_2) (57). This is then converted to nitrate (NO_3) by the nitrite oxidizing bacteria (31, 58), with the subsequent sequential reduction by anaerobic respiration by the chemoorganoheterotrophic denitrifying bacteria to N_2 using NO_3 as electron acceptor (59, 60). Those AOB and NOB identified as major players in nitrification from early culture dependent methods are now viewed largely as laboratory weeds, and instead other bacteria, including many not readily culturable, have emerged as the dominant populations in activated sludge (57, 58).

Thus, most of the dominant AOB in WWTP communities are previously undescribed and often uncultured populations, and NH_3 oxidizing *Archaea* (AOA) are now known to be abundant in WWTP communities (61-63). Furthermore, It is now clear that the NOB bacteria *Nitrospira* and not *Nitrobacter* are largely responsible for nitrite oxidation, and in many plants are found with previously unknown *Nitrotoga* populations (64). *Nitrotoga* are less abundant, except in plants operating at low temperatures (65). Members of the genus *Nitrospira* have been shown to be phylogenetically diverse containing members of the *Proteobacteria* and *Chloroflexi* (66). They are also metabolically diverse, being able to behave as mixotrophs, in oxidizing formate or H_2 as energy source as well as NO_2 (67). The interactions between the AOB and NOB are now known to be mutualistically symbiotic. Each appears microscopically as a tight clusters of cells in close proximity to the other, allowing the AOB to provide the NOB with their energy source of NO_2 which is toxic to the AOB, while the NOB in turn supply their symbiotic partners with NH_3 generated enzymatically from cyanate and urea (67), and probably other growth factors (58).

The long-held view that complete oxidation of NH_3 to NO_3 required the cooperative interaction of the AOB/AOA and NOB is no longer valid. The discovery that certain *Nitrospira* populations alone can carry out this complete oxidation, known as complete ammonia oxidation (Comammox), has led to a radical rethink of the ecological implications of natural communities where these are present. Their abundance and importance in WWTP systems has been questioned by Gonzalez-Martinez et al. (68), but it seems clear now that they are found widely and often in high abundance there (58, 69-71). They exhibit a high level of taxonomic and physiological diversity (72). Equally impressive is our advances in recognizing which of the many bacteria populations capable of denitrification are active in activated sludge communities, and which substrates they use as electron donors (60).

Next generation DNA 16S rRNA amplicon sequencing protocols (73) have also provided the opportunity to understand which factors, intrinsic and extrinsic, are responsible for determining the composition of activated sludge and more recently the dynamics of community assemblage patterns across both space and time (74). Both extrinsic environmental conditions and intrinsic inter-population interactions are considered to play important roles in determining how and why communities assemble and change (74), although little data are currently available in such studies on the impact on *in situ* activity of populations shown by amplicon sequencing to be abundant there. As most activated sludge community compositions are highly dynamic in ways not well understood and are likely to reflect complex and interactions between many still poorly understood factors, it is difficult to arrive at general ecological principles applicable to all currently.

Certainly in many early amplicon sequencing studies, most such analyses were largely descriptive, carried out often on single numbers of biomass samples (75), and often without details of plant configurations or operating parameters. Later studies have, usually employed frequent sampling regimes over extended periods of time. Variables including seasonal and temperature changes (73, 76-78), influent compositions (79), plant location (77, 80), different plant unit processes (75), wastewater biodegradability (81) and plant operational parameters (82) can all influence plant community composition, but each of these variables are not applicable in all plants. Methodological studies have included those addressing the often-ignored importance of plant sampling frequencies and length of sampling on the reliability of subsequent statistical data analyses (79). Most published data were from plants in China, and little information globally has been available. However, the report of Wu et al. (16) has addressed this, where c.a 1200 samples from 269 plants from 6 continents were analysed.

Therefore, while much data is available now on population diversities of plant communities with different configurations (see above), there are scant similar data from plants in Australia. In this study, communities of three WWTP for removal of nitrogen microbiologically were monitored on a weekly basis over 12months using Illumina sequencing of 16S rRNA amplicons. The data here show that communities of each of these plants, all located in close proximity in Victoria, Australia, exposed to similar climate conditions, and treating predominantly similar domestic wastes were distinctively different to each other. Attempts are made here to try to explain these differences, and the dynamic shifts in population abundances in each WWTP, which occurred over the study period.

3.2 Results

3.2.1 General Comments

Although the compositions of the plant communities were quite different to each other (Figures 3.1, 3.2), members of the phylum *Proteobacteria* were the most abundant in all three, with the Betaproteobacteria being the major Class. Most of the populations of highest percentage abundances in each changed little over the course of this study however, there are few exceptions and these are discussed in more detail later (Figures 3.6, 3.8, 3.10). No Archaeal NH_3 oxidizers (AOA) or Anammox bacteria were detected in any of the three plant communities over the study period. However, it is most likely that the primers used for amplicon sequencing in this study are not optimal for archaea and so the AOA are present in the wastewater but not detected by the sequencing methods.

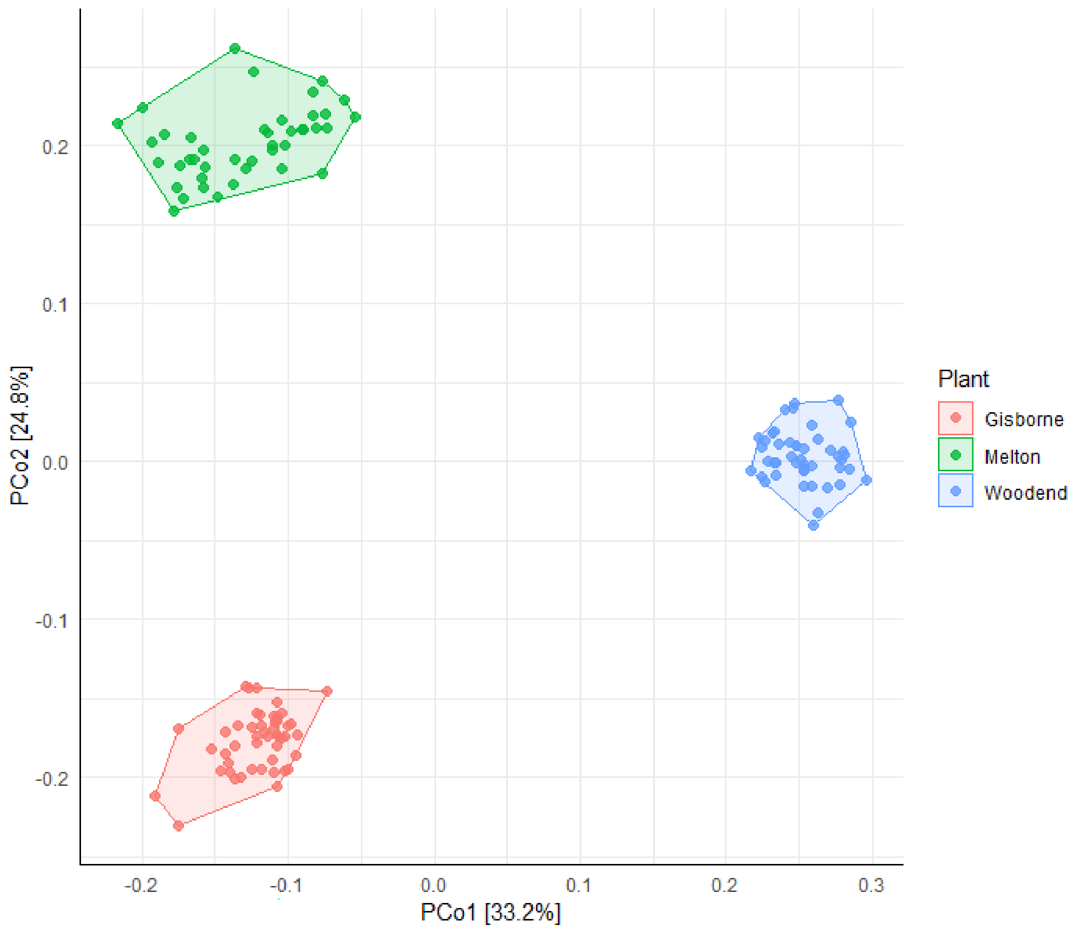


Figure 3.1 PCoA ordination of all samples from the three plants, represented by different colours, which have each formed their own clusters suggesting few community similarities between the three plants.

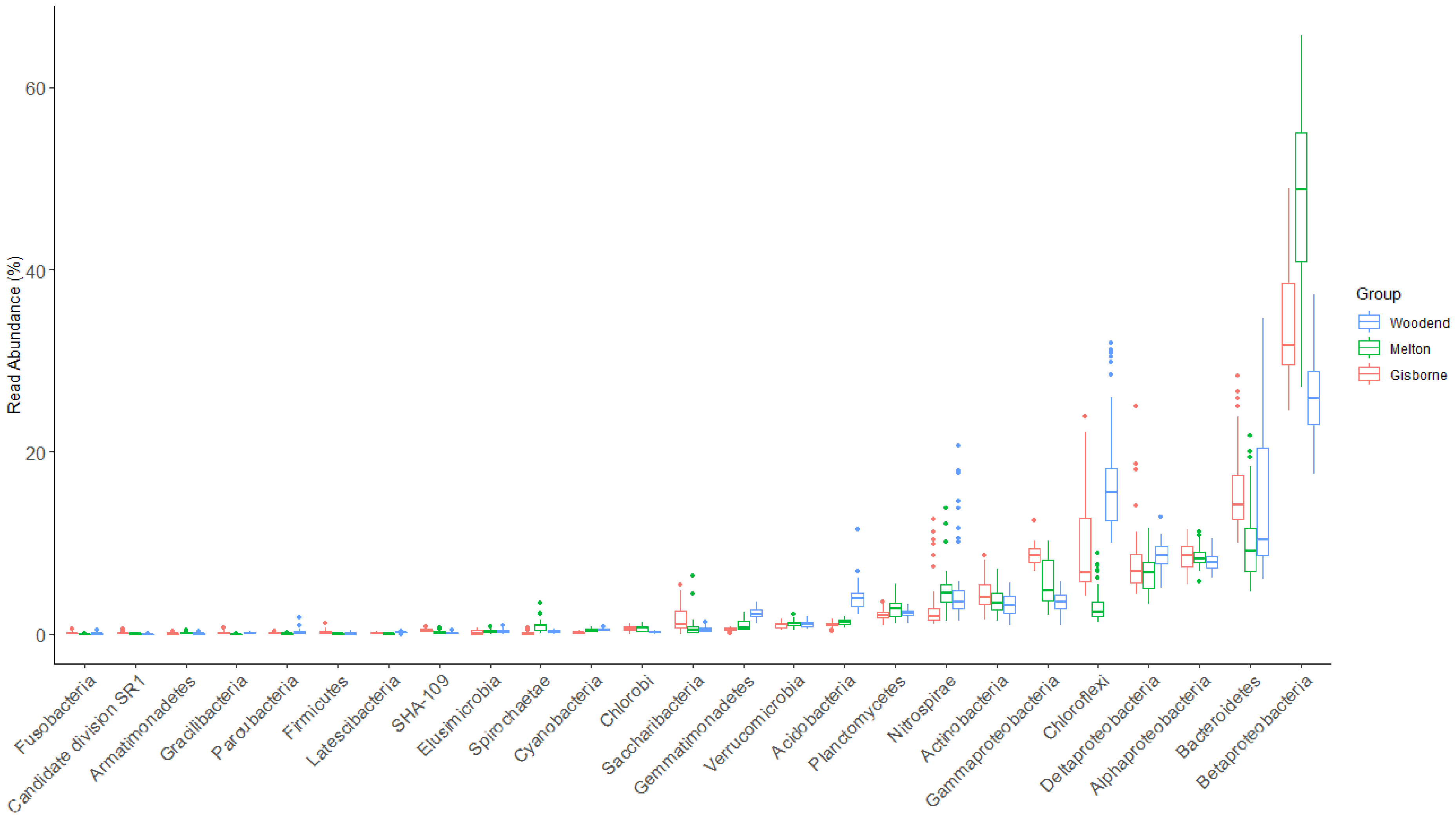
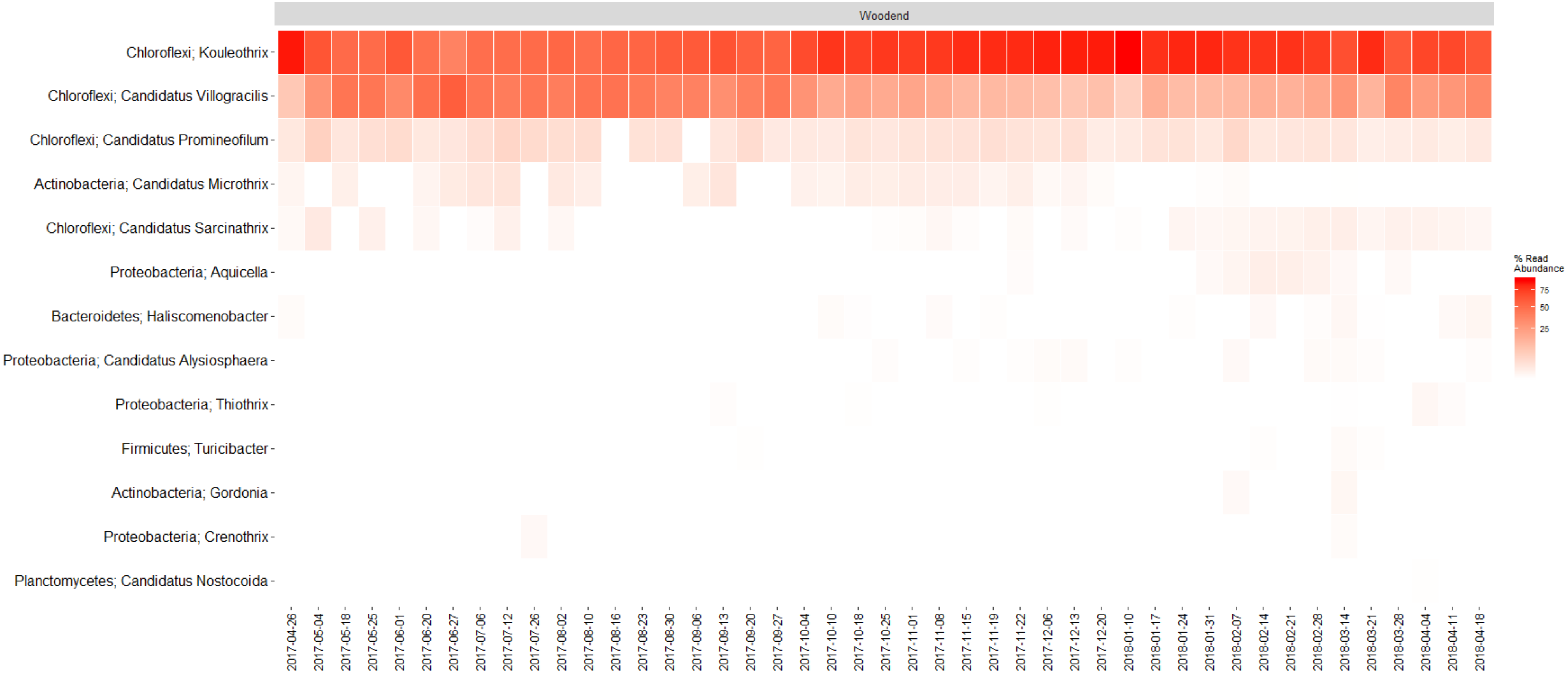


Figure 3.2 Boxplot showing the average abundance of the top 25 phyla across all time points of all plants. Proteobacteria are split into class.

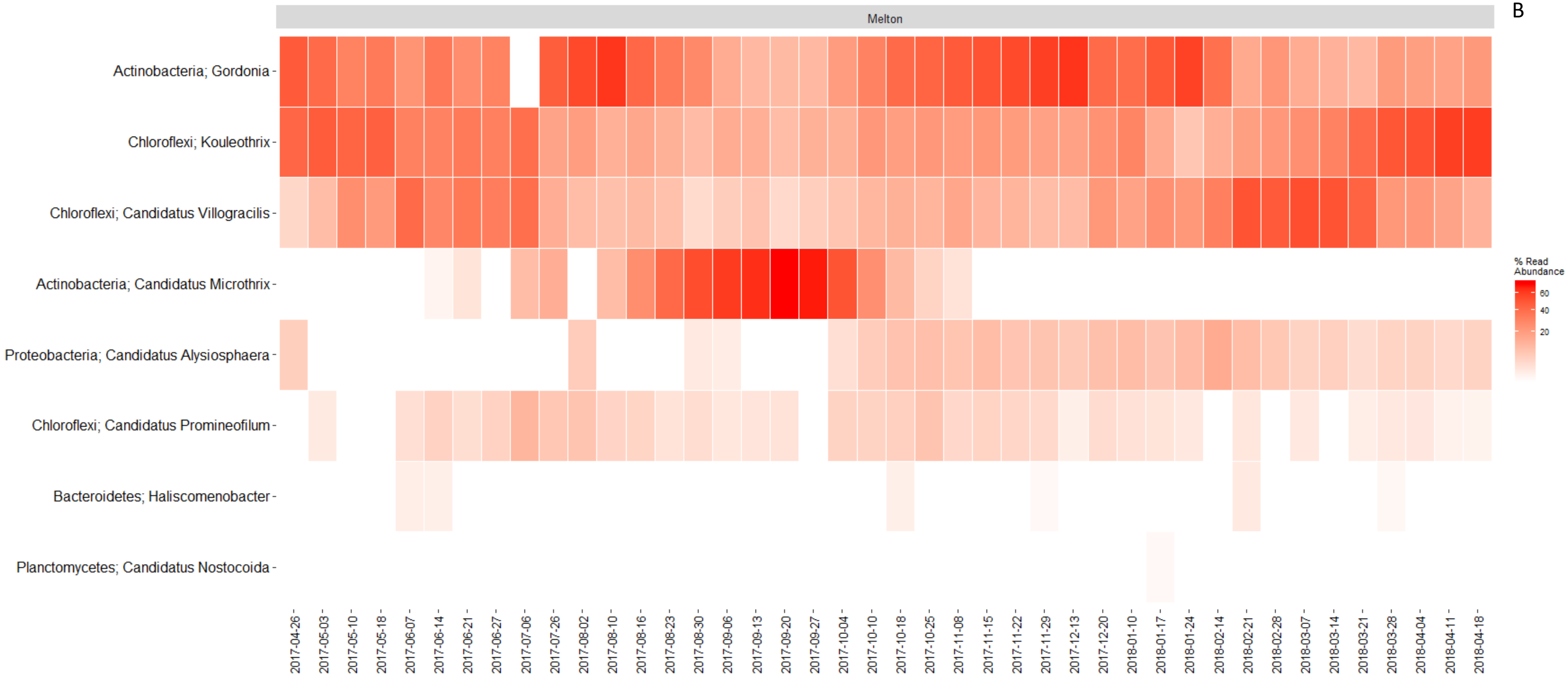
Unfortunately, the plants used for this study, especially that at Woodend, did not always provide sufficient plant operating data to address fully these important considerations. However, it is possible to suggest which of the many factors considered in other studies to be influential may emerge from the data generated here. Plots of the three alpha diversity indices for richness (Amplicon Sequence Variance, ASV), biodiversity (Shannon index) and evenness (Simpson evenness) over the 12month sampling period are given in Appendix 1. They show marked fluctuations over the study period. None of the measured plant parameters for the Gisborne plant showed any statistically significant correlations with any of these indices. However, with the Melton data, statistically significant negative correlations with the Shannon and ASV indices were seen for mixed liquor suspended solids (MLSS) (-43/0.0049) and sludge volume index (SVI) (-0. 53/0.0003) respectively. No correlations were apparent with the Simpson index. With the Gisborne plant, negative correlations were established with pH for only the Simpson and ASV indices (-0.43/0.009 and 0.36/0.32 respectively).

The Melton and Gisborne plants both experienced mild foaming incidents over the majority of the study period. In addition, Gisborne experienced two disruptive events, a plant washout caused by heavy rain and a breakdown in the aeration system each on the day of sampling. No samples were collected during these periods. The Woodend plant did not experience any operational problems. Furthermore, each plant had a community of bulking and foaming bacteria, which showed little change in relative abundances of the more abundant members over the course of the year (Figure 3.3). The main changes in filamentous populations were fluctuations in the intermittent/non-persistent organisms which do not contribute to the core population. In all three plants, the *Chloroflexi Villigracilis* (83) was present at high abundance, being especially predominant in the Gisborne plant. Most of the others detected were at much lower abundances, except for *Kouleothrix* in Woodend and *Gordonia amarae*-like organisms in Melton, where they were the most likely cause of the foaming incident there (Figure 3.4a), as discussed below. Microscopy shows the foam in Gisborne was caused probably by *Ca.* Microthrix parvicella, based on the Eikelboom morphotype identification (37) (Figure 3.4b), which is a microaerophilic filament, preferring conditions of low DO (1), but, was not among the more abundant filaments there, except between August and October.

Very little bulking occurred in the Woodend plant, the only exception being a short period over Xmas, although the sludge volume index (SVI) values never exceeded 180 ml g^{-1} (Figure 3.5). It seems likely that *Kouleothrix*, a known bulking bacterium (83) was the filament responsible. On the other hand, bulking sludge was more frequent in the Gisborne plant, with bulking periods occurring throughout the year, although SVI readings were never >200 ml g^{-1} (Figure 3.5). Its filament community was also of low diversity and again the most likely bulking candidate was probably *Kouleothrix* (Figure 3.3b). Based on SVI data, the Melton plant had serious bulking problems throughout the study period, (Figure 3.5) where SVI values often reached > 300 ml g^{-1}. Of the three most abundant filaments seen there, *Villigracilis*, *Kouleothrix* and *Promineofilum*, Villigracilis seems the likely causative filament (Figure 3.3c), although *Sarcinathrix*, known like *Kouleothrix* to form interfloc bridges of filament bundles (83) may also be involved. It is unlikely the *Ca*. Promineofilum contributed to the bulking as it rarely extends from the floc surface (83) and although *Villigracilis* seemed the obvious culprit for bulking this organism has not been associated with bulking in previous studies (84).


Woodend
Chloroflexi; Kouleothrix
Chloroflexi; Candidatus Villogracilis
Chloroflexi; Candidatus Promineofilum
Actinobacteria; Candidatus Microthrix
Chloroflexi; Candidatus Sarcinathrix
Proteobacteria; Aquicella
Bacteroidetes; Haliscomenobacter
Proteobacteria; Candidatus Alysiosphaera
Proteobacteria; Thiothrix
Firmicutes; Turicibacter
Actinobacteria; Gordonia
Proteobacteria; Crenothrix
Planctomycetes; Candidatus Nostocoida
2017-04-26
2017-05-04
2017-05-18
2017-05-25
2017-06-01
2017-06-20
2017-06-27
2017-07-06
2017-07-12
2017-07-26
2017-08-02
2017-08-10
2017-08-16
2017-08-23
2017-08-30
2017-09-06
2017-09-13
2017-09-20
2017-09-27
2017-10-04
2017-10-10
2017-10-18
2017-10-25
2017-11-01
2017-11-08
2017-11-15
2017-11-19
2017-11-22
2017-12-06
2017-12-13
2017-12-20
2018-01-10
2018-01-17
2018-01-24
2018-01-31
2018-02-07
2018-02-14
2018-02-21
2018-02-28
2018-03-14
2018-03-21
2018-03-28
2018-04-04
2018-04-11
2018-04-18
% Read Abundance
75
50
25

A



B
Melton
Actinobacteria; Gordonia
Chloroflexi; Kouleothrix
Chloroflexi; Candidatus Villogracilis
Actinobacteria; Candidatus Microthrix
Proteobacteria; Candidatus Alysiosphaera
Chloroflexi; Candidatus Promineofilum
Bacteroidetes; Haliscomenobacter
Planctomycetes; Candidatus Nostocoida
% Read Abundance
60
40
20
2017-04-26
2017-05-03
2017-05-10
2017-05-18
2017-06-07
2017-06-14
2017-06-21
2017-06-27
2017-07-06
2017-07-26
2017-08-02
2017-08-10
2017-08-16
2017-08-23
2017-08-30
2017-09-06
2017-09-13
2017-09-20
2017-09-27
2017-10-04
2017-10-10
2017-10-18
2017-10-25
2017-11-08
2017-11-15
2017-11-22
2017-11-29
2017-12-13
2017-12-20
2018-01-10
2018-01-17
2018-01-24
2018-02-14
2018-02-21
2018-02-28
2018-03-07
2018-03-14
2018-03-21
2018-03-28
2018-04-04
2018-04-11
2018-04-18

C

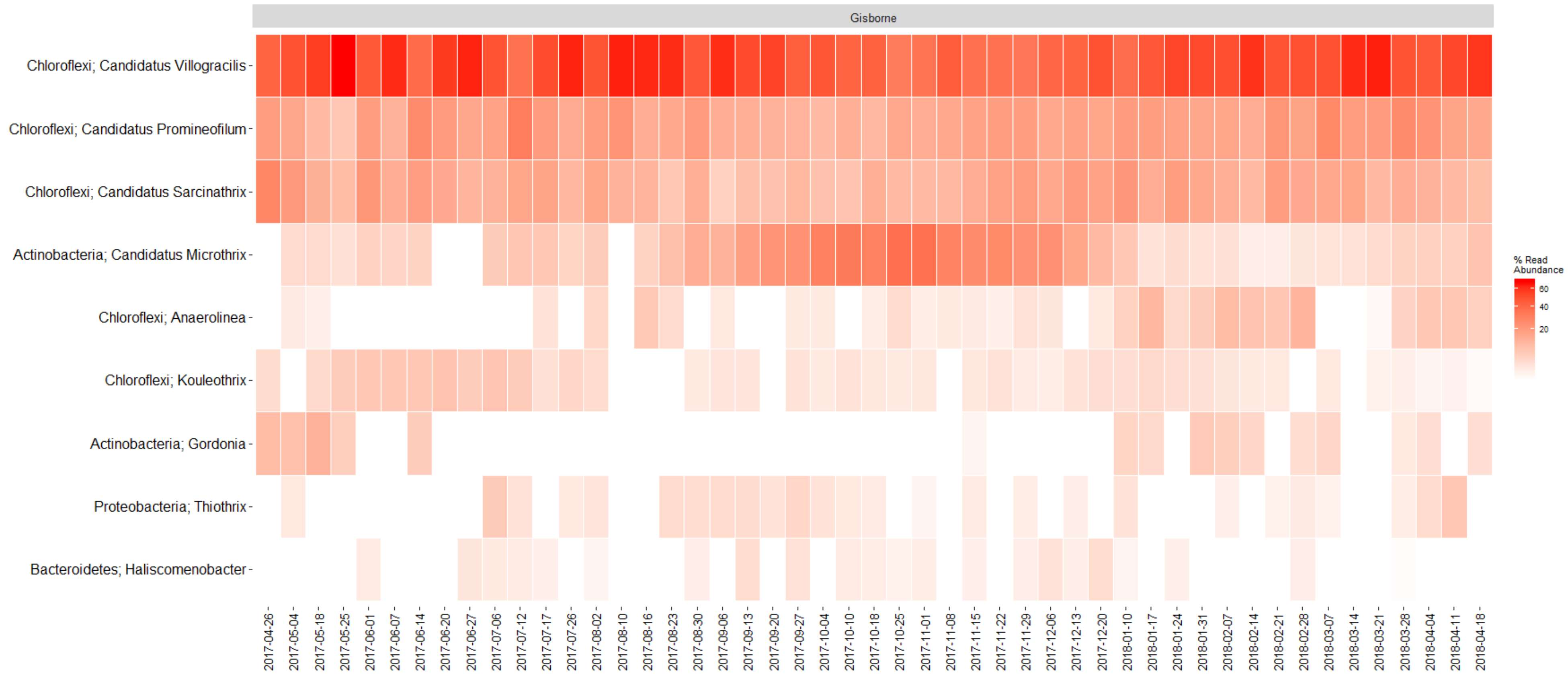
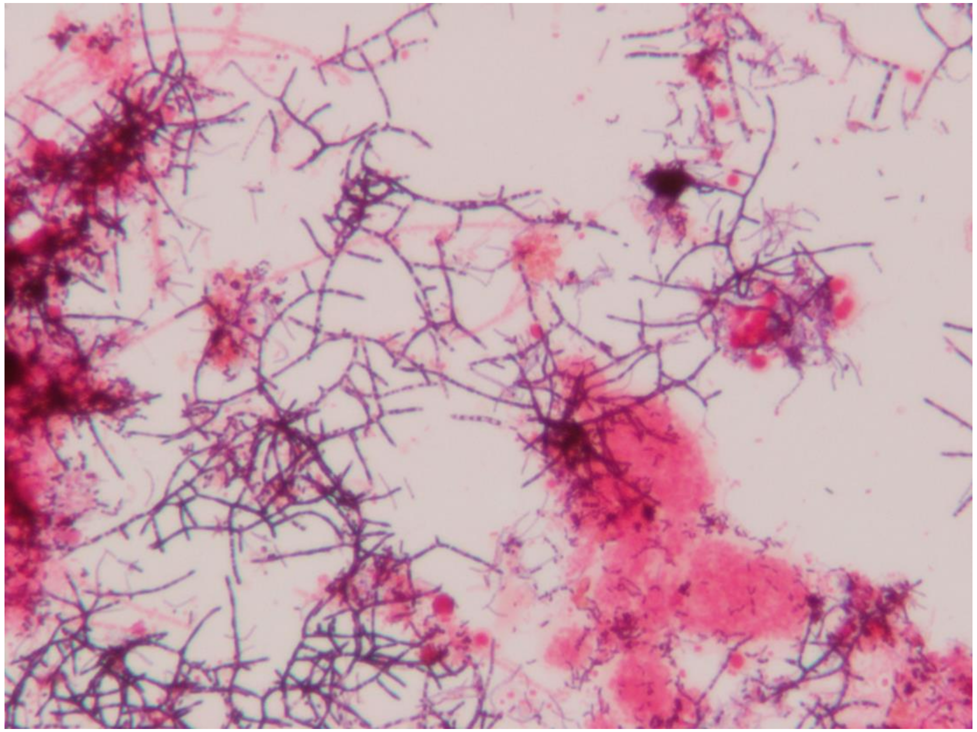


Figure 3.3 Heat maps depicting the filament populations of the Woodend (A), Melton (B) and Gisborne plants (C).

A



B

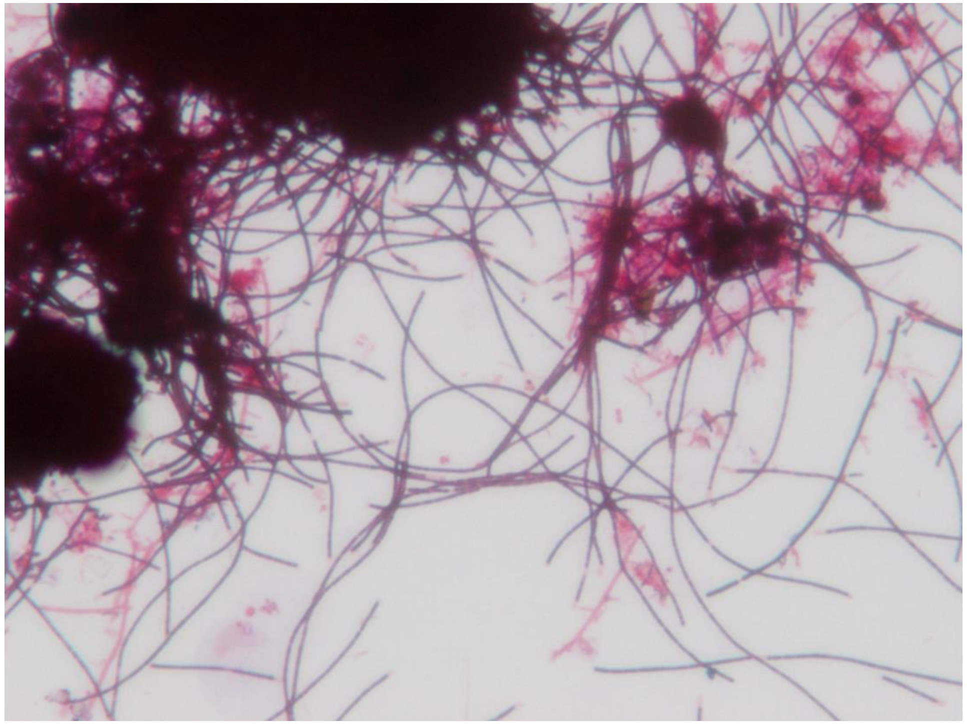


Figure 3.4 Gram stain images of foam samples from Melton (a), showing *Gordonia amarae*-like organisms and Gisborne (b), showing the morphotype characteristic of *Ca.* Microthrix parvicella.

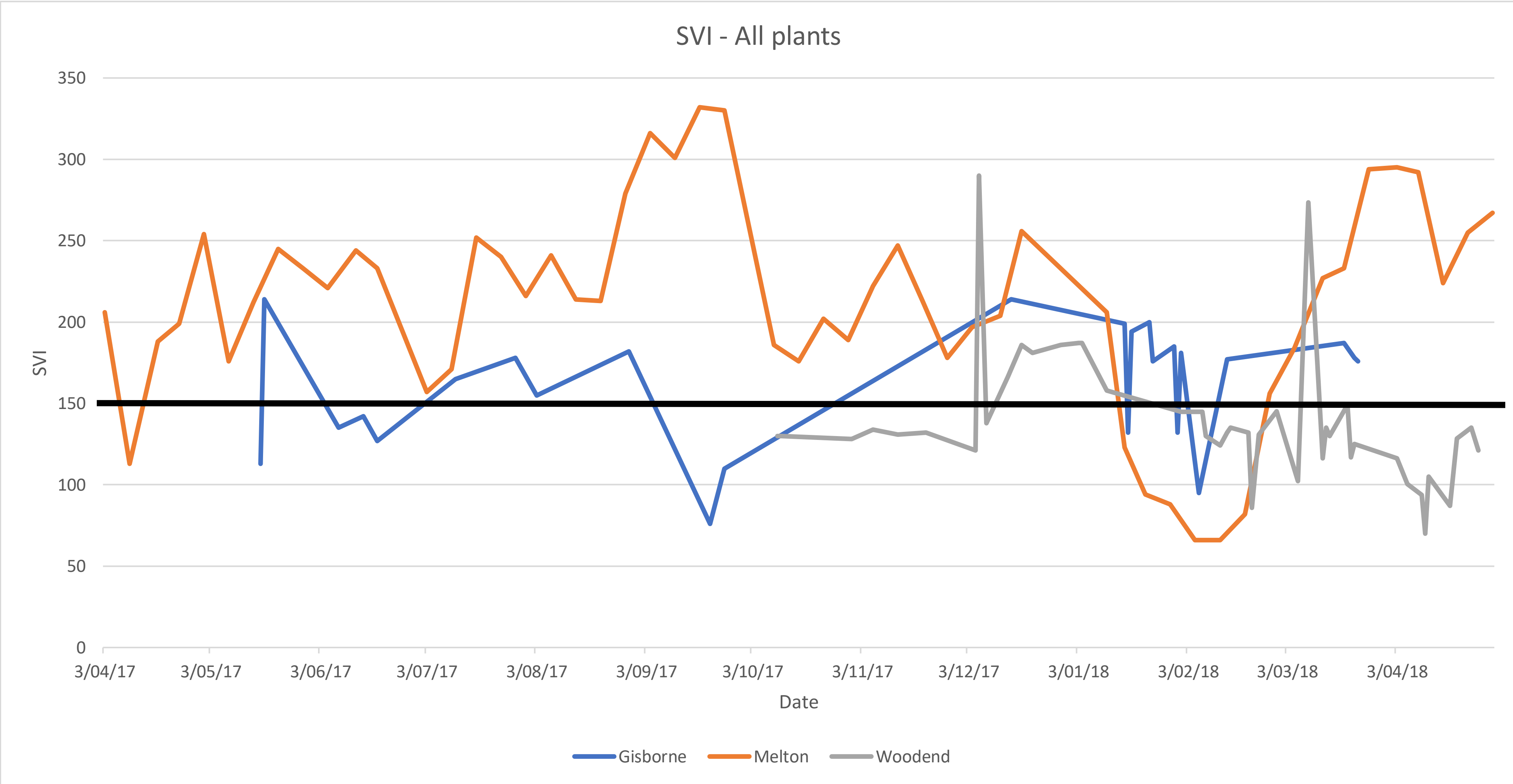


Figure 3.5 Line graph representation of SVI data for all three plants across the duration of the study

3.2.2 Bacterial communities in the Woodend wastewater treatment plant

Operational data showed the Woodend plant functioned well over the study period, with high COD and N removal (Effluent NH_3 always <2 mg l^{-1}). PCoA ordinations were used to understand how the communities changed on a monthly basis across the year-long study, highlighting their similarities and differences (Figure 3.6). Samples taken within the same month generally clustered together, suggesting no major shifts in their community compositions. With samples from different months there were distinct shifts in cluster arrangements, as seen with those taken from September and October (Figure 3.6). The data show that communities examined in November were similar to those for October, while the December communities had clearly changed again, more closely resembling now those observed at the beginning of the study. Toward the end (April '18), the communities appeared to show similarity to those present in 2017. These data suggest that seasonal changes have a marked influence on the community biodiversity of this plant, probably from either changes in seasonal temperatures, which range from 25 °C in the summer months to 9 °C in the winter, or seasonal dietary changes affecting in the influent. Further investigation is required to determine the true effect of temperature on these communities for longer than 12 months.

The heat map data (Figure 3.7) show that most genera detected were at low abundances, which varied little over the study period. Among the more predominant genera was *Kouleothrix* sp., a filamentous member of the *Chloroflexi,* known to cause bulking in activated sludge systems (83). Unpublished data from Japan (T. Nittami, personal communication) suggest that this filament may be favoured at lower temperatures (<20°), although their abundances changed little over the 12 months. These filaments are characterized by having large numbers of attached epiphytic bacterial particles, which may explain in part the high percentage abundances of members of the *Saprospiraceae* in this community (85, 86), However their relative abundances did not always parallel each other, suggesting that other free living *Saprospiraceae,* commonly found in activated sludge (35) are there. No evidence was obtained to suggest the filament *Haliscomenobacter hydrossis*, a member of this family, was present in the community (Figure 3.3a). However, one high SVI period (17.1.2018-21.2.2018) did correspond to substantial increases in abundance over the same period of the *Chloroflexi* B3 65. This organism is reported to be one of the more common *Chloroflexi* members in Danish wastewater treatment plants, although whether it causes bulking is unknown. (S.McIlroy, personal communication). It is not even known if members of this genus are filamentous or not, it can be assumed so however, since members of the Chloroflexi phylum are observed almost exclusively with filamentous morphologies.

Although abundances of the *Nitrospirae* over the course of the study period decreased, they were present consistently in the community. Very low abundances (>0.01% in a total of six samples out of 46) of the *Nitrosomonas* AOB bacteria meant they were detected in only a small number of the plant samples (Fig 3.7). Equally, the effluent profiles showing low levels of NO_3 (Appendix 1) of <4 mg l^{-1} suggest denitrification activity in this plant, and several of the denitrifying bacteria commonly found in activated sludge plants were detected, including both *Rhodoferax* and *Haliangium* (35).

One unexpected finding was the relatively high abundance (1-2%) of members of the genus *Ferribacterium,* also seen less abundantly later in the study period in the Melton plant. These are obligately anaerobic organisms capable of oxidizing fatty acids using Fe(III) as an electron acceptor and *Geothri*x. This plant it dosed is routinely with ferric sulfate (c.a 250 litres every month) to lower chemically the levels of phosphorus in the final plant effluent. Both *Ferribacterium* and *Geothrix* use ferric iron (Fe(III)) as an electron acceptor in anaerobic respiration. Less surprising was the presence of the polyphosphate accumulating *Candidatus* Accumulibacter PAO at relatively high percentage abundances (0.1-0.5%). Even though this plant was not designed to remove phosphate microbiologically, exposure of the biomass to alternating aerobic –anaerobic/anoxic conditions may provide them with a selective advantage (9), where they may also contribute to denitrification (87). Some *Propionivibrio* strains *like Ca*. P. aalborgensis (88) would also be selected under similar conditions to those favoured by *Accumulibacter,* since it has the phenotype of a glycogen accumulating organism (GAO) (21).

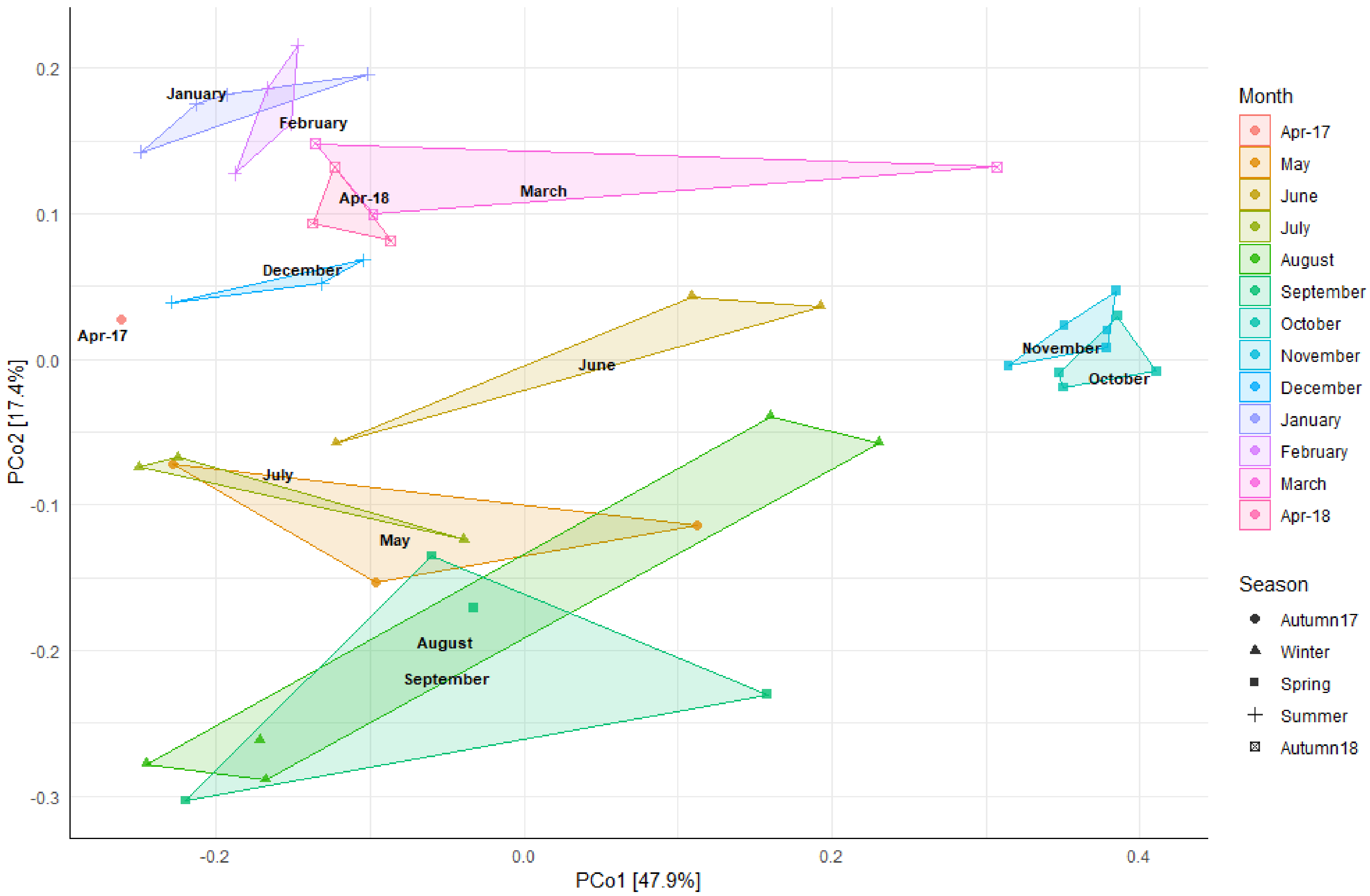


Figure 3.6 PCoA ordination of the Woodend communities at monthly intervals over the twelve-month period. Colours represent the different months and shapes represent different seasons. Similarity between samples is observed by the distance between two dots: the greater the distance the greater the dissimilarity. The shapes represent the shading covered by the outermost samples for each month

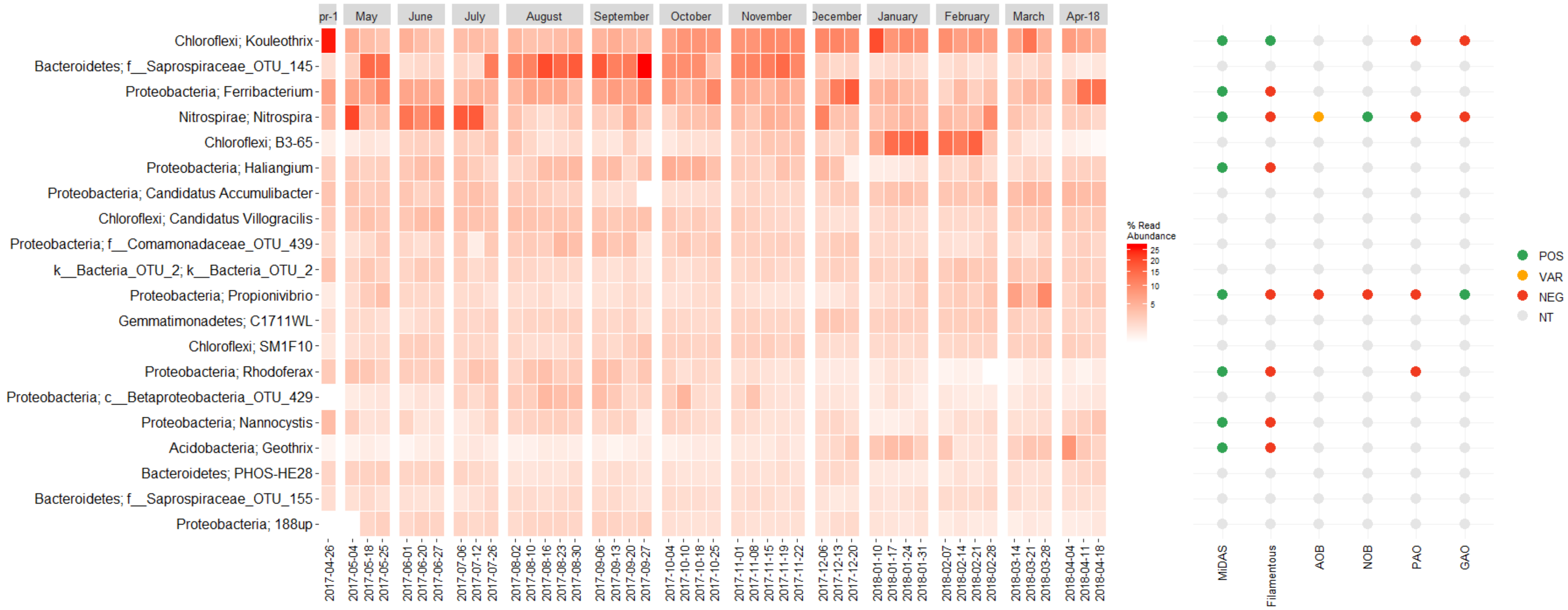


Figure 3.7 Heat map of the Woodend community over a twelve-month period. Putative function based on other known wastewater organisms has been added.

3.2.3 Bacterial communities in the Gisborne wastewater treatment plant

As with the Woodend plant, both COD and NH_3 removal were high during the study period, suggesting efficient plant performance. PCoA ordination analyses reveal the trends in monthly changes in community compositions, which underwent slow and gradual shifts during the first 4 months of the study (Figure 3.8). However, drastic changes then appeared to occur during August 2017 and September 2017 as Summer approached. This shift is most clearly shown by the relative placement of communities from December through to April 2018, where their close clustering indicates a level of community stabilisation. As with the Woodend plant, these shifts in community structure appear to parallel seasonal changes, and so the same factors of changing temperature and possibly human diet, providing varying substrates for metabolism, may also apply here.

The genus-based heat maps show markedly different community compositions to those from the Woodend plant detailed above (Figure 3.7). Neither *Kouleothrix* or *Saprospiraceae* populations were detected at such high abundances, and the most abundant populations over the year were *Dechloromonas* population, with especially large increases over the summer period (Figure 3.9), where it contributed up to 20% of the entire bacterial community reads. The genus *Dechloromonas* includes a diverse collection of strains, some known to be denitrifying bacteria in WWTP (35), while others behave as PAO (89). However, their contributions to P removal in full scale WWTP is considered to be low (21). The reasons for such increases in *Dechloromonas* abundances are unclear, although as suggested above, changes in diet or higher mixed liquor temperatures over this summer period may have had an influence. Several of the more dominant populations, some of which are seen also in the other two plants, are still poorly understood and characterized (eg. *Chloroflexi* SM1F-10, *Bacteroidetes* PHOS HE-28, *Bacteroidetes* PHOS-HE51 (OTU143)), and so attempting to explain why they occur at such high abundances is problematic. Clearly, as in the Woodend communities, high relative abundances of the *Nitrospirae,* again decreasing across the sampling period, and filamentous *Chloroflexi* including members of *Chloroflexi* B3-65, were among the more dominant populations (Figure 3.9).

Operational data profiles from the plant suggest high AOB and NOB and denitrifying bacterial activities, with low residual effluent NH_3 values (Appendix 2). Unlike the Woodend plant, *Nitrosomonas* AOB populations were detected in most samples, albeit at much lower abundances than the NOB *Nitrospira,*(0.4-0.7% and 0.9-11%, respectively), and alone among the 3 plants, *Nitrotoga* NOB were also detected at low abundances, but unexpectedly during the warmer months of the year (Figure 3.10). As with the Woodend plant, PAO populations were detected, but instead of the betaproteobacterial *Ca*. Accumulibacter phosphatis, the PAO were *Tetrasphaera*,sp., an *Actinobacterium* thought to occupy a different niche *to Accumulibacter* (90). Whether they can denitrify is unclear.

As the relative abundances of *Dechloromonas* increased over the spring/summer months, abundances of the uncharacterised phylotype, PHOS-HE28, decreased, a process reversed in the final 2months of the study (Figure 3.8). Pearson correlation analysis showed a strong negative correlation (-0.41) between these organisms, which was statistically significant ($p=0.0121$, $p<0.05$). Furthermore, PHOS-HE28 abundance correlated positively with plant nitrate levels (0.38) at a statistically significant level ($p=0.0156$, $p<0.05$). As the abundance of this OTU increased in March and April, the abundance of *Chloroflexi* B3-65 fell below detectable levels.

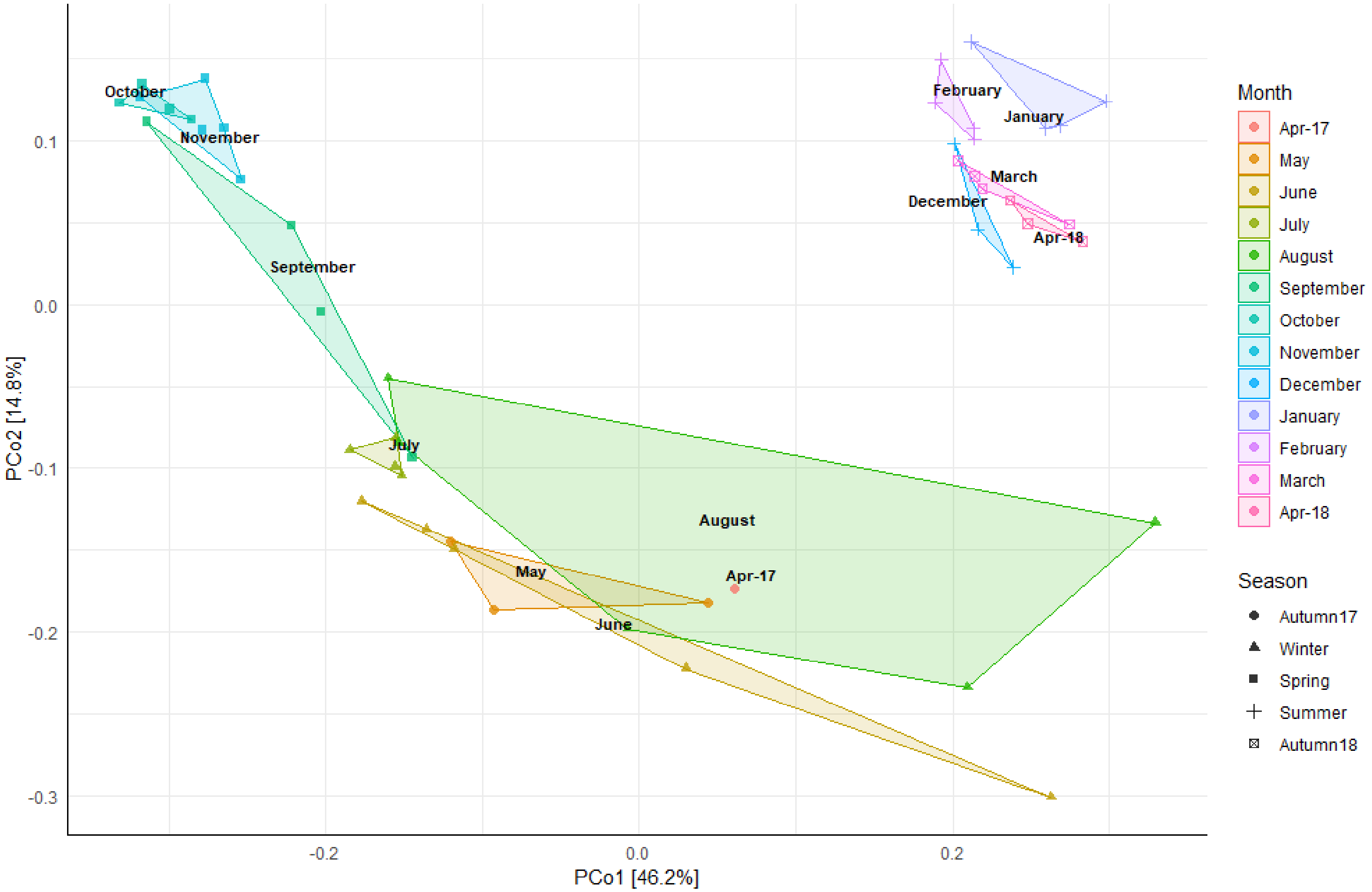


Figure 3.8. PCoA ordination of the Gisborne communities at monthly intervals over the twelve-month period. Colours represent the different months and shapes represent different seasons. Similarity between samples is observed by the distance between two dots: the greater the distance the greater the dissimilarity. The shapes represent the shading covered by the outermost samples for each month

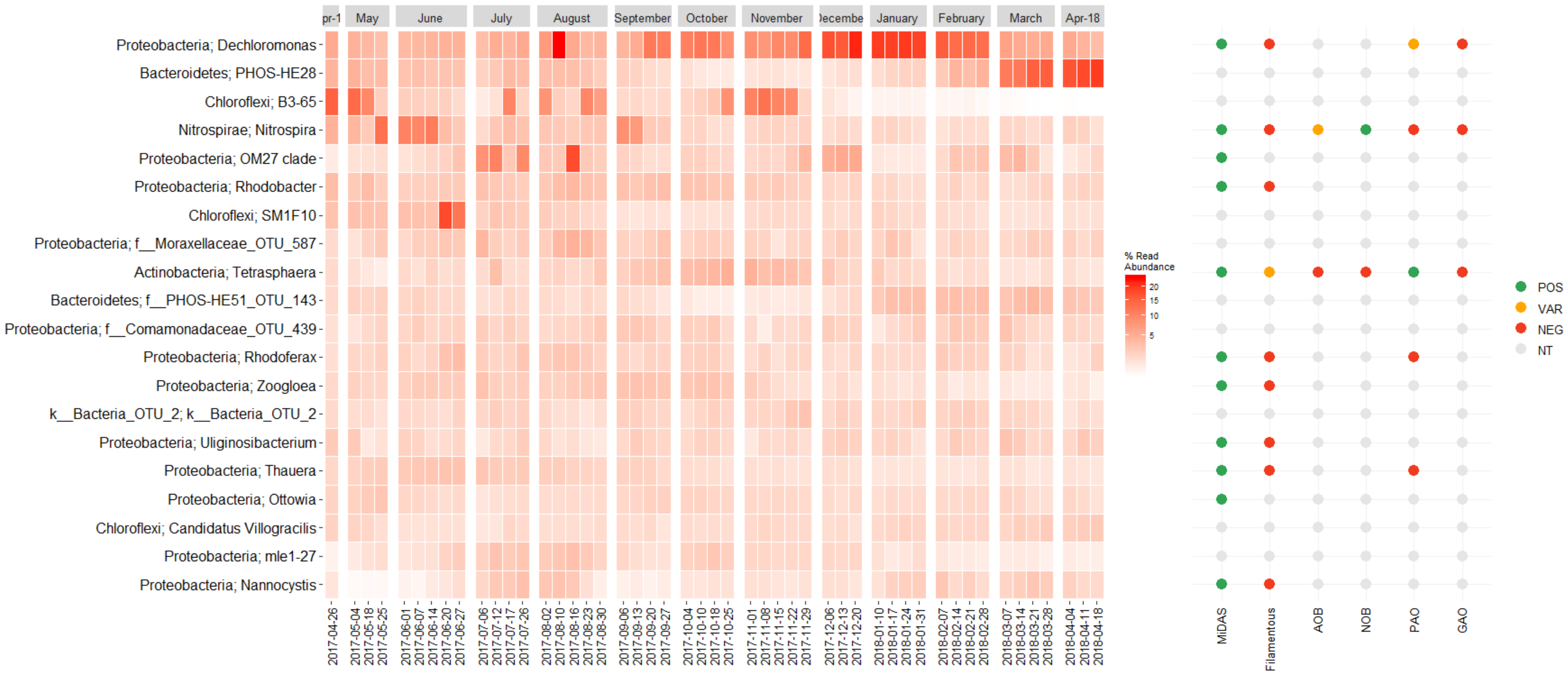
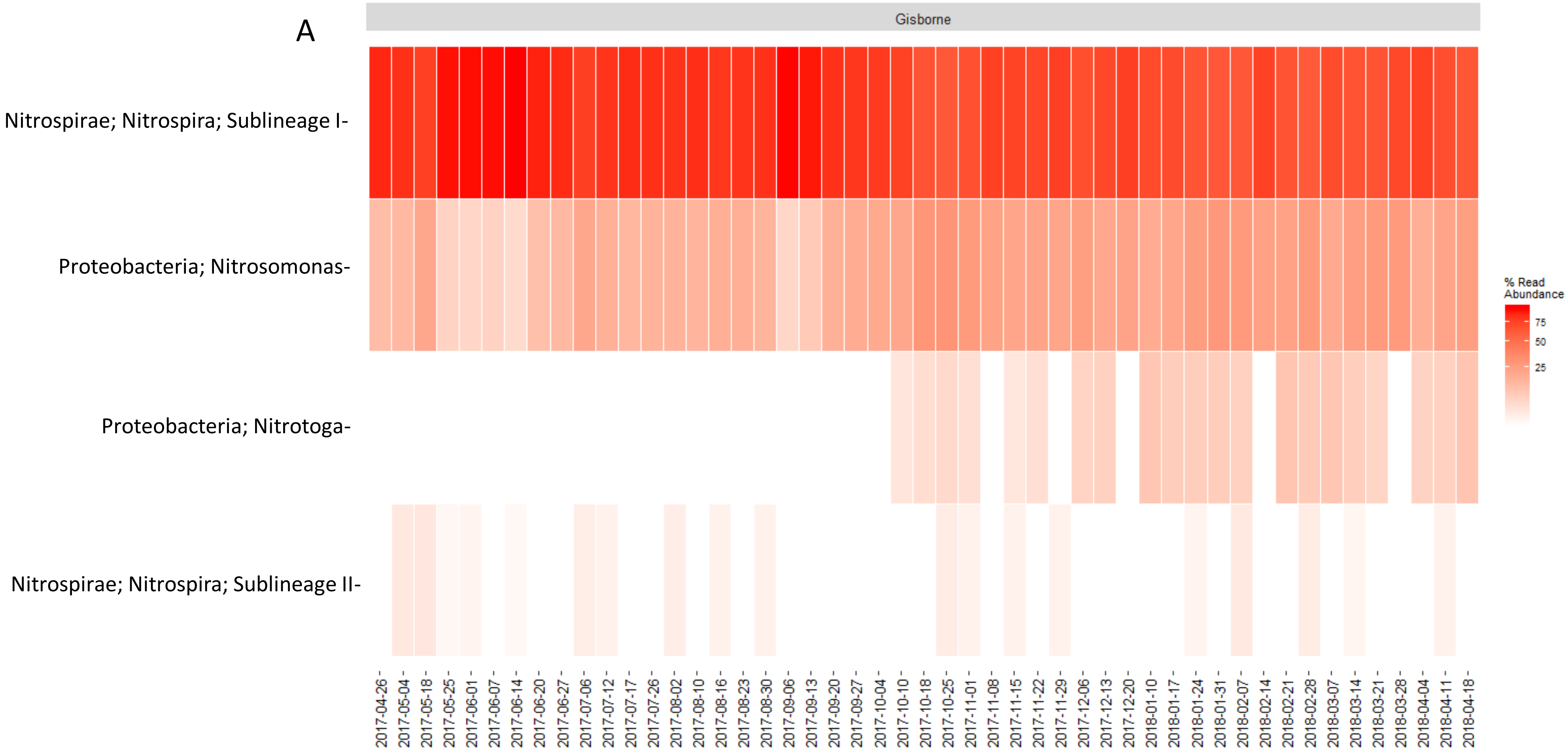
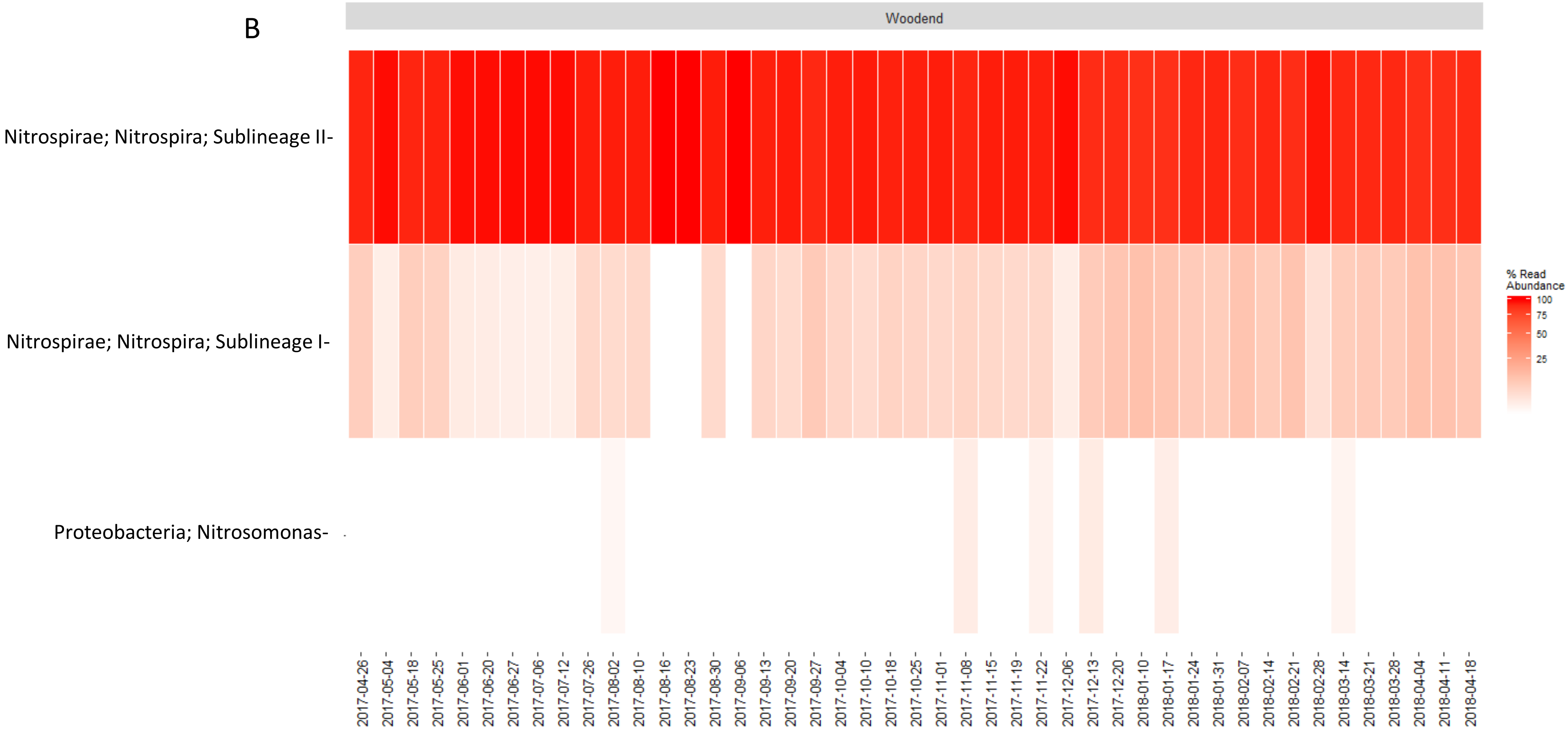


Figure 3.9 Heat map of the Gisborne community over a twelve-month period. Putative function based on other known wastewater organisms has been added.



A
Gisborne
Nitrospirae; Nitrospira; Sublineage I-
Proteobacteria; Nitrosomonas-
Proteobacteria; Nitrotoga-
Nitrospirae; Nitrospira; Sublineage II-
% Read Abundance
75
50
25
2017-04-26
2017-05-04
2017-05-18
2017-05-25
2017-06-01
2017-06-07
2017-06-14
2017-06-20
2017-06-27
2017-07-06
2017-07-12
2017-07-17
2017-07-26
2017-08-02
2017-08-10
2017-08-16
2017-08-23
2017-08-30
2017-09-06
2017-09-13
2017-09-20
2017-09-27
2017-10-04
2017-10-10
2017-10-18
2017-10-25
2017-11-01
2017-11-08
2017-11-15
2017-11-22
2017-11-29
2017-12-06
2017-12-13
2017-12-20
2018-01-10
2018-01-17
2018-01-24
2018-01-31
2018-02-07
2018-02-14
2018-02-21
2018-02-28
2018-03-07
2018-03-14
2018-03-21
2018-03-28
2018-04-04
2018-04-11
2018-04-18

B



Woodend
Nitrospirae; Nitrospira; Sublineage II-
Nitrospirae; Nitrospira; Sublineage I-
Proteobacteria; Nitrosomonas-
% Read Abundance
100
75
50
25
2017-04-26
2017-05-04
2017-05-18
2017-05-25
2017-06-01
2017-06-20
2017-06-27
2017-07-06
2017-07-12
2017-07-26
2017-08-02
2017-08-10
2017-08-16
2017-08-23
2017-08-30
2017-09-06
2017-09-13
2017-09-20
2017-09-27
2017-10-04
2017-10-10
2017-10-18
2017-10-25
2017-11-01
2017-11-08
2017-11-15
2017-11-19
2017-11-22
2017-12-06
2017-12-13
2017-12-20
2018-01-10
2018-01-17
2018-01-24
2018-01-31
2018-02-07
2018-02-14
2018-02-21
2018-02-28
2018-03-14
2018-03-21
2018-03-28
2018-04-04
2018-04-11
2018-04-18

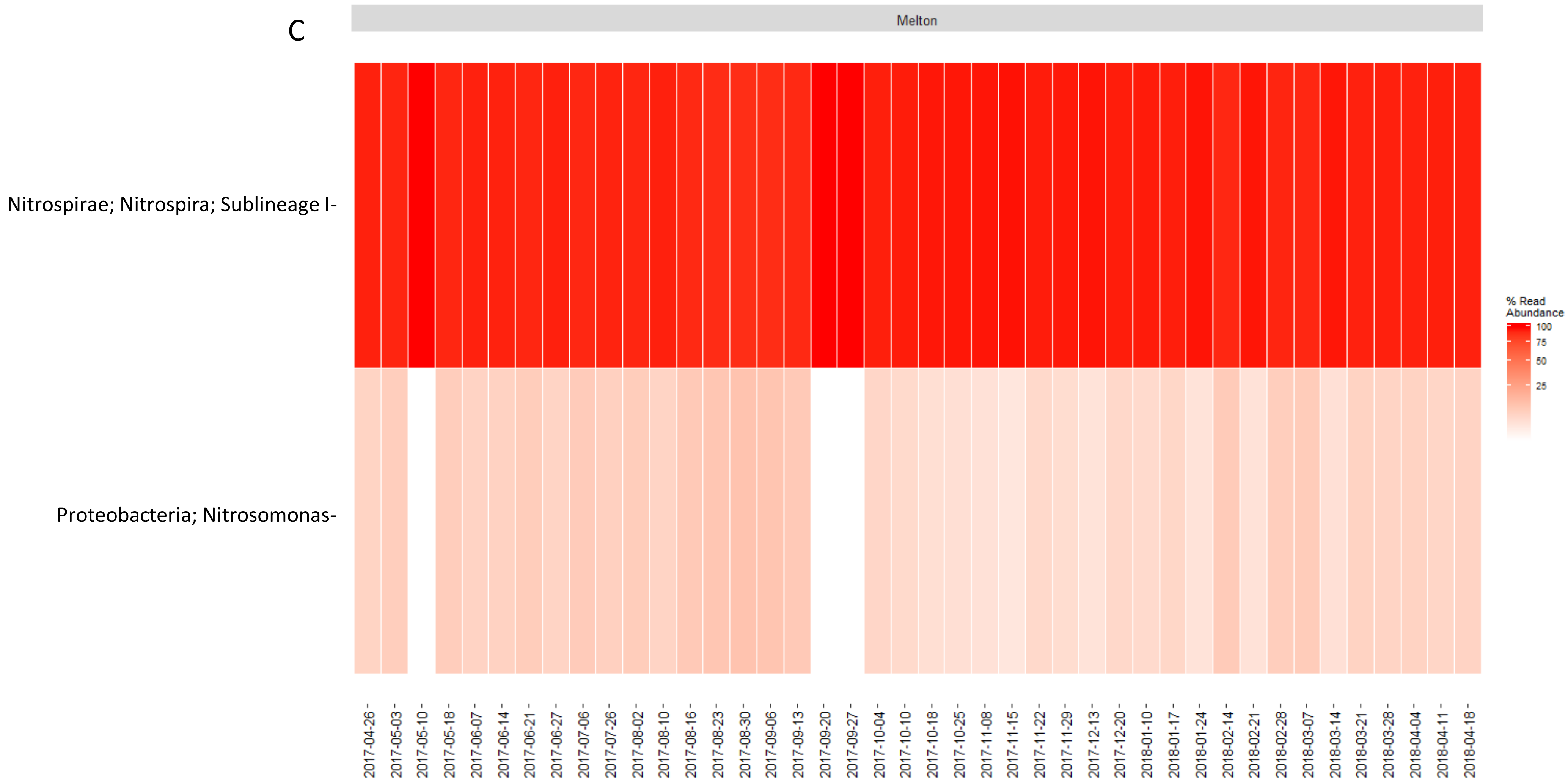


Figure 3.10 Heat map of known nitrifying bacteria from Gisborne (A), Woodend (B) and Melton (C)

3.2.4 Bacterial communities in the Melton wastewater treatment plant

The Melton plant was the largest of the three plants examined in this study and showed the poorest performance for N removal and general performance. For example, effluent NH_3 values frequently exceeded 10 mg^{-1} and occasionally they reached > 20 mg^{-1} where NO_3 levels were generally > 15 mg^{-1}. Apart from a constant low-level foaming problem, this plant did not experience any major operational perturbations during this study. As with the other two plants, PCoA analyses (Figure 3.9) showed how the bacterial communities changed quite markedly during the study period. They reveal a sharp compositional transition from Spring 2017 into the 2017/2018 Summer. The most substantial community changes occurred between October and December 2017, as shown by samples from each month clustering closely together. In other words, within the space of a week, the communities changed sufficiently so that clustering for each of these months was still visible. At the beginning of 2018 the community structure then appeared to stabilise as shown by the time points from the following four months clustering closely together. Again, these patterns seem to follow changes in the seasons, and so, as with both the other plants, these may reflect changes in temperature and/or substrate availability.

In addition, and as with both other plants, the composition of the Melton plant at the genus level was strikingly distinctive, especially in terms of the predominant populations there (Figure 3.10). However, *Thauera* and *Simplicispira,* probably *S. limi* (35, 59) both of which are denitrifiers, and *Dechloromonas* also able to denitrify, were still abundant as they were in the Woodend and Gisborne plants. The most abundant genus in the plant over the 12month study period was *Zoogloea,* and although present at low abundances in the Gisborne plant (Figure 3.8), members of this genus in Melton reached over 60% of the reads of the entire bacterial communities from April 2017 until December 2017, an abundance only rarely been matched in other WWTPs. However, these values fell markedly subsequently. Some members of the genus *Zoogloea* are known denitrifiers and characteristic producers of excessive amounts of exopolysaccharides, especially under unbalanced growth conditions like high C:N ratios (91). However, the measured influent N levels would suggest this would not explain this dominance. Exopolysaccharide production in *Zoogloea* is known to be favoured by conditions leading to unbalanced growth from nutritional stress, and so it is quite possible that other substrate limitations like low reactor pO_2 with high readily biodegradable substrate levels may explain their predominance.

Microscopically the *Zoogloea* existed as separate individual rods embedded in a slimy matrix of exopolysaccharide, although ‘fingered’ forms were seen too (Figure 3.4c). Their strongly hydrophobic nature means they may cause the problem of ‘non-filamentous sludge bulking’, although there was no evidence that this was happening at Melton. Their importance in floc formation is probably overstated, but they may denitrify (92). Despite the presence in the community of a diverse collection of denitrifiers, effluent NO_3 levels were consistently high, suggesting little denitrification occurs in this plant (Appendix 1). As with the Gisborne plant, many of the more dominant populations in this plant (for example mle1-27) are either poorly understood or uncharacterized or could only be identified down to family level or less. Hence their importance in this plant remain unclear. The diversity of denitrifiers can also change within genus, that is not all members within a genus can perform dentrification, potentially explaining the high abundance of known denitrifying organisms but the seeming lack of denitrification.

While *Nitrospira* sublineage II members were highly abundant in all samples examined here, with little changes in abundance, members of the AOB *Nitrosomonas* were rarely detected and then always at low abundances (0-0.5%) (Figure 3.7*).* With such elevated NO_3 effluent levels (Appendix 1) an equally important question is which if any are the active denitrifying bacteria in this plant, and was there adequate organic substrates to support these chemoorganoheterotrophs for anaerobic respiration in the anoxic zones? Highly abundant *Accumulibacter* and less abundant *Tetrasphaera* were both detected, again showing that this plant has to capacity to remove phosphate microbiologically.

As mentioned earlier, and as with the Gisborne plant, the Melton plant had frequent foaming incidents. The heat map of foam samples (Appendix 1) show that the most abundant sequences in the Melton foam were from *Zoogloea.* This organism is likely to end up in any foam because of its hydrophobicity, carrying with it attached biomass, where large Gram negative microcolonies shown in Figure 3.4b are likely to be of the amorphous form of *Zoogloea*. Clearly the Gram-positive *Gordonia amarae* like organisms (GALO) (Figure 3.4a) dominate the foam microbiome, and hence are most probably the foaming bacteria. *Acinetobacter* spp. also detected here in the amplicon library, but not recognizable in the data (Appendix 1) are seen frequently in foam samples especially during plant start-up (40). The three heat maps illustrating the shifts in bacterial populations of these three plants is shown in Appendix 1.

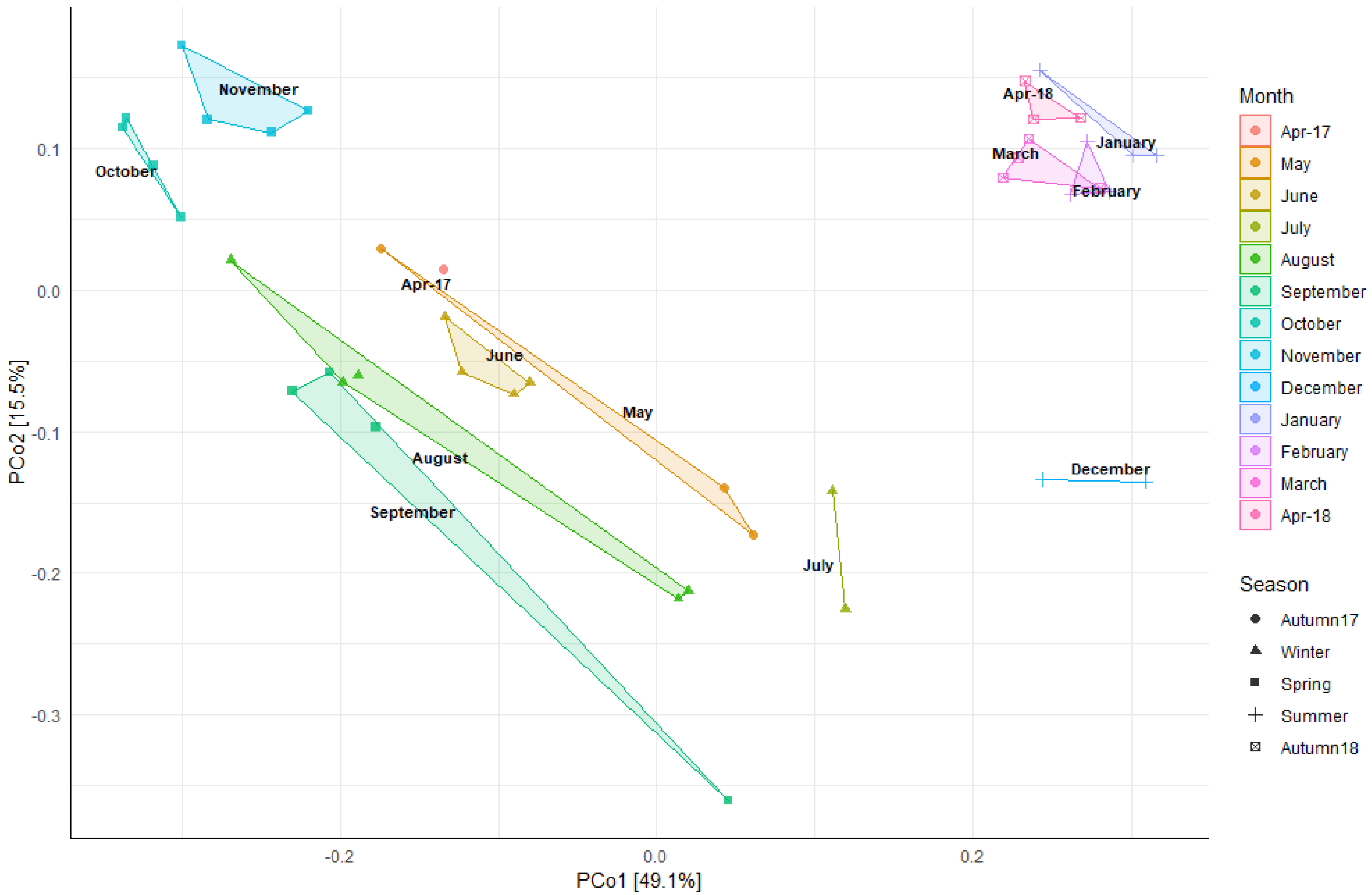


Figure 3.10 PCoA ordination of the Melton communities at monthly intervals over the twelve-month period. Similarity between samples is observed by the distance between two dots; the greater the distance the greater the dissimilarity. The shapes represent the shading covered by the outermost samples for each month

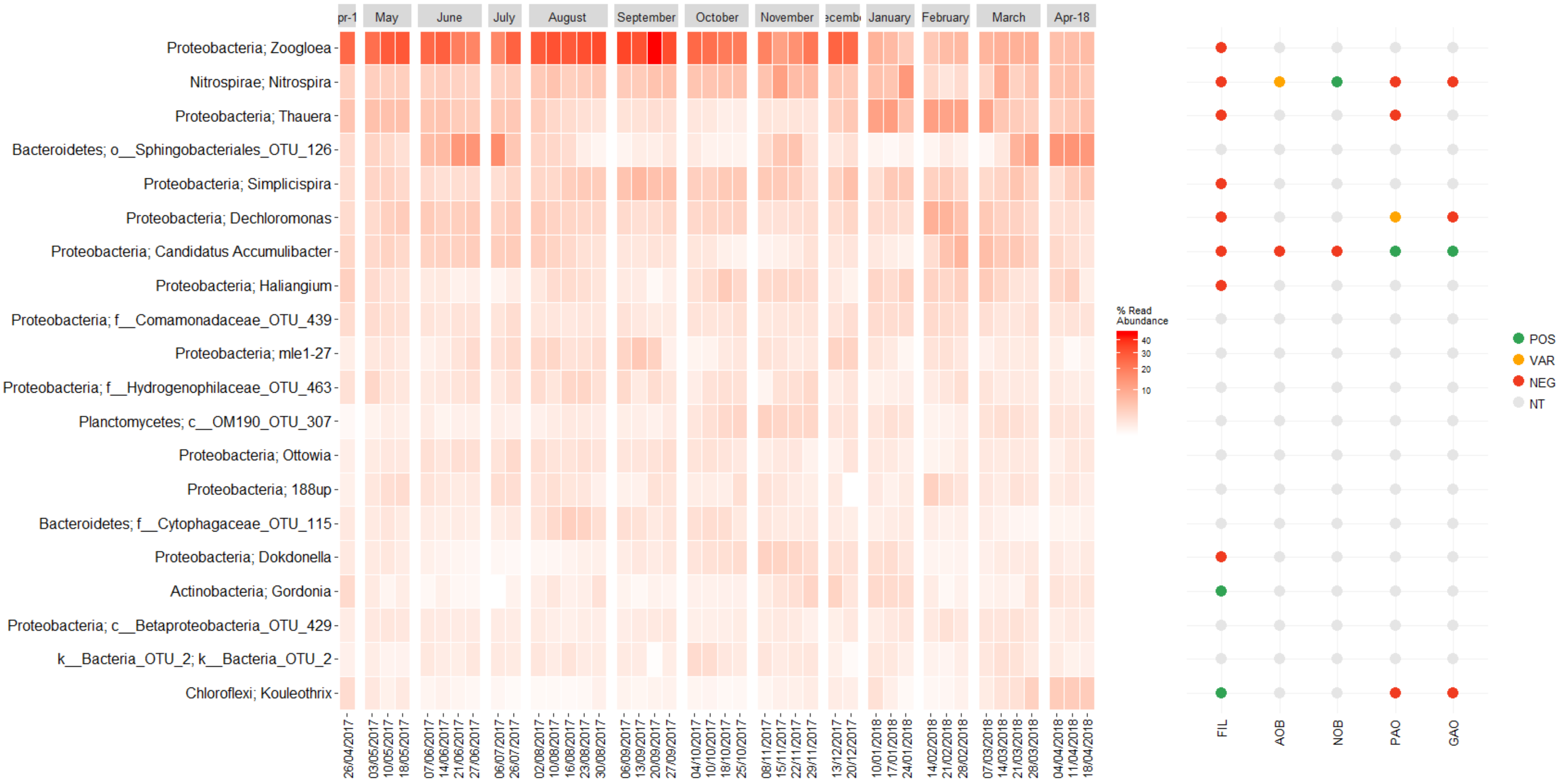


Figure 3.11 Heat map of the Melton community over a twelve-month period. Putative function based on other known wastewater organisms has been added.

3.3 Discussion

The three plants studied here were selected deliberately to avoid as much as possible extrinsic differences between them in terms of their influent feed, regional demographics and weather conditions**.** It seems more likely that the marked differences in community compositions between the three plants seen here must reflect largely differences in their individual plant configurations and basic operational parameters**.** On the other hand, changes in community composition and individual population abundances within each plant are probably determined more by changes in intrinsic factors. Additionally are probably associated with how competitive populations are under the prevailing conditions in terms of being able to maintain the highest growth rates under the dynamic conditions encountered in the activated sludge system. These include uncontrolled changes in abiotic parameters like temperature pH and pO_2 and their abilities to cope with inevitable periods of starvation by synthesising storage products, together with their positive or negative interactions with other members of the community. Together, these will determine to a large extent their survival. There has been an increasing number of statistically based published studies on how these factors and dynamic interactions between individual populations may affect community assemblage (74), but no clear general models have so far emerged. Equally, attempts to associate particular intrinsic and extrinsic dynamics with changes in population abundances are often unconvincing, and in some cases counter- intuitive. How applicable the data are to the three plants here is considered here.

Zhang et al. (81) suggested that the biodegradability of the influent played a major role in determining community composition and hence plant performance. They argued that communities of plants receiving an influent with either a high or low BOD/COD ratio had lowered microbial diversity and formed large complex networks. They considered a BOD/COD influent ratio of 0.5 as being optimal. With low BOD/COD ratios the influent would contain large amounts of non-biodegradable substrates, ensuring effluents with high COD levels, and little substrates availability for chemoorganoheterotrophic denitrification The impact of the BOD/COD ratios on activated sludge plant performance has been the subject of a number of other studies (73, 93), but their impact on dynamics of community composition is poorly understood. Of the three plants examined here, only such data were available from the Gisborne plant. They showed that on a few occasions this ratio of 0.5, this ratio for most of the year was <0.4 (Appendix 1). Yet there appeared to be no marked changes in the community composition at those times, and the effluent COD was consistently low over the whole study period (Appendix 1).

With the exception of the Gisborne plant communities, both the Melton and especially the Woodend plant communities contained very few 16S rRNA amplicons traceable to *Nitrosomonas* and other nitroso AOB. Bearing in mind the very low abundances of *Nitrosomonas* sequences, an important question of which are the nitroso AOB that oxidize NH_3 needs to be addressed, an oxidation step clearly taking place as shown from the low plant effluent NH_3 levels in both plants (Appendix 1) One possible explanation is that the *Nitrospira* comammox nitrifying bacteria are responsible for ammonia and at least partial nitrite oxidation. 16S rRNA amplicon sequencing will not distinguish them from other *Nitrospira* populations (94). There is some indirect evidence to support this proposal. Thus, the high abundances of *Nitrospira* sublineage II in the Melton plant, is interesting since the most commonly occurring environmental members capable of performing Comammox are members of this phylogenetic group (58, 70, 95). It is now generally agreed that the Comammox nitrifiers are selectively advantaged over the other nitrifiers under stressful conditions like low DO levels (70, 71, 96). Although all three plants recorded mixed liquor DO >1 mg l^{-1}, these readings were obtained from a single electrode. Consequently, it is not unlikely that the values obtained did not necessarily describe the DO values throughout the Melton plant, which operates with tapered aeration. Clearly *amo*-qPCR based methods need to be used to confirm their presence here (95, 97, 98).

The data here serve to reinforce the view that reaching models generally applicable to all plants in attempts to explain which factors might play major roles in determining plant community compositions is not yet feasible. The data presented here would suggest that the temporal dynamics of the three plants seems to be influenced to a large extent by temperature and/or qualitative and quantitative changes in the dietary behaviour of the populations serving each plant as seasons change. Certainly temperature has been viewed as one of the more important influences in many other studies especially from the global survey data generated by the Global Water Microbiome Consortium (16).

Section 4

Isolation and whole genome sequence analysis of filamentous bacteria isolated from activated sludge

4.1 Introduction

Since the first description of WWTPs, filamentous bacteria have remained, to this day, as one of the costliest and most detrimental problems to this process (40). There are many different bacterial species capable of causing such problems, the problems being foaming and bulking. Foaming is caused by a group of filamentous bacteria, referred to as the Mycolata as they contain hydrophobic mycolic acids in their cell walls. These hydrophobic cell walls allow the bacteria to associate themselves within the foam and stabilise it thus preventing it from breaking down. All known species which form the Mycolata group are from the phylum Actinobacteria.

Bulking is another operational problem caused by filamentous bacteria which arises when these bacteria overgrow within flocs. This overgrowth from within the floc then allows them to join with another floc and cause inter-floc bridging, an interaction which prevents the sludge from successfully settling from the bulk liquid. The diversity of bacteria capable of causing bulking is far greater than those which can cause foaming as filamentous bacteria do not require hydrophobic cells walls to cause bulking, just a filamentous morphology (1).

Filamentous bacteria were initially identified based on the filamentous morphology which became known as Eikelboom morphotypes (37). As more information on these organisms became available it was revealed that more than one species can encompass a single morphotype (38). As more species of filamentous bacteria were identified the true diversity of these bacteria was revealed (1). It also became clear that, despite the problems these bacteria cause, many were also beneficial to the AS process with the potential ability to initiate floc formation and perform important metabolic processes. The main set back in studying these organisms came down to the inability to readily isolate most of these bacteria in pure culture. This left the field of microbial ecology with a need to readily identify and characterise bacteria with culture independent techniques. Advancements in molecular techniques was the answer that allowed research on these organisms to really flourish.

Molecular techniques such as fluorescence *in situ* hybridisation (FISH) and next generation sequencing have been most beneficial to the microbial ecology field. FISH provided a method for the *in situ* identification of bacteria to determine their morphology within AS and how they associate themselves within the community and/or flocs. The drawback of FISH was that it gave very little understanding about the bacteria and their metabolic potential within the community. FISH can be performed in combination with microautoradiography (FISH-MAR) allowing for the determination of the uptake and metabolism of certain metabolites. However, in order to characterise the entire metabolic potential of a species using such techniques would be time consuming and laborious to cover all substrates and conditions. In order to determine the full metabolic potential in a time efficient manner, DNA sequencing techniques were adopted.

Next generation sequencing (NGS) revolutionised the microbial ecology field as determining and analysing the entire genome of an organism can reveal its entire metabolic potential. The implication of this can allow the determination of what niche a particular organism may be residing in within a community without the need to test experimentally in pure culture. When this is applied to filamentous bacteria it can be determined how important that species may be to the AS process as a whole. It can also reveal which metabolites it may utilise and give insight into its ability to assist in important processes, such as N and P removal. This could allow for prediction of what may cause the over proliferation of these bacteria and may help in the development of preventative measures for these issues. If possible however, it is imperative that genomic data should be validated with experimental data to make accurate conclusions of metabolic potential.

This study attempted to isolate filamentous bacteria in pure culture using micromanipulation (Section 2.2.1). This section will focus on an *Acidovorax* member which was successfully isolated from wastewater. Members of the *Acidovorax* genus were initially a part of the genus *Pseudomonas* but were reclassified into their own genus and are part of the Betaproteobacteria. They currently encompass 20 validly publishable species. Species from this genus can be separated into two groups based on their association as an environmental isolate or a pathogenic isolate (99). *Acidovorax defluvii* and *Acidovorax temperans* are examples of environmental isolates and *Acidovorax cattleyae* and *Acidovorax avenae* are examples of pathogenic isolates.

Environmentally associated members of this genus have previously been implicated in performing denitrification in AS and EPS production (100, 101). Both processes as well as other selected pathways were investigated in the isolate described in this study. However, the true interest in this organism stems from its ability to form a filamentous morphology, a feature which has never been observed in this genus before. *Acidovorax spp*. have only ever been isolated as Gram negative rods. One *Acidovorax* species was observed in AS using FISH as the Eikelboom morphotype 0803 (102) but was never observed again when the techniques were repeated (103). This study aimed to isolate and characterise filamentous bacteria from AS, the focus became that of an *Acidovorax sp*.

Samples of activated sludge were used to micromanipulate filamentous bacteria on R2A agar (section 2.2.1). The successfully identified strain was sequenced using the Illumina MiSeq. The genome sequence obtained was in multiple contigs which gave an unfinished genomes, in an attempt to close this, the Nanopore MinION was used and the genome closed.

4.2 Acidovorax

The *Acidovorax* isolate was of interest due to its ability to form a filamentous morphology (Figure 4.1). A filament forming *Acidovorax* species has only been observed once previously however, subsequent FISH studies have never identified the filament again (102, 103). This study provides the first pure culture and genomic characterisation of a filament forming *Acidovorax* strain.

The isolate described in this study was grown on R2A agar at 28 ˚C for two days in aerobic conditions. After the two days of growth, filamentous structures were formed and identified via Gram stain. During extended growth in broth, >4 days, long visible filaments start to form within the broth. It is unclear if these filamentous structures are aggregations of bacterial cells or excretions. It is also possible this organism exists most commonly as a rod but has the potential to form filamentous structures.

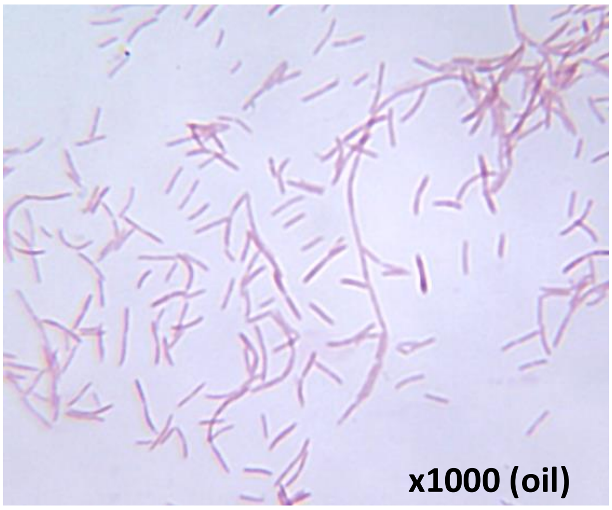


Figure 4.1 Gram stain of putative *Acidovorax* isolate. Long thin filamentous, Gram negative structures can be observed surrounded by smaller rods.

4.3.1 Acidovorax genome

The genome of *Acidovorax* isolated from a conventional EBPR WWTP was subjected to Illumina short read and Nanopore long read sequencing. Sequencing and assembly, using Unicycler, resulted in a closed 4.2 Mbp circular genome (see table 4.1 for details). Through annotations on Prokka, it was determined that every gene identified within this isolate had an identified homologue in another *Acidovorax* species. This indicates that this genus is well characterised however, this is still the first filament forming strain within this genus to be reported.

The metabolic pathways were determined based on the presence or absence of associated genes. Additionally, this was coupled with analysing known metabolic pathways, and the genes involved, to aid in determination of the pathways.

4.2.1.1 Central pathways

The *Acidovorax* isolate possessed candidate genes required for the oxidative pentose phosphate (OPP) pathway, the Embden-Meyerhof-Parnas (EMP) glycolysis pathway and the Entner-Doudoroff (ED) pathway. However, of these three pathways only the complete genes set required for the OPP pathway were present, the ED and EMP pathway were missing integral genes as outlined in Figure 4.2. The most surprising of these absences are that of the glucokinase and glyceraldehyde-3-phosphate dehydrogenase genes which are common among all three pathways however, a potential homolog for glyceraldehyde-3-phosphate dehydrogenase was identified, glyceraldehyde-3-phosphate dehydrogenase A.

All candidate genes were present for the complete oxidative tricaboxylic acid (TCA) cycle. This included the presence of candidate genes for the glyoxylate shunt potentially allowing for the use of acetyl-CoA as a main carbon source and potentially allowing for the use of long chain fatty acids. The breakdown of fatty acids usually utilizes the TCA cycle anaerobically suggesting that this isolate is a facultative anaerobe (104). Further supporting this is the presence of genes which allow the consumption of CO_2 from the atmosphere to ultimately produce pyruvate and the ability to perform denitrification, which is an anoxic process (see below). This can also potentially create a pathway back into the TCA cycle in both the presence and absence of oxygen.

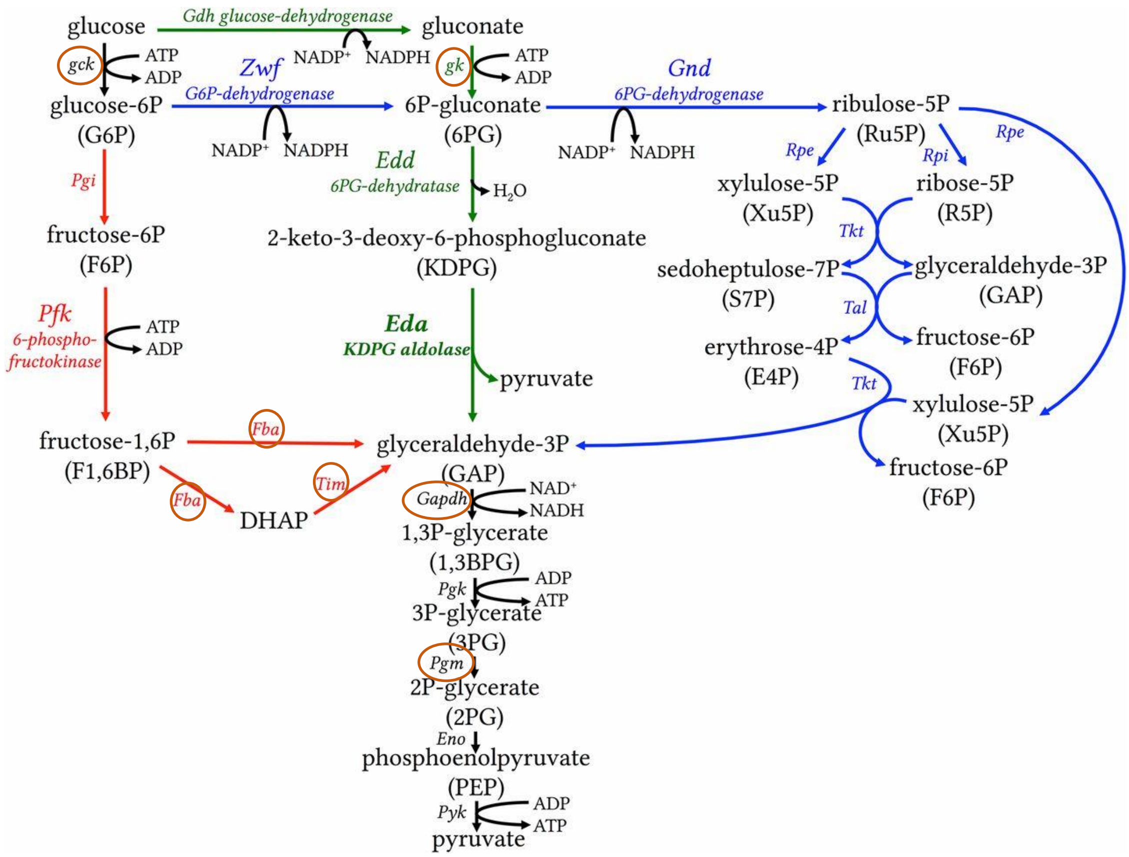


Figure 4.2 The three most common glycolytic pathways in prokaryotes. EMP is shown in red, OPP is shown in blue and ED is shown in green. Genes shown in black are common among all three pathways. Genes circled in orange were absent from *Acidovorax* isolate. Figure adapted from (105).

Acidovorax species are capable of synthesizing all necessary organic compounds from CO_2 making them chemoautotrophs (106). Based on the genome sequence of this *Acidovorax* isolate we could identify candidate genes which allow for atmospheric CO_2 fixation suggesting this too is a chemoautotroph. Based on the pathway this organism will be able to transform atmospheric CO_2 into pyruvate via oxaloacetate, which is then utilised for many downstream processes. Interestingly, many *Acidovorax* species are more commonly associated with being aerobic heterotrophs suggesting they cannot fixate their own carbon (99, 106, 107).

The ability for this organism to be a facultative anaerobe capable of both aerobic and anaerobic growth would be more fitting given its potential environmental significance. This is consistent with other members of *Acidovorax* which have been associated with such metabolic pathways in the environment (99, 101, 108). The facultative ability of this organism is not surprising given its potential to perform denitrification; an anaerobic process which is often associated with chemoautotrophs (see section 4.3.1.4) (109).

4.2.1.2 Carbon storage material

Bacteria can be subjected to harsh conditions, such as periods of starvation. To survive under such conditions, bacteria can produce storage compounds with a high energy potential when broken down. A well-studied storage pathway in wastewater organisms is the ability to produce polyhydroxyalkonoates (PHAs).

The *Acidovorax* isolate has very limited storage potential as no genes were present for a complete metabolic storage process. This includes the lack of genes for triacylglycerol (TAG), polyphosphate and potentially PHA synthesis. The absence of any cyclic AMP-dependent transcription factor (*atf*) genes suggests a complete lack of ability to store TAG. Any genes crucial to the storage of trehalose are also absent. Candidate genes for PHA storage are present, but whether this organism utilises this storage compound or not is undetermined. Some *Acidovorax* species are capable of degrading PHB, although this isolate lacked the *phaZ* gene which is responsible for degradation of PHAs. It is possible that an unidentified homologue exists.

4.2.1.3 *Acidovorax* metabolism

Similarly with polyphosphate storage the *ppx* gene is present, suggesting the ability to turn inorganic phosphate into poly-P, but the absence of the low affinity phosphate transport protein gene, *pit*, and the *ppk2* gene suggests *Acidovorax sp.* is not a PAO. The *pit* gene is thought to be a defining feature in the PAO phenotype (12). However, genes are present for phosphate transport into the cell potentially suggesting some usage of P compounds.

Table 4.1 Genome properties of the closed *Acidovorax sp.* genome

Genome assembly characteristics	***Acidovorax***
Size	4,271,987
GC content	63%
CDS	4,136
CDS assigned function	88.15%
Protein coding density	89.43%
rRNA operons	4

Table 4.2 Overview of potential pathways present. + = Present. - = Absent.

Pathways	***Acidovorax***
TCA cycle	+
Glyoxylate shunt	+
Pentose phosphate (oxidative)	+
Pentose phosphate (non-oxidative)	+
Glycolysis EMP pathway	+
Glycolysis ED pathway	+
Fermentation (glucose to lactate)	-
Storage compound metabolism	
Glycogen synthesis	-
Trehalose synthesis	-
PHA synthesis	Undetermined
TAG synthesis	-
Polyphosphate synthesis	-
Pit transporter	-
Nitrogen metabolism	

Nitrate reduction to nitrite	+
Nitrate reduction to nitrogen (denitrification)	+
Nitrite reduction (respiratory)	+
Nitrite reduction to ammonia (assimilatory)	-
Nitrogen fixation	-

Cell division and cell wall synthesis

Dcw cluster	+

It has been well documented that *Acidovorax* species have the ability to perform denitrification (106, 108). Genes for denitrification within the *Acidovorax* isolate were present suggesting that this organism is most likely capable of performing this process. Furthermore, members of this genus are known to specifically uptake acetate to perform this process (108).

The denitrification process has been well characterised in many different organisms as the process converts nitrate to nitrogen and is of great ecological importance (59). This process allows for the complete reduction of nitrate (NO_3) to gaseous nitrogen (N_2) and requires many different genes to perform the various steps (Figure 4.3). Previously, *Acidovorax spp*. have been identified as acetate-utilising denitrifiers and the *Acidovorax* isolate in this study contained genes which may allow such a process (Table 4.2) (108). This species was identified to contain the *narG* and *narH* genes, the alpha and beta subunits for nitrate reductase. Additionally, it also contains *narV*, a potential substitute for *narI*, nitrate reductase gamma-subunit. Both *napA* and *nas*A were identified which also aid in the reduction of nitrate. Genes were also present for nitrite reductase, *nirS* and *nirD*, and nitric oxide reductase, *norB* and *norC*. These genes, in combination with the presence of *nosZ*, suggest that this organism is capable of denitrification however, experimental data would need to be collected to confirm. Due to this species ability to be a potential facultative anaerobe it is also possible that this species is uses denitrification to allow this survive in both aerobic and anaerobic conditions. It has been well documented that *Acidovorax* species have the ability to perform denitrification (106, 108).

Table 4.3 The genes, their products and the responsible process of each used in denitrification which were present in *Acidovorax* isolate

Gene(s)	Product	process
narGHV	Nitrate reductase	$NO_3^- \rightarrow NO_2^-$
nirS	Nitrite reductase	$NO_2^- \rightarrow NO$
norB	Nitric oxide reductase	$NO \rightarrow N_2O$
nosZ	Nitrous oxide reductase	$N_2O \rightarrow N_2$

4.2.1.4 Defence systems identified in the genome sequence

In addition to general metabolic functions there were also other genes found that might be involved in other pathways within the genome. This includes a CRISPR cas3 system which could potentially be responsible to cell immunity against bacteriophage infection. CRISPR systems are more commonly associated with the cas9 system which makes clean double-stranded breaks in the foreign DNA whereas the cas3 system destroys large fragments of DNA it identifies (110, 111). This system was found alongside a repeat region with 106 identifiable repeats meaning that this species is resistant to many foreign DNA elements such as phages and plasmids. The repeat sequence which was identified 106 times is 27 bp long and a BLAST result revealed that this particular repeat region has been identified in other bacterial species. This suggests that this same system may have been passed between various bacterial species.

Candidate genes were found for two toxin/antitoxin systems within the genome of the *Acidovorax* isolate. These systems provide an advantage to the organism by allowing it to kill off competing bacteria with the toxin and protecting itself with the antitoxin (112). One such system is the *hipBA* toxin/antitoxin system which has been identified in other Gram negative bacteria, such as *Escherichia coli* (113). The candidate gene *hipA* was identified and encodes a toxin normally neutralised by HipB protein however, a gene for this antitoxin was not identified. Another gene which can produce a neutralising agent for this toxin was not identified.

Another such system is the higBA toxin/antitoxin system, which was initially characterised in *Vibrio cholerae* (114). Additionally, both candidate genes for higBA toxin/antitoxin system were identified. The toxin encoding component of this system, higB, functions as an mRNA interferase toxin, this group of toxins are RNA molecules which bind to specific mRNA sequences to inhibit expression. However, annotations labelled the *higB* gene as an endoribonuclease and not the toxin component of a toxin/endotoxin system. Candidate genes for a putative *vapB38* antitoxin and *vapC44* toxin were found however, these two are generally not capable of working together.

4.2.1.5 Genes involved in cell formation and morphology

To determine what might be the genetic determinants of the filamentous morphology of this organism, genes involved in cell division and cell wall formation were investigated. Although the bacterial cell division process is still poorly understood the genes involved are well characterised (115). The most prominent of these is the division and cell wall (*dcw*) cluster of genes which are well characterised in many model organisms (115). The *dcw* cluster has been thoroughly characterised as 15 genes in genomes including *E. coli* and *Heamophilus influenzae*, involved in cell division and cell wall synthesis (116). Variations of this cluster have been found and characterised in many organisms since (115). The dcw cluster within the *Acidovorax* isolate closely resembles that of the *E. coli* dcw cluster. The most notable difference however, is that the *mraW* and *ftsI* genes have been replaced with *rsmH* and *penA*, respectively (Figure 4.3). The *mraW* and *rsmH* genes both encode ribosomal RNA small subunit methyltranferases potentially confirming their interchangeability (117, 118). Both of these genes also encode for a penicillin-binding protein which can allow for penicillin resistance (119, 120). Although both of these genes are related to the cell wall it is unknown if they are interchangeable in their role to allow for cell wall synthesis.

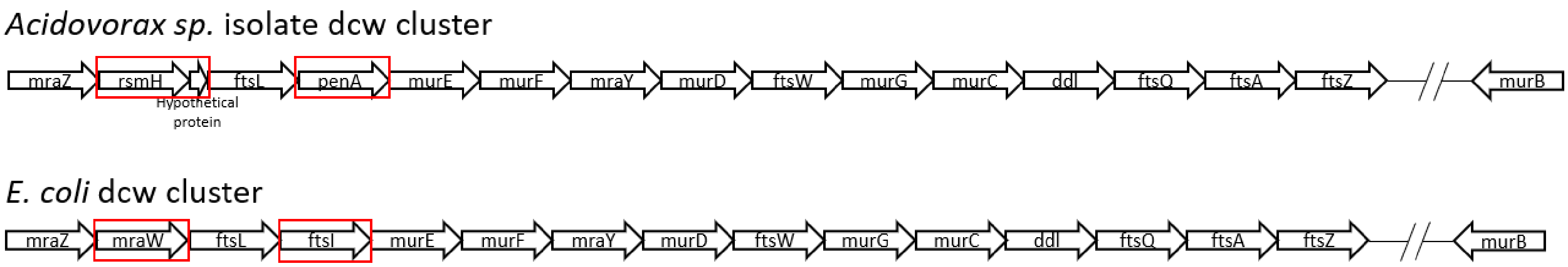


Figure 4.3 Comparison between the *Acidovorax sp.* and the *E. coli* dcw cluster. Differences are highlighted by a red box. The *Acidovorax* dcw cluster has potential homologs for *mraW* and *ftsI* (as seen in *E. coli*) and are identified as *rsmH* and *penA*, respectively

4.2.2 Genomic variations between *Acidovorax spp*. Strains

The genus *Acidovorax* can be split into two groups based on occurrence and habitat; those associated with pathogenicity and those associated with being environmental species (99). The *Acidovorax* isolate analysed in this study is an environmental isolate and contained four distinct rRNA operons, consistent with that of other environmental strains of *Acidovorax spp*. (121). The most closely related *Acidovorax spp*., based on 16S rRNA gene homology, was *Acidovorax temperans* (99.60%). 16S rRNA gene sequence homology also showed a close relatedness to other unidentified *Acidorax* environmental isolates. However, it has been shown that *Acidovorax* species can have close (>97%) interspecies 16S rRNA gene similarities (122).

The genome of *Acidovorax sp.* was analysed and compared against other sequences deposited in the GenBank database. First a 16S rRNA BLAST search revealed that nearly all highly similar (>97%) were either unidentified strains or clones. The exception being an *A. temperans* strain which was 99.60% similar to our *Acidovorax* isolate. Whole genome alignment of our *Acidovorax* isolate was then performed against known *Acidovorax spp*. to determine genetic relatedness. Phylogenetic analysis of the 16S rRNA gene to determine the most closely related strains (Figure 4.4). The most closely related *Acidovorax* with an accessible whole genome was an unknown species strain 1608163. This strain was compared to *Acidovorax sp.* and were subjected to whole genome alignment.

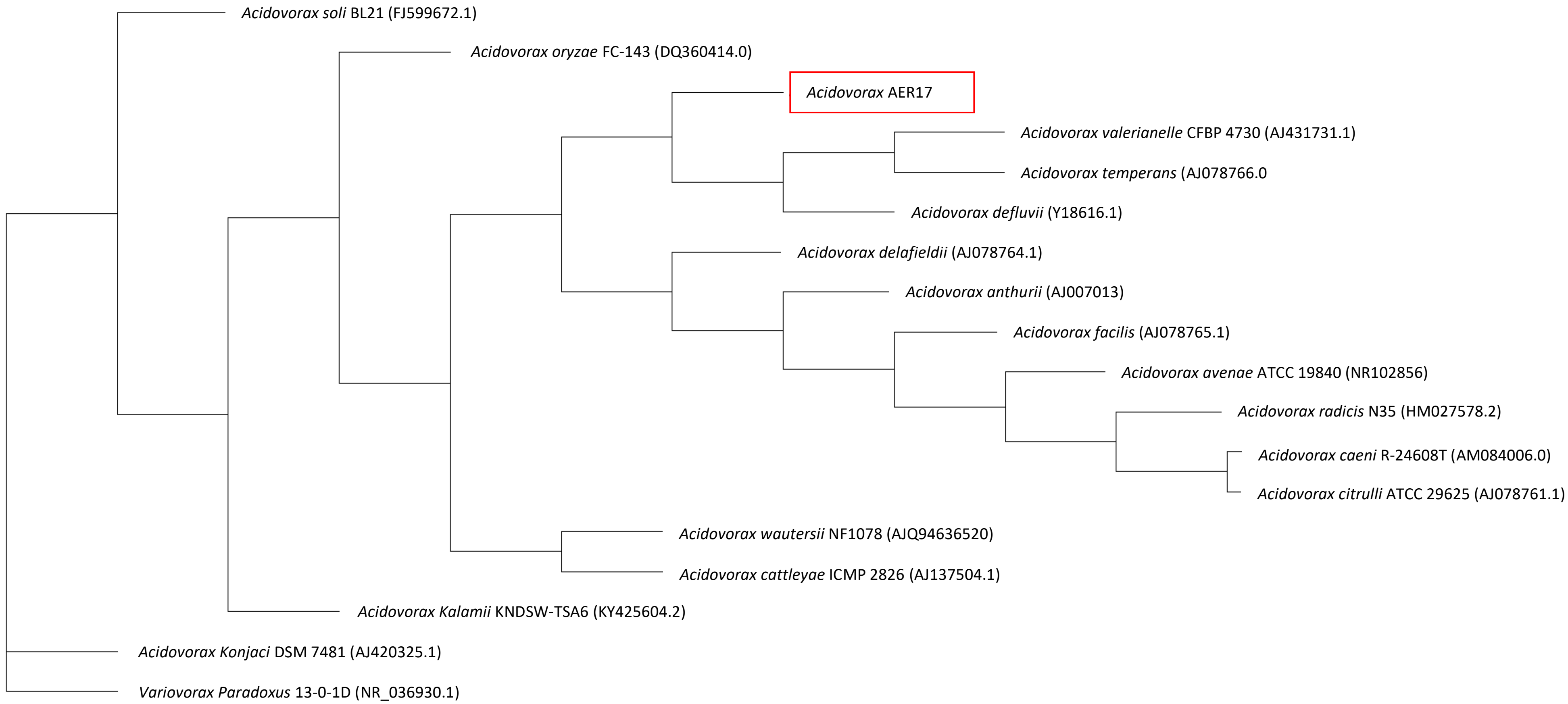


Figure 4.4 Phylogenetic analysis of putative *Acidovorax* sp. and other *Acidovorax* spp. Putative *Acidovorax* sp. is most closely related to a clade which includes *Acidovorax temperans* and two other *Acidovorax* strains unidentified at species level. Bayesian tree (1,001,000 bootstraps) was performed using 16S rRNA gene sequences from known species; NCBI accession numbers are provided in parentheses. *Variovorax paradoxus* was used as an outgroup.

Acidovorax sp. isolated in this study formed a clade on its own but was most closely related to a clade of which included *Acidovorax temperans* and two other strains unidentified at species level. Most importantly the members which the *Acidovorax* isolate was most closely related to were the environmental strains such as *A. temperans*, *Acidovorax defluvii* and *A. facilis* (99). The strains included in the phylogenetic analysis were chosen either based on a known *Acidovorax* species or by having close 16S or 23S rRNA gene sequence homology to the isolate in this study. However, *Acidovorax* taxonomy is difficult to decipher since many have been identified in the environment by 16S rRNA gene sequences and whole genome sequencing but have not been assigned a species name.

Whole genome alignment of the *Acidovorax sp*. strain and the 1608163 strain manage to align 1.87 Mbps of the genomes. The dwc cluster of both strains showed near perfect alignment with some gaps in genes being present, but all genes are present in both strains. However, the 1608163 strain seems to be missing the *murB* gene, but observation of other annotated *Acidovorax* genomes shows that this gene is, in fact, present. Therefore, it is doubtful that this gene allows for this strain to form a filamentous morphotype.

Acidovorax sp. isolated in this study is the first filament forming *Acidovorax* species which was successfully isolated in pure culture. Whole genome analysis suggests that this organism may have a limited metabolic potential with almost no capability of producing storage compounds. However, this organism may be an active denitrifier within activated sludge systems and so could hold an important role within this niche if conditions permitted. Additionally, experimental validation is required to determine the true metabolic diversity of

Phylogenetic analysis suggests that *Acidovorax* isolate is most closely related to *A. temperans*. Although there are strains which have been identified to have high similarity to this organism they have not been identified or characterised at species level.

4.3 Significance in Activated Sludge

Previously many different *Acidovorax* species have been isolated from AS and two of which were identified as novel species (101, 123, 124). Between this and their known affinity to denitrification it is assumed that they may make a substantial contribution in AS systems. Although they are regularly isolated and identified within AS they have not been identified as core active denitrifiers in Danish WWTPs and have not been associated with being a part of any core AS communities (4, 5, 16, 35). Additionally, the *Acidovorax* genus had an extremely small representation in the three plants used in this study only showing up in small amounts in about half of the Gisborne samples. This suggests that the role they play in the AS process may be minimal as they may only be effectively capable of denitrification. However, the isolate analysed in this study did not come from any of the three plants used in this study and perhaps the filamentous morphology may give it a competitive advantage.

The *Acidovorax* isolate was isolated from a WWTP with an EBPR configuration in Queensland, Australia. Members of this genus have been isolated from AS before and are well characterised within this environment; especially for their ability to perform denitrification (101, 123, 125). However, they seem to have very little significant metabolic function within the AS process and are not often highly abundant within these communities (5, 16, 35). It is possible that they are often out competed by other denitrifiers AS communities due to their single ability to perform denitrification. The *Acidovorax* isolate within this study was found to have a filamentous morphotype. It is possible that this gives the strain a competitive advantage, but it is not clear as to how this would prove advantageous although many filamentous bacteria are present within WWTPs (126).

Bibliography

1. Seviour B, Nielsen P. Microbial Ecology of Activated Sludge Preface. Microbial Ecology of Activated Sludge. 2010:Vii-+.
2. Seviour RJ. Factors affecting the bulking and foaming filamentous bacteria in activated sludge. Microbial Ecology of Activated Sludge. 2010:139-67.
3. Jenkins D, Wanner J. Activated Sludge-100 Years and Counting Preface. Activated Sludge - 100 Years and Counting. 2014:Xxxiii-Xxxiv.
4. Saunders AM, Albertsen M, Vollertsen J, Nielsen PH. The activated sludge ecosystem contains a core community of abundant organisms. ISME J. 2016;10(1):11-20.
5. Zhang T, Shao MF, Ye L. 454 pyrosequencing reveals bacterial diversity of activated sludge from 14 sewage treatment plants. ISME J. 2012;6(6):1137-47.
6. Curds CR. Role of Protozoa in Activated-Sludge Process. Am Zool. 1973;13(1):161-9.
7. Fuhs GW, Chen M. Microbiological Basis of Phosphate Removal in the Activated Sludge Process for the Treatment of Wastewater. Microb Ecol. 1975;2(2):119-38.
8. Bond PL, Hugenholtz P, Keller J, Blackall LL. Bacterial Community Structures of Phosphate-Removing and Non-Phosphate-Removing Activated Sludges from Sequencing Batch Reactors. Appl Environ Microb. 1995;61(5):1910-6.
9. Seviour RJ, Mino T, Onuki M. The microbiology of biological phosphorus removal in activated sludge systems. Fems Microbiol Rev. 2003;27(1):99-127.
10. Baker GC, Smith JJ, Cowan DA. Review and re-analysis of domain-specific 16S primers. J Microbiol Meth. 2003;55(3):541-55.
11. Andersen MH, McIlroy SJ, Nierychlo M, Nielsen PH, Albertsen M. Genomic insights into Candidatus Amarolinea aalborgensis gen. nov., sp. nov., associated with settleability problems in wastewater treatment plants. Syst Appl Microbiol. 2019;42(1):77-84.
12. Martin HG, Ivanova N, Kunin V, Warnecke F, Barry KW, McHardy AC, et al. Metagenomic analysis of two enhanced biological phosphorus removal (EBPR) sludge communities. Nat Biotechnol. 2006;24(10):1263-9.
13. Albertsen M, Hansen LBS, Saunders AM, Nielsen PH, Nielsen KL. A metagenome of a full-scale microbial community carrying out enhanced biological phosphorus removal. Isme Journal. 2012;6(6):1094-106.
14. Yu K, Zhang T. Metagenomic and Metatranscriptomic Analysis of Microbial Community Structure and Gene Expression of Activated Sludge. Plos One. 2012;7(5).
15. Milobedzka A, Muszynski A. Can DNA sequencing show differences between microbial communities in Polish and Danish wastewater treatment plants? Water Sci Technol. 2017;75(6):1447-54.
16. Wu L, Ning D, Zhang B, Li Y, Zhang P, Shan X, et al. Global diversity and biogeography of bacterial communities in wastewater treatment plants. Nat Microbiol. 2019.
17. McIlroy SJ, Kirkegaard RH, McIlroy B, Nierychlo M, Kristensen JM, Karst SM, et al. MiDAS 2.0: an ecosystem-specific taxonomy and online database for the organisms of wastewater treatment systems expanded for anaerobic digester groups. Database (Oxford). 2017;2017(1).
18. Albertsen M, Karst SM, Ziegler AS, Kirkegaard RH, Nielsen PH. Back to Basics--The Influence of DNA Extraction and Primer Choice on Phylogenetic Analysis of Activated Sludge Communities. PLoS One. 2015;10(7):e0132783.
19. Srinath EG, Sastry CA, Pillai SC. Rapid Removal of Phosphorus from Sewage by Activated Sludge. Experientia. 1959;15(9):339-40.

20. Flowers JJ, He SM, Malfatti S, del Rio TG, Tringe SG, Hugenholtz P, et al. Comparative genomics of two 'Candidatus Accumulibacter' clades performing biological phosphorus removal. Isme Journal. 2013;7(12):2301-14.
21. Nielsen PH, McIlroy SJ, Albertsen M, Nierychlo M. Re-evaluating the microbiology of the enhanced biological phosphorus removal process. Curr Opin Biotechnol. 2019;57:111-8.
22. Beer M, Stratton HM, Griffiths PC, Seviour RJ. Which are the polyphosphate accumulating organisms in full-scale activated sludge enhanced biological phosphate removal systems in Australia? 2006;100(2):233-43.
23. Nielsen PH, Saunders AM, Hansen AA, Larsen P, Nielsen JL. Microbial communities involved in enhanced biological phosphorus removal from wastewater--a model system in environmental biotechnology. Curr Opin Biotechnol. 2012;23(3):452-9.
24. He S, Gu AZ, McMahon KD. Progress Toward Understanding the Distribution of Accumulibacter Among Full-Scale Enhanced Biological Phosphorus Removal Systems. Microb Ecol. 2008;55(2):229-36.
25. Stokholm-Bjerregaard M, McIlroy SJ, Nierychlo M, Karst SM, Albertsen M, Nielsen PH. A Critical Assessment of the Microorganisms Proposed to be Important to Enhanced Biological Phosphorus Removal in Full-Scale Wastewater Treatment Systems. Front Microbiol. 2017;8.
26. Kristiansen R, Nguyen HTT, Saunders AM, Nielsen JL, Wimmer R, Le VQ, et al. A metabolic model for members of the genus Tetrasphaera involved in enhanced biological phosphorus removal. Isme Journal. 2013;7(3):543-54.
27. Jobbagy A, Tardy GM, Literathy B. Enhanced nitrogen removal in the combined activated sludge-biofilter system of the Southpest Wastewater Treatment Plant. Water Sci Technol. 2004;50(7):1-8.
28. Geets J, de Cooman M, Wittebolle L, Heylen K, Vanparys B, De Vos P, et al. Real-time PCR assay for the simultaneous quantification of nitrifying and denitrifying bacteria in activated sludge. Appl Microbiol Biot. 2007;75(1):211-21.
29. van Kessel MAHJ, Speth DR, Albertsen M, Nielsen PH, Op den Camp HJM, Kartal B, et al. Complete nitrification by a single microorganism. Nature. 2015;528:555.
30. Palomo A, Pedersen AG, Fowler SJ, Dechesne A, Sicheritz-Pontén T, Smets BF. Comparative genomics sheds light on niche differentiation and the evolutionary history of comammox Nitrospira. The ISME Journal. 2018;12(7):1779-93.
31. Daims H, Lebedeva EV, Pjevac P, Han P, Herbold C, Albertsen M, et al. Complete nitrification by Nitrospira bacteria. Nature. 2015;528(7583):504-9.
32. Daims H, Wagner M. Nitrospira. Trends Microbiol. 2018;26(5):462-3.
33. Zumft WG. Cell biology and molecular basis of denitrification. Microbiol Mol Biol R. 1997;61(4):533-+.
34. Thomsen TR, Kong Y, Nielsen PH. Ecophysiology of abundant denitrifying bacteria in activated sludge. Fems Microbiology Ecology. 2007;60(3):370-82.
35. McIlroy SJ, Starnawska A, Starnawski P, Saunders AM, Nierychlo M, Nielsen PH, et al. Identification of active denitrifiers in full-scale nutrient removal wastewater treatment systems. Environ Microbiol. 2016;18(1):50-64.
36. Alvarez L, Bricio C, Blesa A, Hidalgo A, Berenguer J. Transferable denitrification capability of Thermus thermophilus. Appl Environ Microbiol. 2014;80(1):19-28.
37. Eikelboom DH. Filamentous Organisms Observed in Activated-Sludge. Water Research. 1975;9(4):365-88.

38. Seviour EM, Blackall LL, Christensson C, Hugenholtz P, Cunningham MA, Bradford D, et al. The filamentous morphotype Eikelboom Type 1863 is not a single genetic entity. J Appl Microbiol. 1997;82(4):411-21.
39. Feng L, Chen Y, Zheng X. Enhancement of waste activated sludge protein conversion and volatile fatty acids accumulation during waste activated sludge anaerobic fermentation by carbohydrate substrate addition: the effect of pH. Environ Sci Technol. 2009;43(12):4373-80.
40. Petrovski S, Dyson ZA, Quill ES, McIlroy SJ, Tillett D, Seviour RJ. An examination of the mechanisms for stable foam formation in activated sludge systems. Water Research. 2011;45(5):2146-54.
41. Marrengane Z, Kumar SKS, Pillay L, Bux F. Rapid quantification and analysis of genetic diversity among Gordonia populations in foaming activated sludge plants. J Basic Microb. 2011;51(4):415-23.
42. Eales KL, Nielsen JL, Seviour EM, Nielsen PH, Seviour RJ. The in situ physiology of Skermania piniformis in foams in Australian activated sludge plants. Environmental Microbiology. 2006;8(10):1712-20.
43. Friedman BA, Dugan PR. Identification of Zoogloea species and the relationship to zoogloeal matrix and floc formation. J Bacteriol. 1968;95(5):1903-9.
44. Shao Y, Chung BS, Lee SS, Park W, Lee SS, Jeon CO. Zoogloea caeni sp. nov., a floc-forming bacterium isolated from activated sludge. Int J Syst Evol Microbiol. 2009;59(Pt 3):526-30.
45. McIlroy SJ, Kristiansen R, Albertsen M, Karst SM, Rossetti S, Nielsen JL, et al. Metabolic model for the filamentous 'Candidatus Microthrix parvicella' based on genomic and metagenomic analyses. ISME J. 2013;7(6):1161-72.
46. McIlroy SJ, Karst SM, Nierychlo M, Dueholm MS, Albertsen M, Kirkegaard RH, et al. Genomic and in situ investigations of the novel uncultured Chloroflexi associated with 0092 morphotype filamentous bulking in activated sludge. ISME J. 2016;10(9):2223-34.
47. Skerman VBD. A New Type of Micromanipulator and Microforge. J Gen Microbiol. 1968;54:287-&.
48. Callahan BJ, McMurdie PJ, Rosen MJ, Han AW, Johnson AJA, Holmes SP. DADA2: High-resolution sample inference from Illumina amplicon data. Nat Methods. 2016;13(7):581-+.
49. Bolyen E, Rideout JR, Dillon MR, Bokulich NA, Abnet C, Al-Ghalith GA, et al. QIIME 2: Reproducible, interactive, scalable, and extensible microbiome data science. PeerJ Preprints; 2018. Report No.: 2167-9843.
50. McIlroy SJ, Saunders AM, Albertsen M, Nierychlo M, McIlroy B, Hansen AA, et al. MiDAS: the field guide to the microbes of activated sludge. Database-Oxford. 2015.
51. Skytte KA, Kirkegaard R, Karst S, Albertsen M. ampvis2: an R package to analyse and visualise 16S rRNA amplicon data. 2018.
52. Epskamp S, Cramer AOJ, Waldorp LJ, Schmittmann VD, Borsboom D. qgraph: Network Visualizations of Relationships in Psychometric Data. J Stat Softw. 2012;48(4):1-18.
53. Hmisc: harrell miscellaneous.
54. Wickham H, Wickham MH. The ggplot package. 2007.
55. Darling AE, Tritt A, Eisen JA, Facciotti MT. Mauve assembly metrics. Bioinformatics. 2011;27(19):2756-7.
56. Ju F, Zhang T. Bacterial assembly and temporal dynamics in activated sludge of a full-scale municipal wastewater treatment plant. ISME J. 2015;9(3):683-95.

57. Stein LY. Insights into the physiology of ammonia-oxidizing microorganisms. Curr Opin Chem Biol. 2019;49:9-15.
58. Daims H, Lucker S, Wagner M. A New Perspective on Microbes Formerly Known as Nitrite-Oxidizing Bacteria. Trends Microbiol. 2016;24(9):699-712.
59. Lu HJ, Chandran K, Stensel D. Microbial ecology of denitrification in biological wastewater treatment. Water Research. 2014;64:237-54.
60. McIlroy SJ, Albertsen M, Andresen EK, Saunders AM, Kristiansen R, Stokholm-Bjerregaard M, et al. 'Candidatus Competibacter'-lineage genomes retrieved from metagenomes reveal functional metabolic diversity. Isme Journal. 2014;8(3):613-24.
61. Zhang Y, Chen LJ, Sun RH, Dai TJ, Tian JP, Wen DH. Ammonia-oxidizing bacteria and archaea in wastewater treatment plant sludge and nearby coastal sediment in an industrial area in China. Appl Microbiol Biot. 2015;99(10):4495-507.
62. Gao JF, Luo X, Wu GX, Li T, Peng YZ. Abundance and diversity based on amoA genes of ammonia-oxidizing archaea and bacteria in ten wastewater treatment systems. Appl Microbiol Biot. 2014;98(7):3339-54.
63. Sauder LA, Peterse F, Schouten S, Neufeld JD. Low-ammonia niche of ammonia-oxidizing archaea in rotating biological contactors of a municipal wastewater treatment plant. Environmental Microbiology. 2012;14(9):2589-600.
64. Alawi M, Off S, Kaya M, Spieck E. Temperature influences the population structure of nitrite-oxidizing bacteria in activated sludge. Env Microbiol Rep. 2009;1(3):184-90.
65. Lucker BF, Hall CC, Zegarac R, Kramer DM. The environmental photobioreactor (ePBR): An algal culturing platform for simulating dynamic natural environments. Algal Res. 2014;6:242-9.
66. Sorokin DY, Lucker S, Vejmelkova D, Kostrikina NA, Kleerebezem R, Rijpstra WIC, et al. Nitrification expanded: discovery, physiology and genomics of a nitrite-oxidizing bacterium from the phylum Chloroflexi. Isme Journal. 2012;6(12):2245-56.
67. Gruber-Dorninger C, Pester M, Kitzinger K, Savio DF, Loy A, Rattei T, et al. Functionally relevant diversity of closely related Nitrospira in activated sludge. ISME J. 2015;9(3):643-55.
68. Gonzalez-Martinez A, Rodriguez-Sanchez A, van Loosdrecht MCM, Gonzalez-Lopez J, Vahala R. Detection of comammox bacteria in full-scale wastewater treatment bioreactors using tag-454-pyrosequencing. Environ Sci Pollut R. 2016;23(24):25501-11.
69. Fan XY, Zhu Y, Gu PF, Li YM, Xiao GQ, Song DX, et al. Bacterial community compositions of propylene oxide saponification wastewater treatment plants. Rsc Adv. 2017;7(36):22347-52.
70. Koch C, Huber KJ, Bunk B, Overmann J, Harnisch F. Trophic networks improve the performance of microbial anodes treating wastewater. Npj Biofilms Microme. 2019;5.
71. Roots P, Wang YB, Rosenthal AF, Griffin JS, Sabba F, Petrovich M, et al. Comammox Nitrospira are the dominant ammonia oxidizers in a mainstream low dissolved oxygen nitrification reactor. Water Research. 2019;157:396-405.
72. Zheng MS, Wang MY, Zhao ZR, Zhou N, He SS, Liu SF, et al. Transcriptional activity and diversity of comammox bacteria as a previously overlooked ammonia oxidizing prokaryote in full-scale wastewater treatment plants. Sci Total Environ. 2019;656:717-22.
73. Ju F, Zhang T. Experimental Design and Bioinformatics Analysis for the Application of Metagenomics in Environmental Sciences and Biotechnology. Environ Sci Technol. 2015;49(21):12628-40.

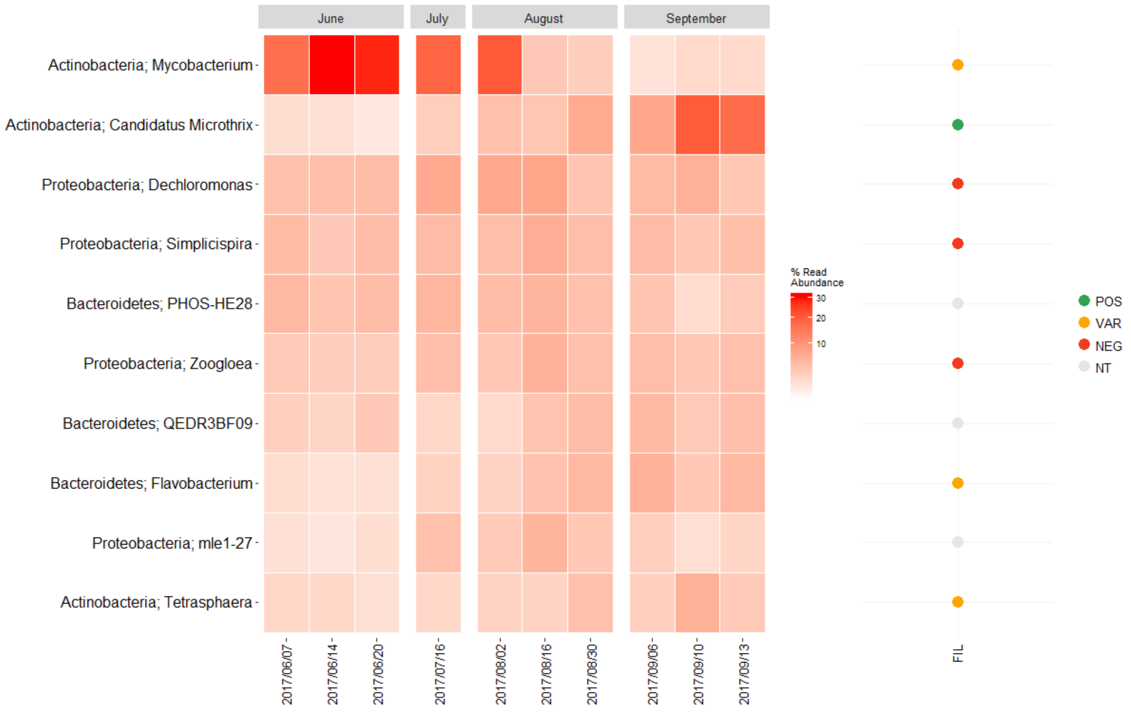
74. Xia Y, Wen XH, Zhang B, Yang YF. Diversity and assembly patterns of activated sludge microbial communities: A review. Biotechnol Adv. 2018;36(4):1038-47.
75. Ye L, Zhang T. Bacterial communities in different sections of a municipal wastewater treatment plant revealed by 16S rDNA 454 pyrosequencing. Appl Microbiol Biot. 2013;97(6):2681-90.
76. Cai X, Mao Y, Xu J, Tian L, Wang Y, Iqbal W, et al. Characterizing community dynamics and exploring bacterial assemblages in two activated sludge systems. Appl Microbiol Biotechnol. 2020;104(4):1795-808.
77. Griffin JS, Wells GF. Regional synchrony in full-scale activated sludge bioreactors due to deterministic microbial community assembly. Isme Journal. 2017;11(2):500-11.
78. Jiang XT, Ye L, Ju F, Wang YL, Zhang T. Toward an Intensive Longitudinal Understanding of Activated Sludge Bacterial Assembly and Dynamics. Environ Sci Technol. 2018;52(15):8224-32.
79. Jiang XT, Ye L, Ju F, Li B, Ma LP, Zhang T. Temporal dynamics of activated sludge bacterial communities in two diversity variant full-scale sewage treatment plants. Appl Microbiol Biotechnol. 2018;102(21):9379-88.
80. Zhao D, Huang R, Zeng J, Yu Z, Liu P, Cheng S, et al. Pyrosequencing analysis of bacterial community and assembly in activated sludge samples from different geographic regions in China. Appl Microbiol Biotechnol. 2014;98(21):9119-28.
81. Zhang B, Ning DL, Yang YF, Van Nostrand JD, Zhou JZ, Wen XH. Biodegradability of wastewater determines microbial assembly mechanisms in full-scale wastewater treatment plants. Water Research. 2020;169.
82. Jo SJ, Kwon H, Jeong SY, Lee CH, Kim TG. Comparison of microbial communities of activated sludge and membrane biofilm in 10 full-scale membrane bioreactors. Water Research. 2016;101:214-25.
83. Speirs LBM, Rice DTF, Petrovski S, Seviour RJ. The Phylogeny, Biodiversity, and Ecology of the Chloroflexi in Activated Sludge. Front Microbiol. 2019;10:2015.
84. Nierychlo M, Milobedzka A, Petriglieri F, McIlroy B, Nielsen PH, McIlroy SJ. The morphology and metabolic potential of the Chloroflexi in full-scale activated sludge wastewater treatment plants. FEMS Microbiol Ecol. 2019;95(2).
85. Kong Y, Xia Y, Nielsen JL, Nielsen PH. Structure and function of the microbial community in a full-scale enhanced biological phosphorus removal plant. Microbiology. 2007;153(Pt 12):4061-73.
86. Xia Y, Kong YH, Thomsen TR, Nielsen PH. Identification and ecophysiological characterization of epiphytic protein-hydrolyzing Saprospiraceae ("Candidatus epiflobacter" spp.) in activated sludge. Appl Environ Microb. 2008;74(7):2229-38.
87. Saad SA, Welles L, Abbas B, Lopez-Vazquez CM, van Loosdrecht MCM, Brdjanovic D. Denitrification of nitrate and nitrite by 'Candidatus Accumulibacter phosphatis' clade IC. Water Research. 2016;105:97-109.
88. Albertsen M, McIlroy SJ, Stokholm-Bjerregaard M, Karst SM, Nielsen PH. "Candidatus Propionivibrio aalborgensis": A Novel Glycogen Accumulating Organism Abundant in Full-Scale Enhanced Biological Phosphorus Removal Plants. Front Microbiol. 2016;7.
89. Terashima M, Yama A, Sato M, Yumoto I, Kamagata Y, Kato S. Culture-Dependent and -Independent Identification of Polyphosphate-Accumulating Dechloromonas spp. Predominating in a Full-Scale Oxidation Ditch Wastewater Treatment Plant. Microbes Environ. 2016;31(4):449-55.

90. Nguyen HTT, Kristiansen R, Vestergaard M, Wimmer R, Nielsen PH. Intracellular Accumulation of Glycine in Polyphosphate-Accumulating Organisms in Activated Sludge, a Novel Storage Mechanism under Dynamic Anaerobic-Aerobic Conditions. Appl Environ Microb. 2015;81(14):4809-18.
91. Subramanian SB, Yan S, Tyagi RD, Surampalli RY. Extracellular polymeric substances (EPS) producing bacterial strains of municipal wastewater sludge: Isolation, molecular identification, EPS characterization and performance for sludge settling and dewatering. Water Research. 2010;44(7):2253-66.
92. Huang TL, Zhou SL, Zhang HH, Bai SY, He XX, Yang X. Nitrogen Removal Characteristics of a Newly Isolated Indigenous Aerobic Denitrifier from Oligotrophic Drinking Water Reservoir, Zoogloea sp. N299. Int J Mol Sci. 2015;16(5):10038-60.
93. Xia Y, Hu M, Wen XH, Wang XH, Yang YF, Zhou JZ. Diversity and interactions of microbial functional genes under differing environmental conditions: insights from a membrane bioreactor and an oxidation ditch. Scientific Reports. 2016;6.
94. Pjevac P, Schauberger C, Poghosyan L, Herbold CW, van Kessel MAHJ, Daebeler A, et al. AmoA-Targeted Polymerase Chain Reaction Primers for the Specific Detection and Quantification of Comammox Nitrospira in the Environment. Front Microbiol. 2017;8.
95. Zhao ZR, Huang GH, He SS, Zhou N, Wang MY, Dang CY, et al. Abundance and community composition of comammox bacteria in different ecosystems by a universal primer set. Sci Total Environ. 2019;691:146-55.
96. Camejo PY, Domingo JS, McMahon KD, Noguera DR. Genome-Enabled Insights into the Ecophysiology of the Comammox Bacterium "Candidatus Nitrospira nitrosa". Msystems. 2017;2(5).
97. Beach NK, Noguera DR. Design and Assessment of Species-Level qPCR Primers Targeting Comammox. Front Microbiol. 2019;10.
98. Wang MY, Huang GH, Zhao ZR, Dang CY, Liu W, Zheng MS. Newly designed primer pair revealed dominant and diverse comammox amoA gene in full-scale wastewater treatment plants. Bioresource Technol. 2018;270:580-7.
99. Choi JH, Kim MS, Roh SW, Bae JW. Acidovorax soli sp nov., isolated from landfill soil. Int J Syst Evol Micr. 2010;60:2715-8.
100. Ehlers GAC, Turner SJ. Triggers of Aggregation and Extracellular Polysaccharide Polymer Production in Acidovorax temperans. Curr Microbiol. 2013;66(5):515-21.
101. Heylen K, Lebbe L, De Vos P. Acidovorax caeni sp nov., a denitrifying species with genetically diverse isolates from activated sludge. Int J Syst Evol Micr. 2008;58:73-7.
102. Bradford D, Hugenholtz P, Seviour EM, Cunningham MA, Stratton H, Seviour RJ, et al. 16S rRNA analysis of isolates obtained from gram-negative, filamentous bacteria micromanipulated from activated sludge. Syst Appl Microbiol. 1996;19(3):334-43.
103. Speirs LBM, Tucci J, Seviour RJ. The activated sludge bulking filament Eikelboom morphotype 0803 embraces more than one member of the Chloroflexi. Fems Microbiology Ecology. 2015;91(9).
104. Zhou Y, Pijuan M, Zeng RJ, Yuan ZG. Involvement of the TCA cycle in the anaerobic metabolism of polyphosphate accumulating organisms (PAOs). Water Research. 2009;43(5):1330-40.
105. Chen X, Schreiber K, Appel J, Makowka A, Fahnrich B, Roettger M, et al. The Entner-Doudoroff pathway is an overlooked glycolytic route in cyanobacteria and plants. P Natl Acad Sci USA. 2016;113(19):5441-6.

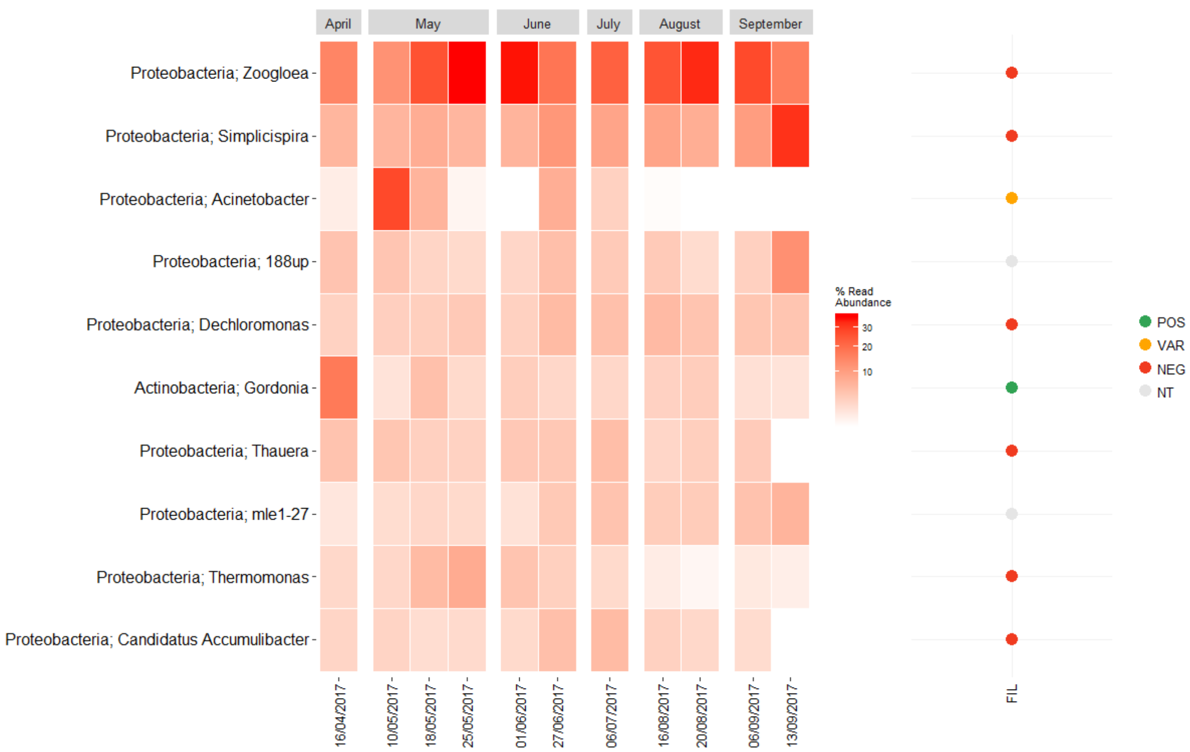
106. Willems A, Falsen E, Pot B, Jantzen E, Hoste B, Vandamme P, et al. Acidovorax, a New Genus for Pseudomonas-Facilis, Pseudomonas-Delafieldii, E-Falsen (Ef) Group 13, Ef Group 16, and Several Clinical Isolates, with the Species Acidovorax-Facilis Comb-Nov, Acidovorax-Delafieldii Comb-Nov, and Acidovorax-Temperans Sp-Nov. International Journal of Systematic Bacteriology. 1990;40(4):384-98.
107. Gardan L, Dauga C, Prior P, Gillis M, Saddler GS. Acidovorax anthurii sp. nov., a new phytopathogenic bacterium which causes bacterial leaf-spot of anthurium (vol 50, pg 235, 2000). Int J Syst Evol Micr. 2000;50:1411-.
108. Ginige MP, Keller J, Blackall LL. Investigation of an acetate-fed denitrifying microbial community by stable isotope probing, full-cycle rRNA analysis, and fluorescent in situ hybridization-microautoradiography. Appl Environ Microbiol. 2005;71(12):8683-91.
109. Shively JM, van Keulen G, Meijer WG. Something from almost nothing: Carbon dioxide fixation in chemoautotrophs. Annu Rev Microbiol. 1998;52:191-230.
110. Jinek M, Jiang FG, Taylor DW, Sternberg SH, Kaya E, Ma EB, et al. Structures of Cas9 Endonucleases Reveal RNA-Mediated Conformational Activation. Science. 2014;343(6176):1215-+.
111. Kunne T, Kieper SN, Bannenberg JW, Vogel AIM, Miellet WR, Klein M, et al. Cas3-Derived Target DNA Degradation Fragments Fuel Primed CRISPR Adaptation. Mol Cell. 2016;63(5):852-64.
112. Van Melderen L, Saavedra De Bast M. Bacterial toxin-antitoxin systems: more than selfish entities? PLoS Genet. 2009;5(3):e1000437.
113. Hansen S, Vulic M, Min J, Yen TJ, Schumacher MA, Brennan RG, et al. Regulation of the Escherichia coli HipBA toxin-antitoxin system by proteolysis. PLoS One. 2012;7(6):e39185.
114. Budde PP, Davis BM, Yuan J, Waldor MK. Characterization of a higBA toxin-antitoxin locus in Vibrio cholerae. J Bacteriol. 2007;189(2):491-500.
115. Tamames J, Gonzalez-Moreno M, Mingorance J, Valencia A, Vicente M. Bringing gene order into bacterial shape. Trends Genet. 2001;17(3):124-6.
116. Vicente M, Gomez MJ, Ayala JA. Regulation of transcription of cell division genes in the Escherichia coli dcw cluster. Cell Mol Life Sci. 1998;54(4):317-24.
117. Carrion M, Gomez MJ, Merchante-Schubert R, Dongarra S, Ayala JA. mraW, an essential gene at the dcw cluster of Escherichia coli codes for a cytoplasmic protein with methyltransferase activity. Biochimie. 1999;81(8-9):879-88.
118. Wei Y, Zhang H, Gao ZQ, Wang WJ, Shtykova EV, Xu JH, et al. Crystal and solution structures of methyltransferase RsmH provide basis for methylation of C1402 in 16S rRNA. J Struct Biol. 2012;179(1):29-40.
119. Daniel RA, Harry EJ, Katis VL, Wake RG, Errington J. Characterization of the essential cell division gene ftsL(yIID) of Bacillus subtilis and its role in the assembly of the division apparatus. Mol Microbiol. 1998;29(2):593-604.
120. Ameyama S, Onodera S, Takahata M, Minami S, Maki N, Endo K, et al. Mosaic-like structure of penicillin-binding protein 2 Gene (penA) in clinical isolates of Neisseria gonorrhoeae with reduced susceptibility to cefixime. Antimicrob Agents Chemother. 2002;46(12):3744-9.
121. Singleton DR, Lee J, Dickey AN, Stroud A, Scholl EH, Wright FA, et al. Polyphasic characterization of four soil-derived phenanthrene-degrading Acidovorax strains and proposal of Acidovorax carolinensis sp nov. Syst Appl Microbiol. 2018;41(5):460-72.

122. Li D, Rothballer M, Schmid M, Esperschutz J, Hartmann A. Acidovorax radicis sp nov., a wheat-root-colonizing bacterium. Int J Syst Evol Micr. 2011;61:2589-94.
123. Schulze R, Spring S, Amann R, I H, Ludwig W, Schleifer KH, et al. Genotypic diversity of Acidovorax strains isolated from activated sludge and description of Acidovorax defluvii sp nov. Syst Appl Microbiol. 1999;22(2):205-14.
124. Manefield M, Griffiths RI, Leigh MB, Fisher R, Whiteley AS. Functional and compositional comparison of two activated sludge communities remediating coking effluent. Environmental Microbiology. 2005;7(5):715-22.
125. Gonzalez-Martinez A, Rodriguez-Sanchez A, Lotti T, Garcia-Ruiz MJ, Osorio F, Gonzalez-Lopez J, et al. Comparison of bacterial communities of conventional and A-stage activated sludge systems. Scientific Reports. 2016;6.
126. Nielsen PH, Kragelund C, Seviour RJ, Nielsen JL. Identity and ecophysiology of filamentous bacteria in activated sludge. Fems Microbiol Rev. 2009;33(6):969-98.

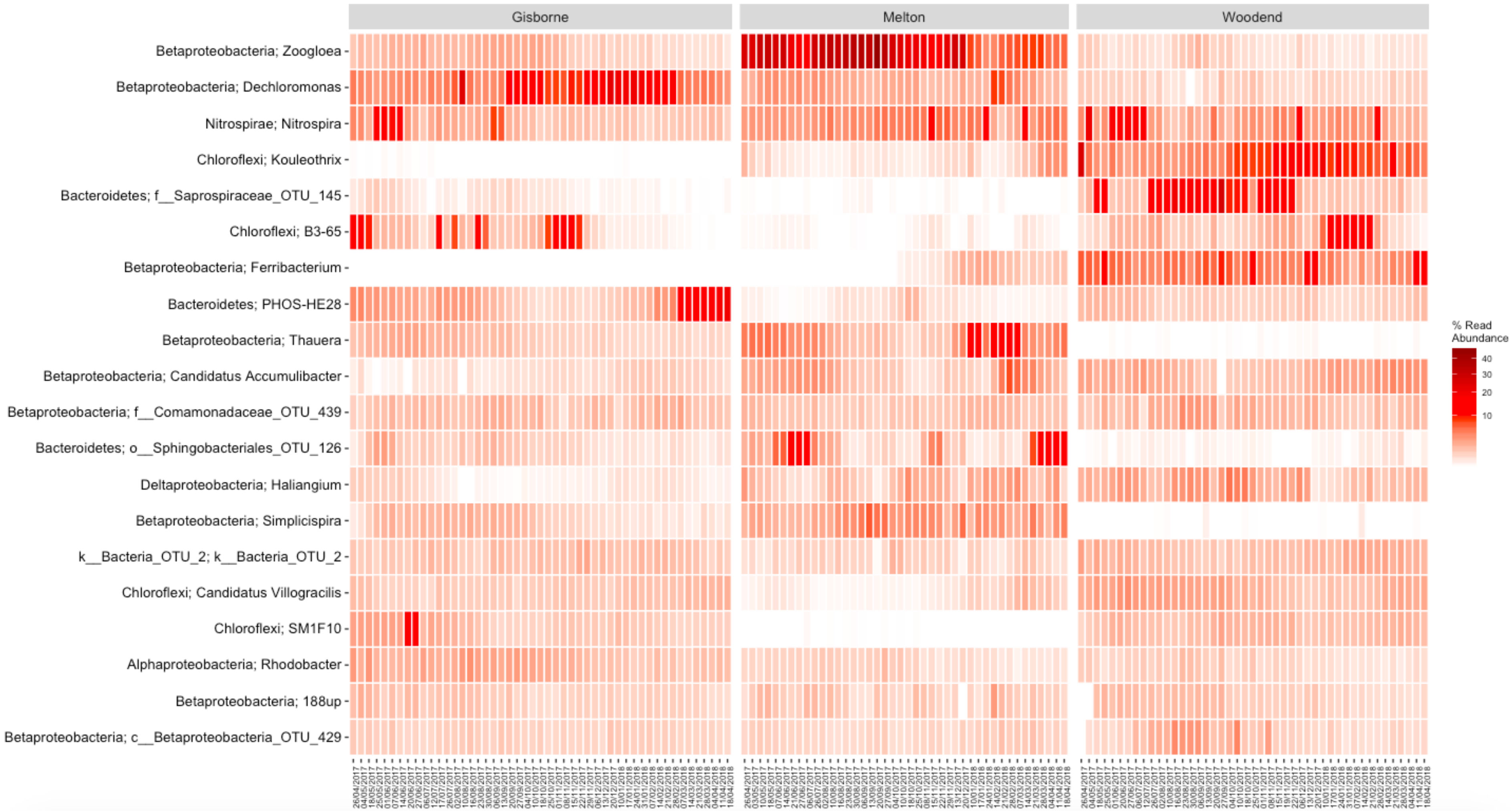
APPENDIX 1 – SUPPLEMENTAL DATA FOR AMPLICON ANALYSIS



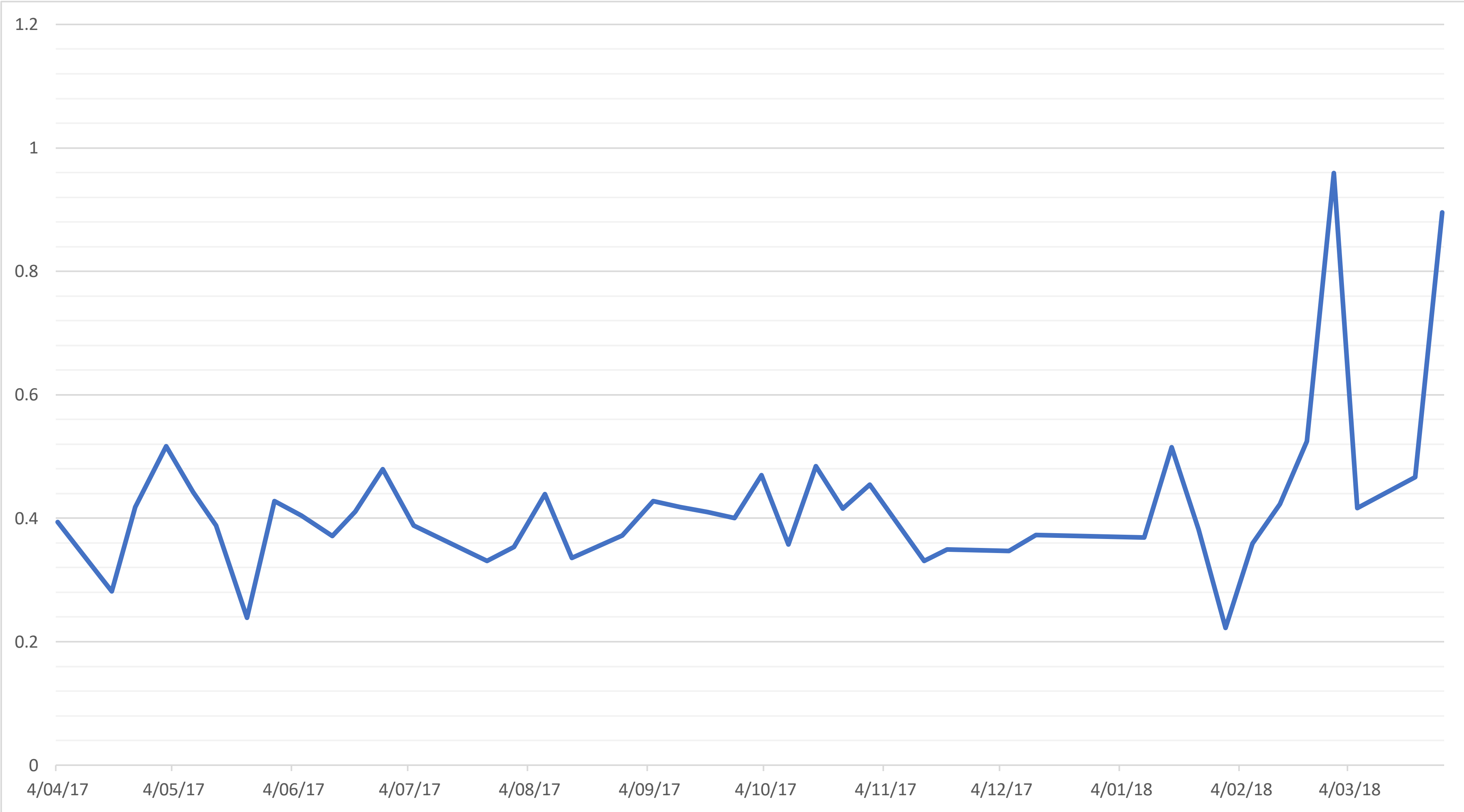
1.1 Heat map of the top 10 most abundant genera from the Gisborne foam



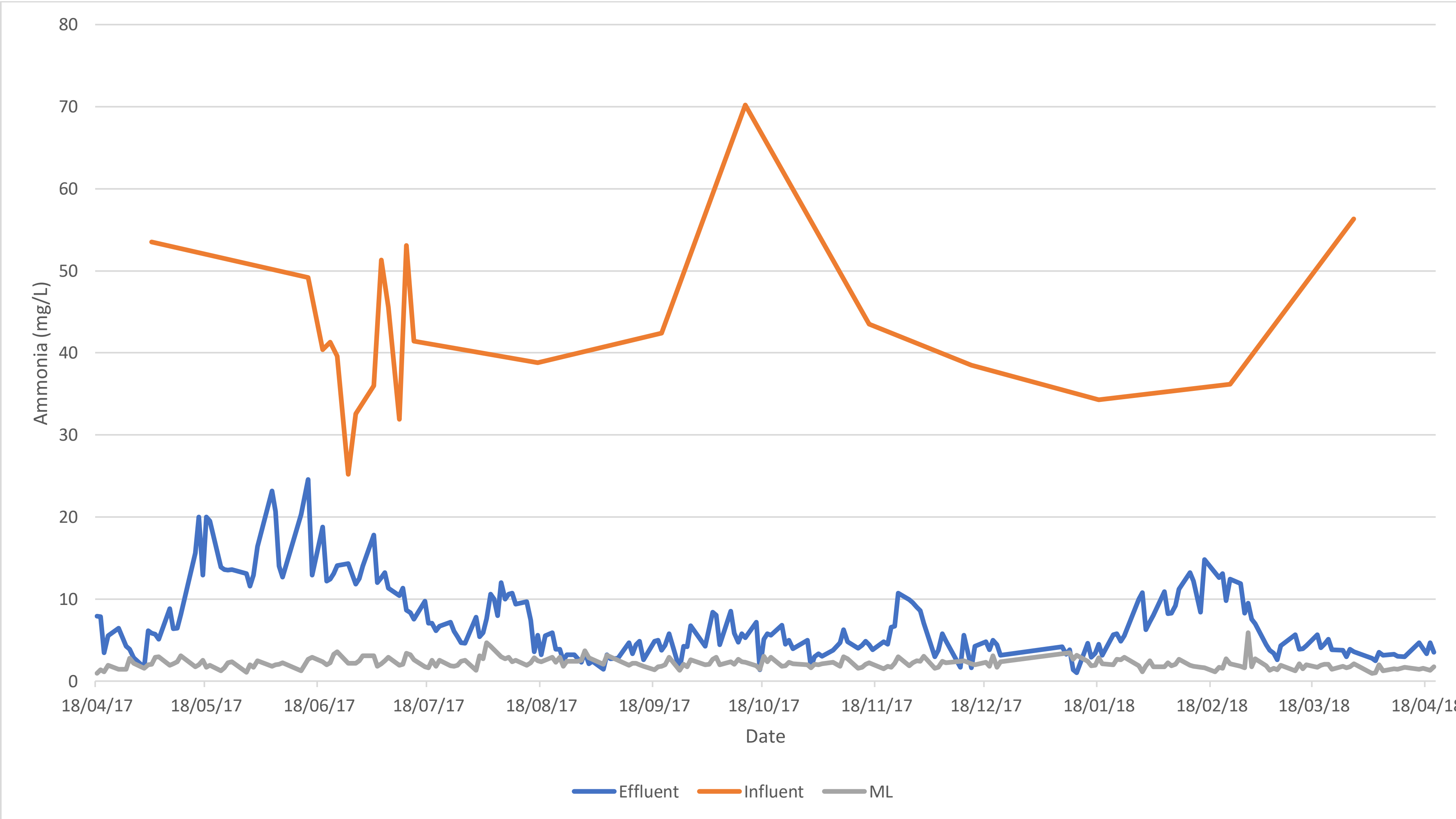
1.2 Heat map of the top 10 most abundant genera from the Melton foam



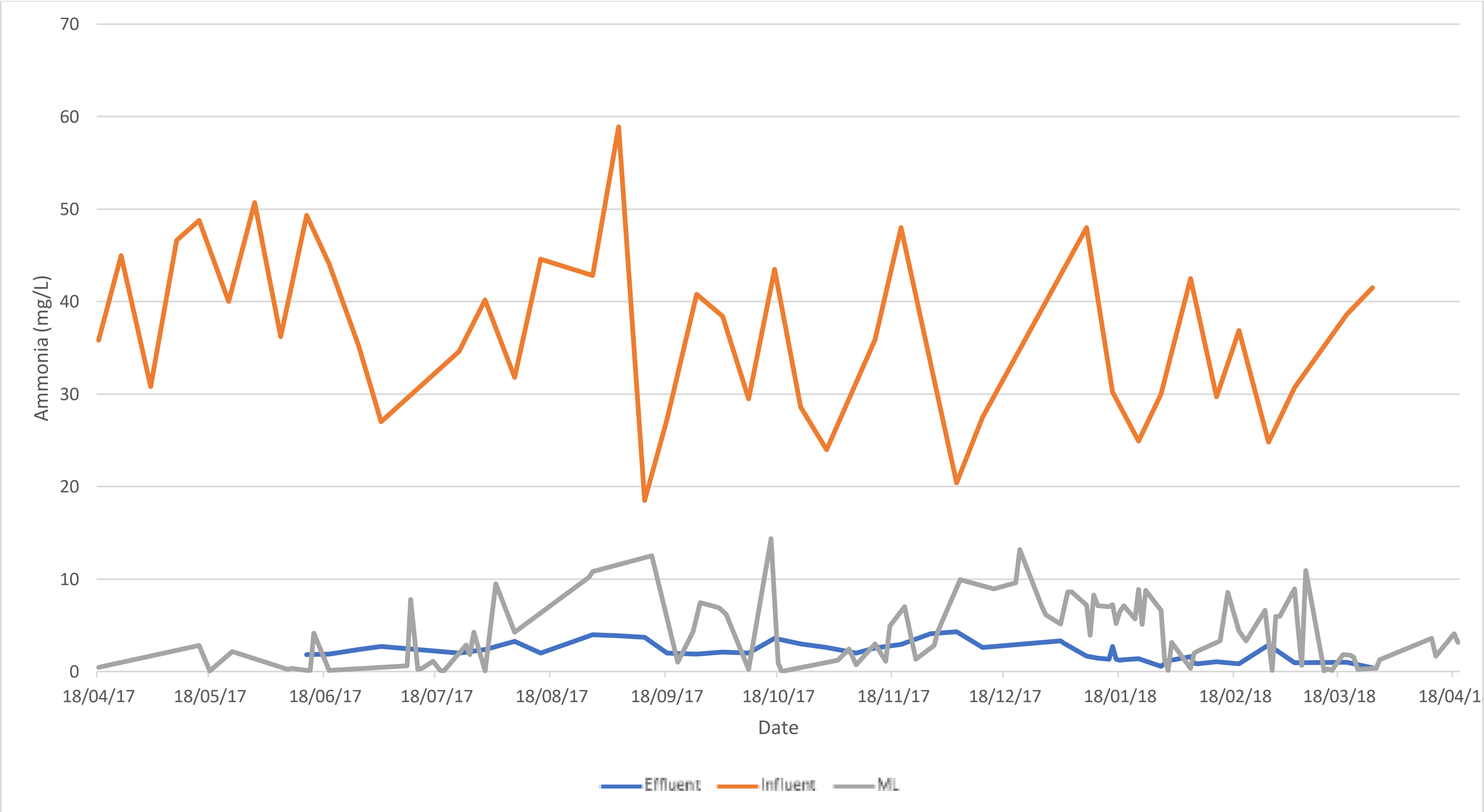
1.2 Heat map showing the top 20 genera across all three wastewater treatment plants



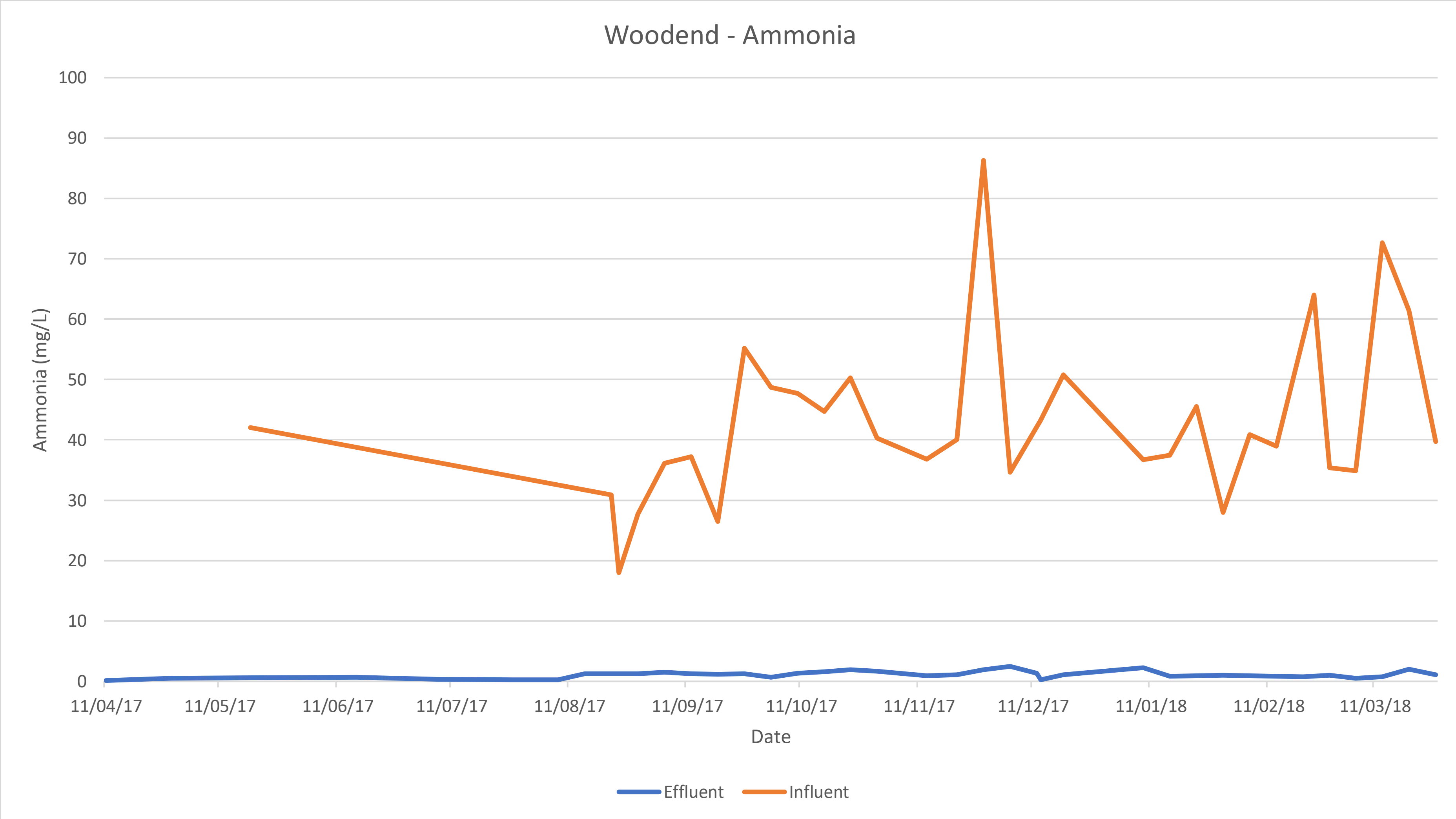
1.3 BOD/COD ratio for the Gisborne plant



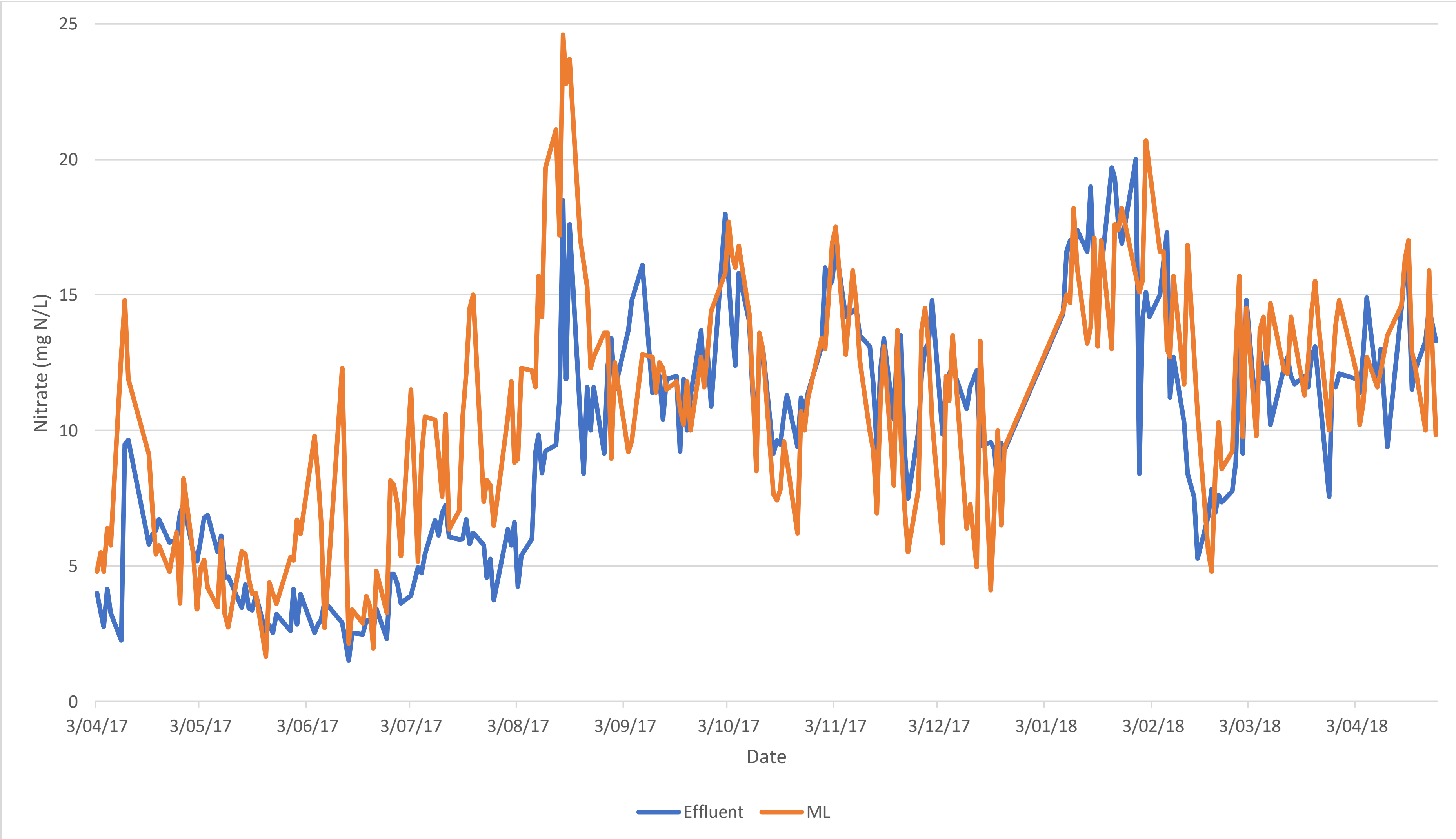
1.5 Ammonia levels for the Melton plant



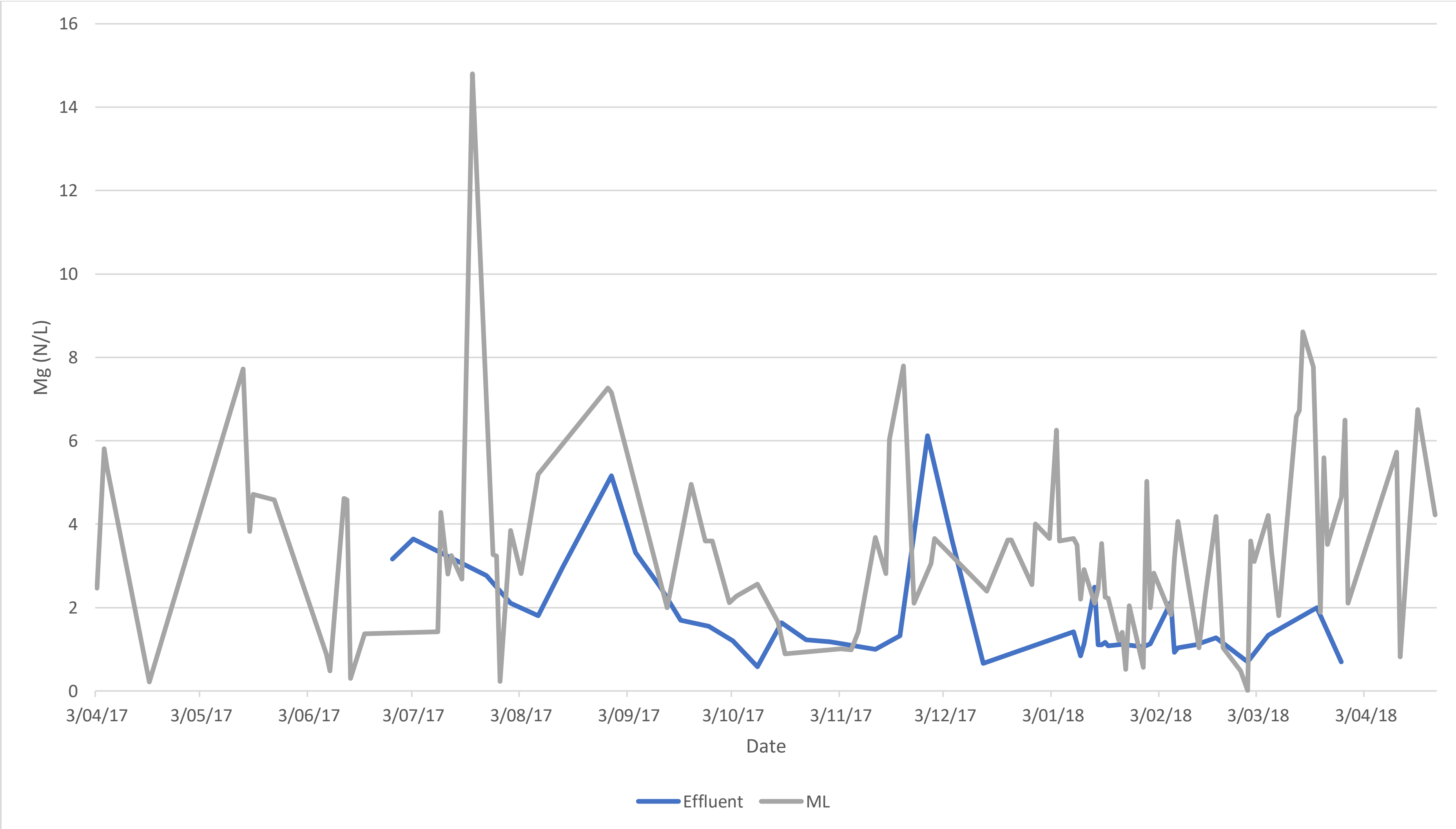
1.6 Ammonia levels for the Gisborne plant



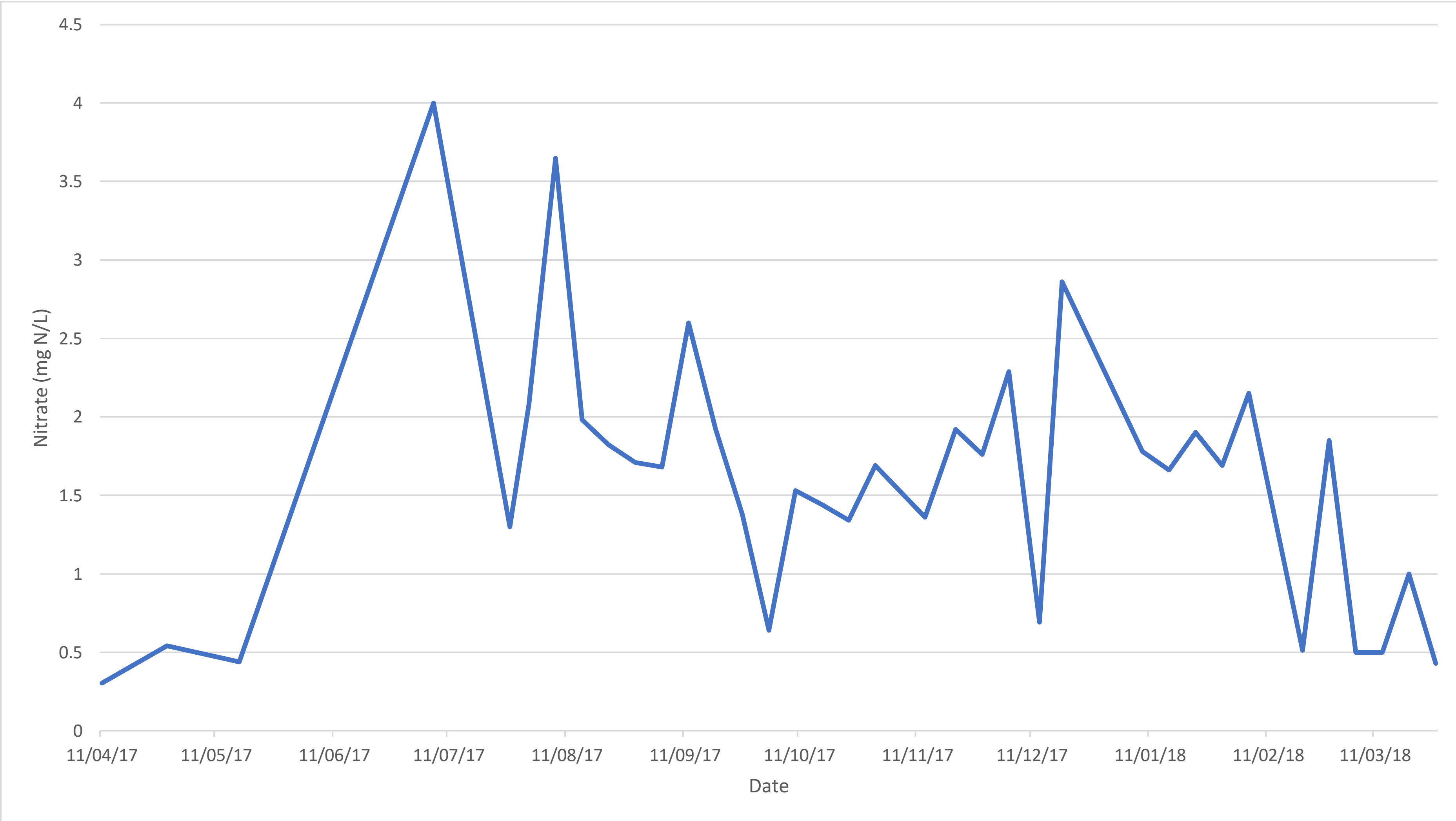
1.7 Ammonia levels for the Woodend plant



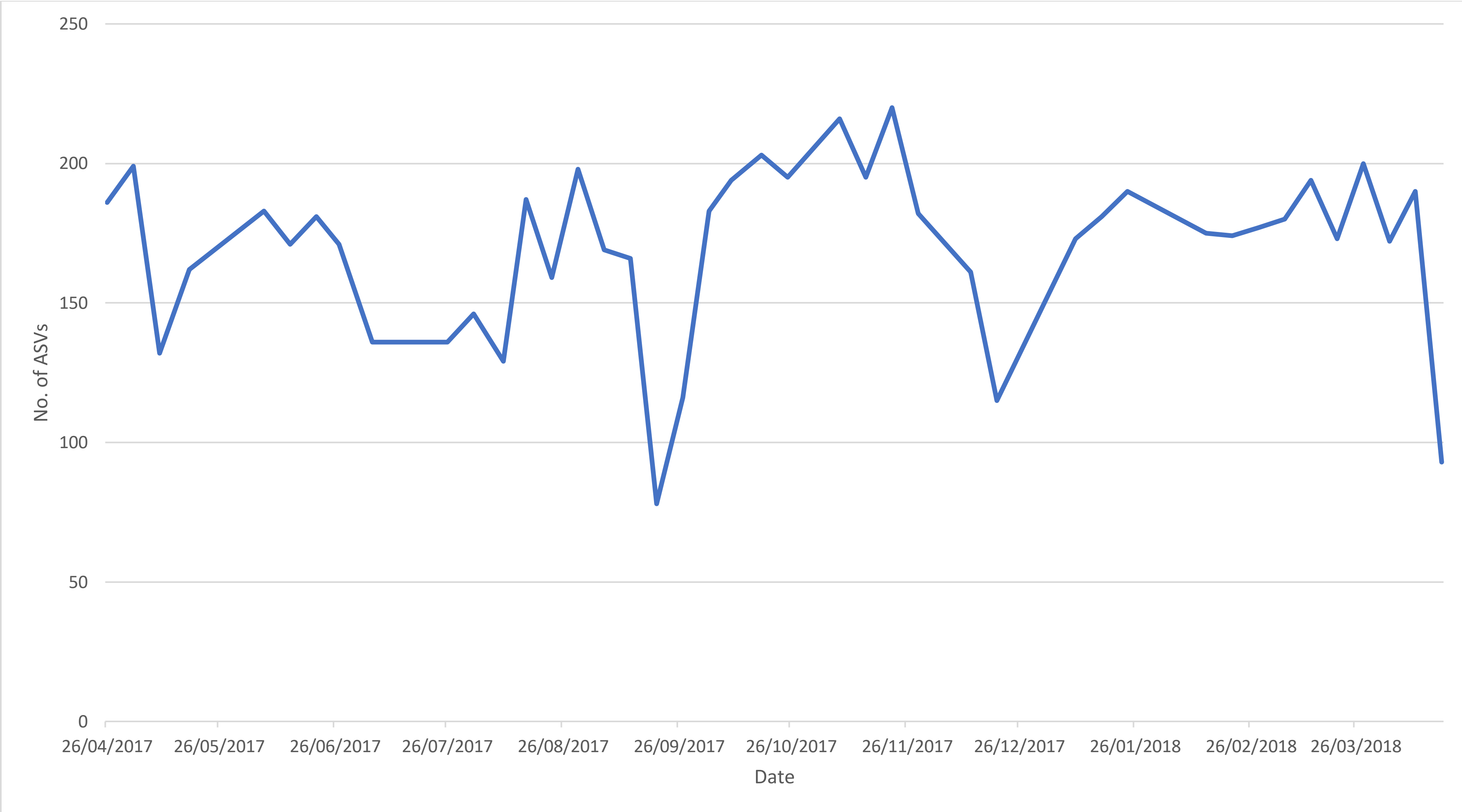
1.8 Nitrate levels for the Melton plant



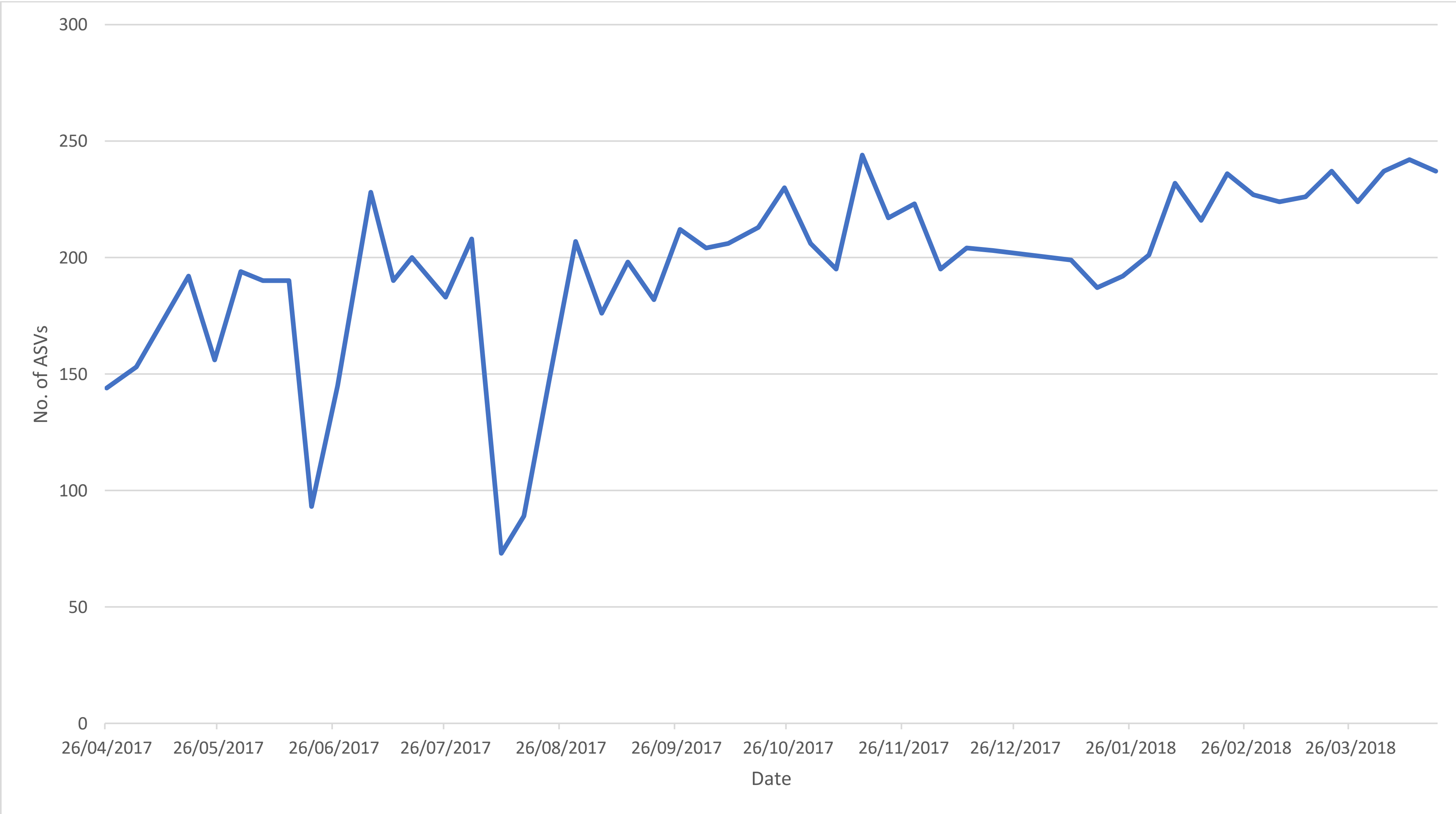
1.9 Nitrate levels for the Gisborne plant



1.10 Nitrate levels for the Woodend plant. Only effluent nitrate data was available for this plant.

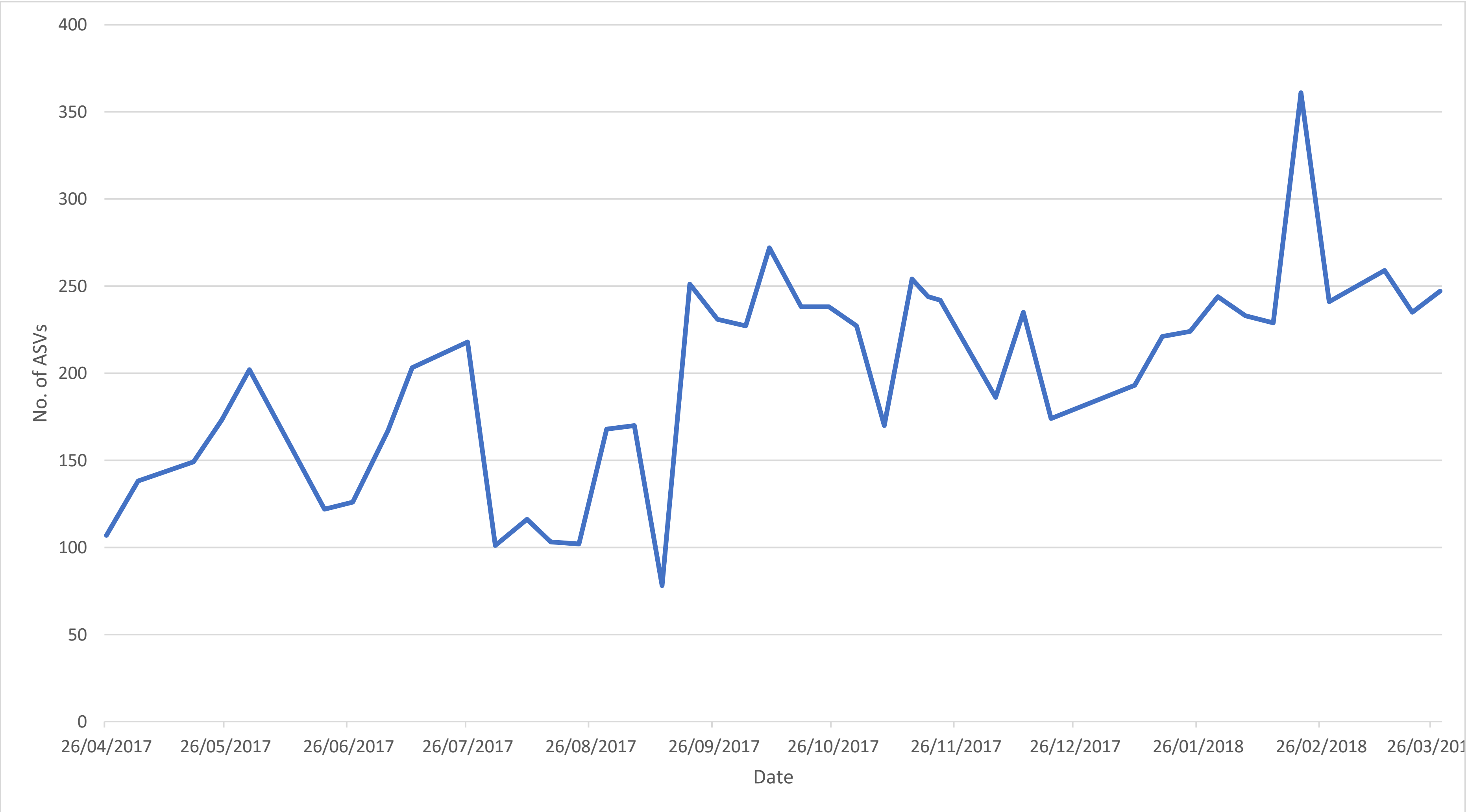


1.11 Species richness plots for the Melton plant

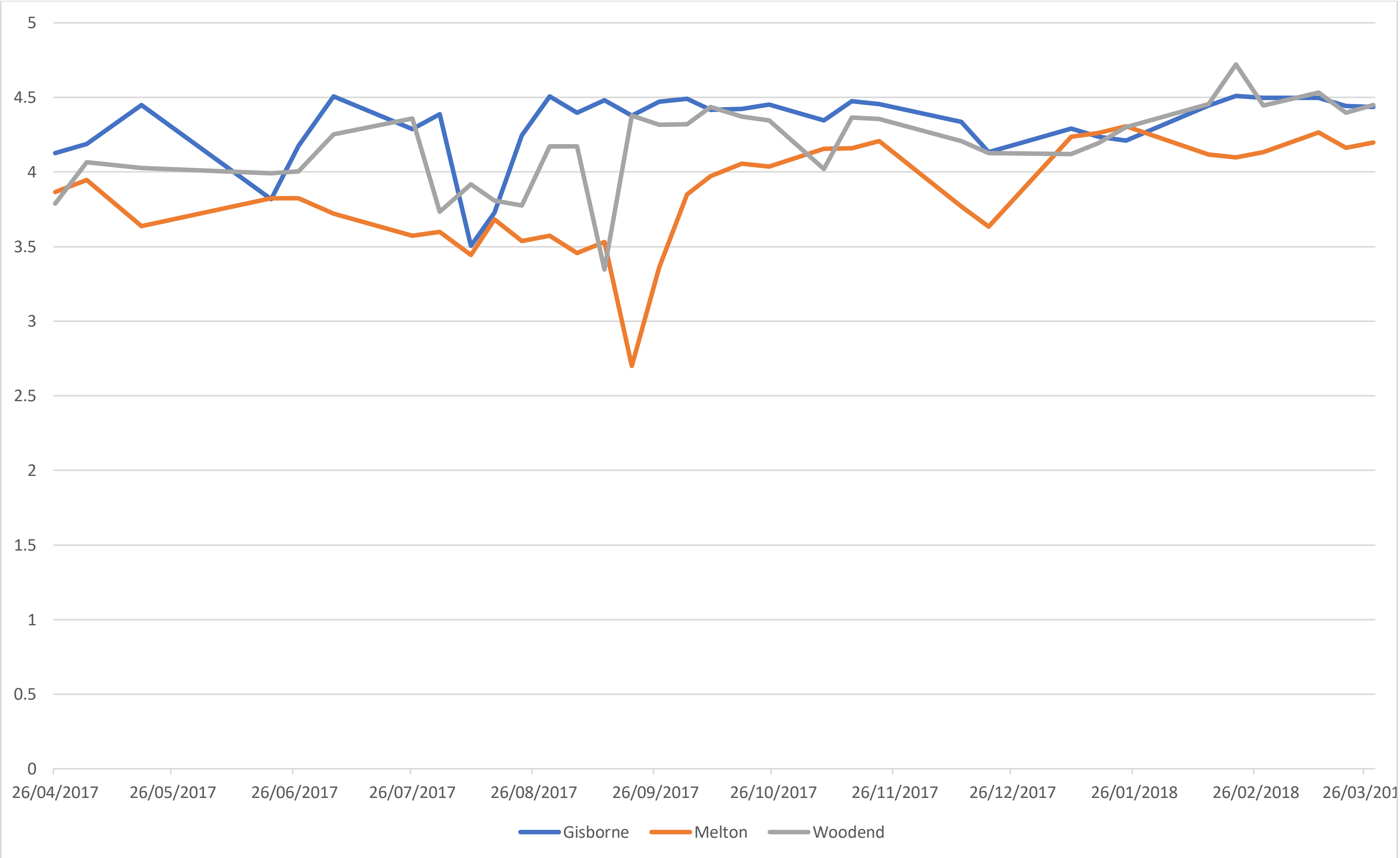


1.12 Species richness plots for the Gisborne plant

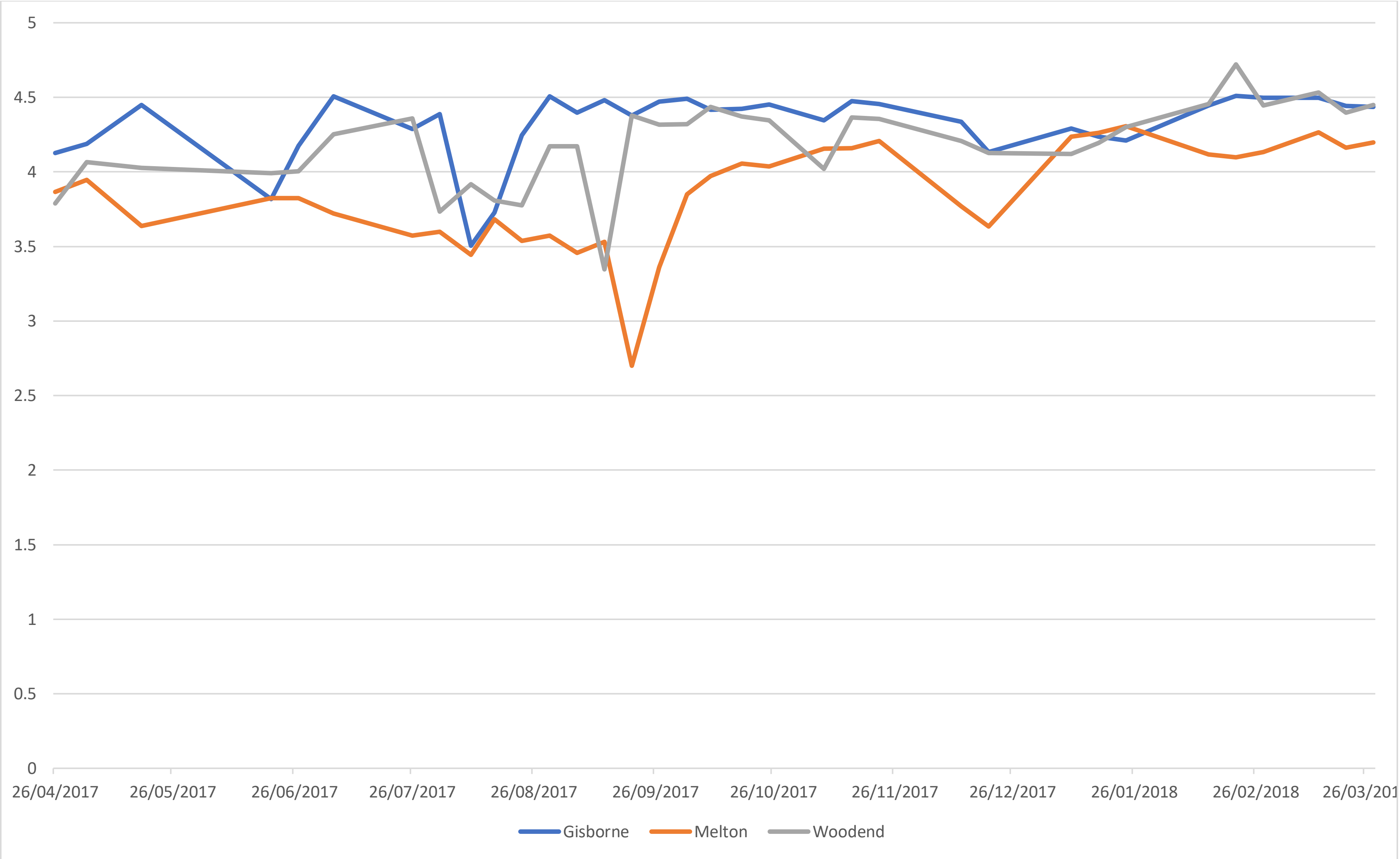
C



1.13 Species richness plot for the Woodend plant



1.14 Shannon index plot for the three plants



1.15 Simpson index plot for the three plant

APPENDIX 2 – OPERATIONAL DATA

2.1 Operational data for the Woodend wastewater treatment plant

Parameter	Date	Amount	Unit	Plant	Water type
Ammonia					
	19/05/17	42	mg/L	Woodend	Influent
	22/08/17	30.9	mg/L	Woodend	Influent
	24/08/17	18	mg/L	Woodend	Influent
	29/08/17	27.7	mg/L	Woodend	Influent
	5/09/17	36.1	mg/L	Woodend	Influent
	12/09/17	37.2	mg/L	Woodend	Influent
	19/09/17	26.5	mg/L	Woodend	Influent
	26/09/17	27.6	mg/L	Woodend	Influent
	26/09/17	27.6	mg/L	Woodend	Influent
	3/10/17	48.7	mg/L	Woodend	Influent
	10/10/17	47.7	mg/L	Woodend	Influent
	17/10/17	44.7	mg/L	Woodend	Influent
	24/10/17	50.3	mg/L	Woodend	Influent
	31/10/17	40.3	mg/L	Woodend	Influent
	13/11/17	36.8	mg/L	Woodend	Influent
	21/11/17	40	mg/L	Woodend	Influent
	28/11/17	41	mg/L	Woodend	Influent
	28/11/17	45.3	mg/L	Woodend	Influent
	5/12/17	34.6	mg/L	Woodend	Influent
	13/12/17	43.3	mg/L	Woodend	Influent
	19/12/17	50.8	mg/L	Woodend	Influent
	9/01/18	36.7	mg/L	Woodend	Influent
	16/01/18	37.5	mg/L	Woodend	Influent
	23/01/18	45.5	mg/L	Woodend	Influent
	30/01/18	28	mg/L	Woodend	Influent
	6/02/18	40.9	mg/L	Woodend	Influent
	13/02/18	39	mg/L	Woodend	Influent
	23/02/18	64	mg/L	Woodend	Influent
	27/02/18	35.4	mg/L	Woodend	Influent
	6/03/18	34.9	mg/L	Woodend	Influent
	13/03/18	72.7	mg/L	Woodend	Influent
	20/03/18	61.4	mg/L	Woodend	Influent
	27/03/18	39.7	mg/L	Woodend	Influent
	11/04/17	0.138	mg/L	Woodend	Effluent
	28/04/17	0.509	mg/L	Woodend	Effluent
	17/05/17	0.556	mg/L	Woodend	Effluent
	16/06/17	0.7	mg/L	Woodend	Effluent
	7/07/17	0.383	mg/L	Woodend	Effluent
	27/07/17	0.29	mg/L	Woodend	Effluent
	3/08/17	0.292	mg/L	Woodend	Effluent
	8/08/17	0.249	mg/L	Woodend	Effluent
	15/08/17	1.3	mg/L	Woodend	Effluent
	22/08/17	1.24	mg/L	Woodend	Effluent

29/08/17	1.23	mg/L	Woodend	Effluent
5/09/17	1.48	mg/L	Woodend	Effluent
12/09/17	1.25	mg/L	Woodend	Effluent
19/09/17	1.14	mg/L	Woodend	Effluent
26/09/17	1.26	mg/L	Woodend	Effluent
3/10/17	0.639	mg/L	Woodend	Effluent
10/10/17	1.33	mg/L	Woodend	Effluent
17/10/17	1.57	mg/L	Woodend	Effluent
24/10/17	1.94	mg/L	Woodend	Effluent
31/10/17	1.69	mg/L	Woodend	Effluent
13/11/17	0.94	mg/L	Woodend	Effluent
21/11/17	1.11	mg/L	Woodend	Effluent
28/11/17	1.96	mg/L	Woodend	Effluent
5/12/17	2.48	mg/L	Woodend	Effluent
12/12/17	1.36	mg/L	Woodend	Effluent
13/12/17	0.234	mg/L	Woodend	Effluent
19/12/17	1.12	mg/L	Woodend	Effluent
9/01/18	2.24	mg/L	Woodend	Effluent
16/01/18	0.87	mg/L	Woodend	Effluent
23/01/18	0.923	mg/L	Woodend	Effluent
30/01/18	1	mg/L	Woodend	Effluent
6/02/18	0.89	mg/L	Woodend	Effluent
20/02/18	0.78	mg/L	Woodend	Effluent
27/02/18	1.04	mg/L	Woodend	Effluent
6/03/18	0.5	mg/L	Woodend	Effluent
13/03/18	0.72	mg/L	Woodend	Effluent
20/03/18	2	mg/L	Woodend	Effluent
27/03/18	1.11	mg/L	Woodend	Effluent

Nitrate

11/04/17	0.303	mg N/L	Woodend	Effluent
28/04/17	0.542	mg N/L	Woodend	Effluent
17/05/17	0.439	mg N/L	Woodend	Effluent
7/07/17	4	mg N/L	Woodend	Effluent
27/07/17	1.3	mg N/L	Woodend	Effluent
1/08/17	2.08	mg N/L	Woodend	Effluent
8/08/17	3.65	mg N/L	Woodend	Effluent
15/08/17	1.98	mg N/L	Woodend	Effluent
22/08/17	1.82	mg N/L	Woodend	Effluent
29/08/17	1.71	mg N/L	Woodend	Effluent
5/09/17	1.68	mg N/L	Woodend	Effluent
12/09/17	2.6	mg N/L	Woodend	Effluent
19/09/17	1.92	mg N/L	Woodend	Effluent
26/09/17	1.38	mg N/L	Woodend	Effluent
3/10/17	0.639	mg N/L	Woodend	Effluent
10/10/17	1.53	mg N/L	Woodend	Effluent
17/10/17	1.44	mg N/L	Woodend	Effluent
24/10/17	1.34	mg N/L	Woodend	Effluent
31/10/17	1.69	mg N/L	Woodend	Effluent

	13/11/17	1.36	mg N/L	Woodend	Effluent
	21/11/17	1.92	mg N/L	Woodend	Effluent
	28/11/17	1.76	mg N/L	Woodend	Effluent
	5/12/17	2.29	mg N/L	Woodend	Effluent
	13/12/17	0.69	mg N/L	Woodend	Effluent
	19/12/17	2.86	mg N/L	Woodend	Effluent
	9/01/18	1.78	mg N/L	Woodend	Effluent
	16/01/18	1.66	mg N/L	Woodend	Effluent
	23/01/18	1.9	mg N/L	Woodend	Effluent
	30/01/18	1.69	mg N/L	Woodend	Effluent
	6/02/18	2.15	mg N/L	Woodend	Effluent
	20/02/18	0.513	mg N/L	Woodend	Effluent
	27/02/18	1.85	mg N/L	Woodend	Effluent
	6/03/18	0.5	mg N/L	Woodend	Effluent
	13/03/18	0.5	mg N/L	Woodend	Effluent
	20/03/18	1	mg N/L	Woodend	Effluent
	27/03/18	0.43	mg N/L	Woodend	Effluent
pH					
	18/04/17	7.49	units	Woodend	Influent
	18/04/17	7.49	units	Woodend	Influent
	19/05/17	7.2	units	Woodend	Influent
	22/08/17	7.5	units	Woodend	Influent
	24/08/17	6.9	units	Woodend	Influent
	29/08/17	7.38	units	Woodend	Influent
	5/09/17	6.43	units	Woodend	Influent
	12/09/17	7.32	units	Woodend	Influent
	19/09/17	7.39	units	Woodend	Influent
	27/09/17	7.59	units	Woodend	Influent
	3/10/17	7.49	units	Woodend	Influent
	10/10/17	7.23	units	Woodend	Influent
	17/10/17	7.6	units	Woodend	Influent
	24/10/17	7.26	units	Woodend	Influent
	31/10/17	7.31	units	Woodend	Influent
	13/11/17	6.92	units	Woodend	Influent
	21/11/17	7.37	units	Woodend	Influent
	28/11/17	7.56	units	Woodend	Influent
	28/11/17	7.1	units	Woodend	Influent
	5/12/17	7.23	units	Woodend	Influent
	13/12/17	7.32	units	Woodend	Influent
	19/12/17	6.36	units	Woodend	Influent
	9/01/18	7.32	units	Woodend	Influent
	17/01/18	7.56	units	Woodend	Influent
	23/01/18	7.31	units	Woodend	Influent
	30/01/18	7.65	units	Woodend	Influent
	6/02/18	7.22	units	Woodend	Influent
	13/02/18	7.43	units	Woodend	Influent
	20/02/18	7.41	units	Woodend	Influent
	23/02/18	7.3	units	Woodend	Influent

27/02/18	7.18	units	Woodend	Influent
6/03/18	7.23	units	Woodend	Influent
13/03/18	7.71	units	Woodend	Influent
20/03/18	7.36	units	Woodend	Influent
27/03/18	7.19	units	Woodend	Influent
18/04/17	6.57	units	Woodend	Mixed liquor
2/10/17	6.78	units	Woodend	Mixed liquor
2/10/17	6.63	units	Woodend	Mixed liquor
4/10/17	6.79	units	Woodend	Mixed liquor
6/10/17	7.02	units	Woodend	Mixed liquor
10/10/17	6.76	units	Woodend	Mixed liquor
11/10/17	6.79	units	Woodend	Mixed liquor
12/10/17	6.89	units	Woodend	Mixed liquor
16/10/17	6.72	units	Woodend	Mixed liquor
17/10/17	6.8	units	Woodend	Mixed liquor
31/10/17	6.67	units	Woodend	Mixed liquor
6/11/17	6.74	units	Woodend	Mixed liquor
8/11/17	6.69	units	Woodend	Mixed liquor
8/11/17	6.69	units	Woodend	Mixed liquor
13/11/17	6.68	units	Woodend	Mixed liquor
14/11/17	7.14	units	Woodend	Mixed liquor
4/12/17	6.47	units	Woodend	Mixed liquor
6/12/17	6.52	units	Woodend	Mixed liquor
8/12/17	6.98	units	Woodend	Mixed liquor
18/12/17	6.65	units	Woodend	Mixed liquor
19/12/17	6.97	units	Woodend	Mixed liquor
21/12/17	6.63	units	Woodend	Mixed liquor
22/12/17	7	units	Woodend	Mixed liquor
29/12/17	6.79	units	Woodend	Mixed liquor
3/01/18	6.75	units	Woodend	Mixed liquor
1/02/18	6.84	units	Woodend	Mixed liquor
7/02/18	6.98	units	Woodend	Mixed liquor
8/02/18	6.88	units	Woodend	Mixed liquor
12/02/18	7.07	units	Woodend	Mixed liquor
14/02/18	6.9	units	Woodend	Mixed liquor
15/02/18	7.08	units	Woodend	Mixed liquor
20/02/18	6.99	units	Woodend	Mixed liquor
21/02/18	6.92	units	Woodend	Mixed liquor
23/02/18	7.01	units	Woodend	Mixed liquor
28/02/18	7.08	units	Woodend	Mixed liquor
6/03/18	7.07	units	Woodend	Mixed liquor
8/03/18	7.07	units	Woodend	Mixed liquor
9/03/18	6.95	units	Woodend	Mixed liquor
13/03/18	6.93	units	Woodend	Mixed liquor
14/03/18	6.84	units	Woodend	Mixed liquor
15/03/18	6.78	units	Woodend	Mixed liquor
21/03/18	6.69	units	Woodend	Mixed liquor
22/03/18	6.89	units	Woodend	Mixed liquor

27/03/18	6.91	units	Woodend	Mixed liquor
3/04/18	7.12	units	Woodend	Mixed liquor
6/04/18	7.02	units	Woodend	Mixed liquor
10/04/18	6.65	units	Woodend	Mixed liquor
11/04/18	6.6	units	Woodend	Mixed liquor
12/04/18	6.88	units	Woodend	Mixed liquor
16/04/18	6.52	units	Woodend	Mixed liquor
18/04/18	6.98	units	Woodend	Mixed liquor
20/04/18	7.43	units	Woodend	Mixed liquor
24/04/18	6.93	units	Woodend	Mixed liquor
26/04/18	7.06	units	Woodend	Mixed liquor
10/05/18	7.05	units	Woodend	Mixed liquor
11/05/18	6.89	units	Woodend	Mixed liquor
17/05/18	6.91	units	Woodend	Mixed liquor
18/05/18	6.53	units	Woodend	Mixed liquor
22/05/18	6.58	units	Woodend	Mixed liquor
23/05/18	7.25	units	Woodend	Mixed liquor
24/05/18	6.82	units	Woodend	Mixed liquor
31/05/18	6.91	units	Woodend	Mixed liquor
6/06/18	6.75	units	Woodend	Mixed liquor
14/06/18	6.85	units	Woodend	Mixed liquor
18/06/18	6.63	units	Woodend	Mixed liquor
19/06/18	7.31	units	Woodend	Mixed liquor
21/06/18	7.21	units	Woodend	Mixed liquor
25/06/18	6.6	units	Woodend	Mixed liquor
3/07/18	6.92	units	Woodend	Mixed liquor
4/07/18	7.06	units	Woodend	Mixed liquor
10/07/18	7.13	units	Woodend	Mixed liquor
12/07/18	6.84	units	Woodend	Mixed liquor
18/07/18	7.06	units	Woodend	Mixed liquor
20/07/18	6.86	units	Woodend	Mixed liquor
11/04/17	7.68	units	Woodend	Effluent
18/04/17	9.24	units	Woodend	Effluent
28/04/17	8.85	units	Woodend	Effluent
17/05/17	8.71	units	Woodend	Effluent
16/06/17	7.76	units	Woodend	Effluent
7/07/17	7.9	units	Woodend	Effluent
27/07/17	7.72	units	Woodend	Effluent
1/08/17	7.86	units	Woodend	Effluent
3/08/17	8.57	units	Woodend	Effluent
8/08/17	8.53	units	Woodend	Effluent
15/08/17	8.94	units	Woodend	Effluent
22/08/17	8.88	units	Woodend	Effluent
29/08/17	9.01	units	Woodend	Effluent
5/09/17	9	units	Woodend	Effluent
12/09/17	9.16	units	Woodend	Effluent
19/09/17	9	units	Woodend	Effluent
26/09/17	9.34	units	Woodend	Effluent

3/10/17	8.28	units	Woodend	Effluent
10/10/17	9.19	units	Woodend	Effluent
10/10/17	8.29	units	Woodend	Effluent
17/10/17	9.45	units	Woodend	Effluent
24/10/17	8.44	units	Woodend	Effluent
31/10/17	8.45	units	Woodend	Effluent
13/11/17	9.11	units	Woodend	Effluent
21/11/17	9.26	units	Woodend	Effluent
28/11/17	8.53	units	Woodend	Effluent
5/12/17	7.81	units	Woodend	Effluent
13/12/17	8.31	units	Woodend	Effluent
19/12/17	9.28	units	Woodend	Effluent
9/01/18	9.33	units	Woodend	Effluent
17/01/18	8.9	units	Woodend	Effluent
23/01/18	9.27	units	Woodend	Effluent
30/01/18	9.03	units	Woodend	Effluent
6/02/18	9	units	Woodend	Effluent
20/02/18	9.27	units	Woodend	Effluent
27/02/18	9.28	units	Woodend	Effluent
6/03/18	8.75	units	Woodend	Effluent
13/03/18	8	units	Woodend	Effluent
20/03/18	7.8	units	Woodend	Effluent
27/03/18	7.98	units	Woodend	Effluent

Phosphorous

19/05/17	7.5	mg/L	Woodend	Influent
1/08/17	11	mg/L	Woodend	Influent
9/08/17	3	mg/L	Woodend	Influent
15/08/17	9.82	mg/L	Woodend	Influent
22/08/17	6.4	mg/L	Woodend	Influent
24/08/17	5.1	mg/L	Woodend	Influent
29/08/17	5	mg/L	Woodend	Influent
5/09/17	6.2	mg/L	Woodend	Influent
12/09/17	8.08	mg/L	Woodend	Influent
19/09/17	4.78	mg/L	Woodend	Influent
26/09/17	17.1	mg/L	Woodend	Influent
3/10/17	9.13	mg/L	Woodend	Influent
10/10/17	21.6	mg/L	Woodend	Influent
17/10/17	9.3	mg/L	Woodend	Influent
24/10/17	9.8	mg/L	Woodend	Influent
31/10/17	8.25	mg/L	Woodend	Influent
13/11/17	6.21	mg/L	Woodend	Influent
21/11/17	11.1	mg/L	Woodend	Influent
28/11/17	12.7	mg/L	Woodend	Influent
28/11/17	7.8	mg/L	Woodend	Influent
5/12/17	8.93	mg/L	Woodend	Influent
13/12/17	7.4	mg/L	Woodend	Influent
19/12/17	15.7	mg/L	Woodend	Influent
9/01/18	6.8	mg/L	Woodend	Influent

17/01/18	13.8	mg/L	Woodend	Influent
23/01/18	19.2	mg/L	Woodend	Influent
30/01/18	7.53	mg/L	Woodend	Influent
6/02/18	10	mg/L	Woodend	Influent
13/02/18	10.3	mg/L	Woodend	Influent
20/02/18	12.3	mg/L	Woodend	Influent
23/02/18	12	mg/L	Woodend	Influent
27/02/18	10.2	mg/L	Woodend	Influent
6/03/18	12.1	mg/L	Woodend	Influent
13/03/18	15.4	mg/L	Woodend	Influent
20/03/18	18.6	mg/L	Woodend	Influent
27/03/18	11.8	mg/L	Woodend	Influent
9/08/17	1.3	mg/L	Woodend	Mixed liquor
21/11/17	1.9	mg/L	Woodend	Mixed liquor
5/12/17	1.7	mg/L	Woodend	Mixed liquor
12/12/17	5.9	mg/L	Woodend	Mixed liquor
21/12/17	2.02	mg/L	Woodend	Mixed liquor
9/01/18	2.6	mg/L	Woodend	Mixed liquor
23/01/18	2.1	mg/L	Woodend	Mixed liquor
30/01/18	0.69	mg/L	Woodend	Mixed liquor
12/02/18	1.32	mg/L	Woodend	Mixed liquor
20/02/18	0.2	mg/L	Woodend	Mixed liquor
27/02/18	1.1	mg/L	Woodend	Mixed liquor
6/03/18	1.3	mg/L	Woodend	Mixed liquor
13/03/18	0.3	mg/L	Woodend	Mixed liquor
20/03/18	0.2	mg/L	Woodend	Mixed liquor
27/03/18	0.8	mg/L	Woodend	Mixed liquor
3/04/18	0.5	mg/L	Woodend	Mixed liquor
17/04/18	0.2	mg/L	Woodend	Mixed liquor
24/04/18	0.2	mg/L	Woodend	Mixed liquor
1/05/18	0.47	mg/L	Woodend	Mixed liquor
8/05/18	0.3	mg/L	Woodend	Mixed liquor
15/05/18	0.3	mg/L	Woodend	Mixed liquor
22/05/18	0.2	mg/L	Woodend	Mixed liquor
31/05/18	0.59	mg/L	Woodend	Mixed liquor
5/06/18	0.4	mg/L	Woodend	Mixed liquor
13/06/18	0.7	mg/L	Woodend	Mixed liquor
19/06/18	0.49	mg/L	Woodend	Mixed liquor
27/06/18	0.1	mg/L	Woodend	Mixed liquor
3/07/18	7.2	mg/L	Woodend	Mixed liquor
10/07/18	1.32	mg/L	Woodend	Mixed liquor
17/07/18	0.4	mg/L	Woodend	Mixed liquor
11/04/17	3.22	mg/L	Woodend	Effluent
28/04/17	3.64	mg/L	Woodend	Effluent
17/05/17	11.1	mg/L	Woodend	Effluent
16/06/17	2.58	mg/L	Woodend	Effluent
7/07/17	0.476	mg/L	Woodend	Effluent
27/07/17	3.08	mg/L	Woodend	Effluent

3/08/17	5.73	mg/L	Woodend	Effluent
8/08/17	1.74	mg/L	Woodend	Effluent
15/08/17	1.6	mg/L	Woodend	Effluent
22/08/17	1.6	mg/L	Woodend	Effluent
29/08/17	1.5	mg/L	Woodend	Effluent
5/09/17	1.6	mg/L	Woodend	Effluent
12/09/17	1.6	mg/L	Woodend	Effluent
19/09/17	1.6	mg/L	Woodend	Effluent
26/09/17	1.8	mg/L	Woodend	Effluent
3/10/17	2	mg/L	Woodend	Effluent
10/10/17	2	mg/L	Woodend	Effluent
17/10/17	2.2	mg/L	Woodend	Effluent
24/10/17	2.2	mg/L	Woodend	Effluent
31/10/17	2.4	mg/L	Woodend	Effluent
13/11/17	2.3	mg/L	Woodend	Effluent
21/11/17	3.1	mg/L	Woodend	Effluent
28/11/17	3.2	mg/L	Woodend	Effluent
5/12/17	4.2	mg/L	Woodend	Effluent
12/12/17	3.4	mg/L	Woodend	Effluent
13/12/17	4.5	mg/L	Woodend	Effluent
19/12/17	3.4	mg/L	Woodend	Effluent
9/01/18	3.8	mg/L	Woodend	Effluent
17/01/18	3.3	mg/L	Woodend	Effluent
23/01/18	4.8	mg/L	Woodend	Effluent
30/01/18	4.8	mg/L	Woodend	Effluent
6/02/18	4.4	mg/L	Woodend	Effluent
20/02/18	5.6	mg/L	Woodend	Effluent
27/02/18	4.6	mg/L	Woodend	Effluent
6/03/18	7.2	mg/L	Woodend	Effluent
13/03/18	5.7	mg/L	Woodend	Effluent
20/03/18	5.6	mg/L	Woodend	Effluent
27/03/18	6.1	mg/L	Woodend	Effluent

Alkilinity

18/04/17	238.2	mg/L	Woodend	influent
19/05/17	240	mg/L	Woodend	influent
1/08/17	250	mg/L	Woodend	influent
8/08/17	120	mg/L	Woodend	influent
15/08/17	230	mg/L	Woodend	influent
22/08/17	160	mg/L	Woodend	influent
24/08/17	140	mg/L	Woodend	influent
29/08/17	140	mg/L	Woodend	influent
5/09/17	140	mg/L	Woodend	influent
12/09/17	240	mg/L	Woodend	influent
19/09/17	160	mg/L	Woodend	influent
27/09/17	226.2	mg/L	Woodend	influent
3/10/17	270	mg/L	Woodend	influent
10/10/17	215.2	mg/L	Woodend	influent
10/10/17	280	mg/L	Woodend	influent

17/10/17	267.6	mg/L	Woodend	influent
24/10/17	240	mg/L	Woodend	influent
31/10/17	220	mg/L	Woodend	influent
13/11/17	190	mg/L	Woodend	influent
21/11/17	270	mg/L	Woodend	influent
28/11/17	310	mg/L	Woodend	influent
28/11/17	220	mg/L	Woodend	influent
5/12/17	220	mg/L	Woodend	influent
12/12/17	300	mg/L	Woodend	influent
13/12/17	247.5	mg/L	Woodend	influent
19/12/17	240	mg/L	Woodend	influent
9/01/18	220	mg/L	Woodend	influent
16/01/18	290	mg/L	Woodend	influent
23/01/18	280	mg/L	Woodend	influent
30/01/18	220	mg/L	Woodend	influent
6/02/18	260	mg/L	Woodend	influent
13/02/18	290	mg/L	Woodend	influent
20/02/18	310	mg/L	Woodend	influent
23/02/18	330	mg/L	Woodend	influent
27/02/18	270	mg/L	Woodend	influent
6/03/18	260	mg/L	Woodend	influent
13/03/18	330	mg/L	Woodend	influent
20/03/18	340	mg/L	Woodend	influent
27/03/18	280	mg/L	Woodend	influent
18/04/17	110.3	mg/L	Woodend	Mixed liquor
5/09/17	80	mg/L	Woodend	Mixed liquor
2/10/17	118.5	mg/L	Woodend	Mixed liquor
2/10/17	118.5	mg/L	Woodend	Mixed liquor
4/10/17	155.9	mg/L	Woodend	Mixed liquor
6/10/17	174.5	mg/L	Woodend	Mixed liquor
10/10/17	123.2	mg/L	Woodend	Mixed liquor
11/10/17	120.8	mg/L	Woodend	Mixed liquor
11/10/17	122.9	mg/L	Woodend	Mixed liquor
17/10/17	124.3	mg/L	Woodend	Mixed liquor
31/10/17	130.3	mg/L	Woodend	Mixed liquor
6/11/17	138.7	mg/L	Woodend	Mixed liquor
8/11/17	130.5	mg/L	Woodend	Mixed liquor
8/11/17	130.5	mg/L	Woodend	Mixed liquor
13/11/17	138.3	mg/L	Woodend	Mixed liquor
4/12/17	92.5	mg/L	Woodend	Mixed liquor
6/12/17	82.2	mg/L	Woodend	Mixed liquor
8/12/17	98.3	mg/L	Woodend	Mixed liquor
18/12/17	109.3	mg/L	Woodend	Mixed liquor
21/12/17	149.1	mg/L	Woodend	Mixed liquor
29/12/17	127.2	mg/L	Woodend	Mixed liquor
3/01/18	122	mg/L	Woodend	Mixed liquor
1/02/18	133.2	mg/L	Woodend	Mixed liquor
7/02/18	162.2	mg/L	Woodend	Mixed liquor

8/02/18	140.5	mg/L	Woodend	Mixed liquor
12/02/18	163.3	mg/L	Woodend	Mixed liquor
14/02/18	159.2	mg/L	Woodend	Mixed liquor
15/02/18	182.1	mg/L	Woodend	Mixed liquor
20/02/18	132.2	mg/L	Woodend	Mixed liquor
21/02/18	139.3	mg/L	Woodend	Mixed liquor
23/02/18	137	mg/L	Woodend	Mixed liquor
28/02/18	144.2	mg/L	Woodend	Mixed liquor
6/03/18	127.3	mg/L	Woodend	Mixed liquor
8/03/18	148.7	mg/L	Woodend	Mixed liquor
9/03/18	136.5	mg/L	Woodend	Mixed liquor
13/03/18	131	mg/L	Woodend	Mixed liquor
14/03/18	397.1	mg/L	Woodend	Mixed liquor
15/03/18	574	mg/L	Woodend	Mixed liquor
3/04/18	0	mg/L	Woodend	Mixed liquor
31/05/18	0	mg/L	Woodend	Mixed liquor
6/06/18	664.3	mg/L	Woodend	Mixed liquor
14/06/18	455.2	mg/L	Woodend	Mixed liquor
18/06/18	403	mg/L	Woodend	Mixed liquor
19/06/18	562.7	mg/L	Woodend	Mixed liquor
21/06/18	472.3	mg/L	Woodend	Mixed liquor
4/07/18	477.2	mg/L	Woodend	Mixed liquor
10/07/18	378.3	mg/L	Woodend	Mixed liquor
12/07/18	377.3	mg/L	Woodend	Mixed liquor
11/04/17	79.8	mg/L	Woodend	Effluent
18/04/17	94	mg/L	Woodend	Effluent
28/04/17	92.8	mg/L	Woodend	Effluent
17/05/17	95.8	mg/L	Woodend	Effluent
16/06/17	105.9	mg/L	Woodend	Effluent
7/07/17	238.5	mg/L	Woodend	Effluent
27/07/17	99.3	mg/L	Woodend	Effluent
1/08/17	90	mg/L	Woodend	Effluent
8/08/17	83.4	mg/L	Woodend	Effluent
15/08/17	80	mg/L	Woodend	Effluent
22/08/17	60	mg/L	Woodend	Effluent
29/08/17	90	mg/L	Woodend	Effluent
5/09/17	76	mg/L	Woodend	Effluent
12/09/17	80	mg/L	Woodend	Effluent
19/09/17	80	mg/L	Woodend	Effluent
26/09/17	67	mg/L	Woodend	Effluent
3/10/17	90	mg/L	Woodend	Effluent
10/10/17	89.3	mg/L	Woodend	Effluent
10/10/17	83	mg/L	Woodend	Effluent
24/10/17	90	mg/L	Woodend	Effluent
31/10/17	90	mg/L	Woodend	Effluent
13/11/17	100	mg/L	Woodend	Effluent
21/11/17	90	mg/L	Woodend	Effluent
28/11/17	110	mg/L	Woodend	Effluent

	5/12/17	90	mg/L	Woodend	Effluent
	12/12/17	70	mg/L	Woodend	Effluent
	13/12/17	102.5	mg/L	Woodend	Effluent
	19/12/17	90	mg/L	Woodend	Effluent
	9/01/18	210	mg/L	Woodend	Effluent
	17/01/18	100	mg/L	Woodend	Effluent
	23/01/18	120	mg/L	Woodend	Effluent
	30/01/18	110	mg/L	Woodend	Effluent
	6/02/18	110	mg/L	Woodend	Effluent
	20/02/18	110	mg/L	Woodend	Effluent
	26/02/18	110	mg/L	Woodend	Effluent
	6/03/18	130	mg/L	Woodend	Effluent
	13/03/18	130	mg/L	Woodend	Effluent
	20/03/18	120	mg/L	Woodend	Effluent
	27/03/18	120	mg/L	Woodend	Effluent
VSS					
	1/08/17	93	%	Woodend	Influent
	8/08/17	85	%	Woodend	Influent
	15/08/17	90	%	Woodend	Influent
	22/08/17	88	%	Woodend	Influent
	29/08/17	89	%	Woodend	Influent
	8/09/17	90	%	Woodend	Influent
	12/09/17	90	%	Woodend	Influent
	19/09/17	87	%	Woodend	Influent
	27/09/17	96	%	Woodend	Influent
	3/10/17	92	%	Woodend	Influent
	10/10/17	83	%	Woodend	Influent
	17/10/17	96	%	Woodend	Influent
	24/10/17	88	%	Woodend	Influent
	31/10/17	92	%	Woodend	Influent
	13/11/17	76	%	Woodend	Influent
	21/11/17	93	%	Woodend	Influent
	28/11/17	89	%	Woodend	Influent
	5/12/17	88	%	Woodend	Influent
	14/12/17	84	%	Woodend	Influent
	22/12/17	95	%	Woodend	Influent
	11/01/18	95	%	Woodend	Influent
	18/01/18	94	%	Woodend	Influent
	23/01/18	87	%	Woodend	Influent
	31/01/18	83	%	Woodend	Influent
	2/02/18	91	%	Woodend	Influent
	13/02/18	92	%	Woodend	Influent
	21/02/18	92	%	Woodend	Influent
	28/02/18	93	%	Woodend	Influent
	7/03/18	99	%	Woodend	Influent
	14/03/18	93	%	Woodend	Influent
	20/03/18	92	%	Woodend	Influent
	28/03/18	94	%	Woodend	Influent

28/09/17	81	%	Woodend	Effluent
12/10/17	79	%	Woodend	Effluent
21/11/17	75	%	Woodend	Effluent
5/12/17	75	%	Woodend	Effluent
14/12/17	74	%	Woodend	Effluent
20/12/17	74	%	Woodend	Effluent
12/01/18	75	%	Woodend	Effluent
23/01/18	73	%	Woodend	Effluent
31/01/18	73	%	Woodend	Effluent
12/02/18	124.3	%	Woodend	Effluent
21/02/18	73	%	Woodend	Effluent
28/02/18	74	%	Woodend	Effluent
7/03/18	77	%	Woodend	Effluent
14/03/18	75	%	Woodend	Effluent
20/03/18	70	%	Woodend	Effluent
28/03/18	76	%	Woodend	Effluent
3/04/18	77	%	Woodend	Effluent
18/04/18	77	%	Woodend	Effluent
26/04/18	77	%	Woodend	Effluent
1/05/18	77	%	Woodend	Effluent
8/05/18	80	%	Woodend	Effluent
16/05/18	77	%	Woodend	Effluent
23/05/18	77	%	Woodend	Effluent
31/05/18	78	%	Woodend	Effluent
6/06/18	78	%	Woodend	Effluent
15/06/18	79	%	Woodend	Effluent
20/06/18	76	%	Woodend	Effluent
28/06/18	76	%	Woodend	Effluent
4/07/18	80	%	Woodend	Effluent
10/07/18	79	%	Woodend	Effluent
19/07/18	84	%	Woodend	Effluent

COD

4/04/17	840	mg/L	Woodend	Influent
11/04/17	590	mg/L	Woodend	Influent
18/04/17	991	mg/L	Woodend	Influent
24/04/17	890	mg/L	Woodend	Influent
9/05/17	916	mg/L	Woodend	Influent
16/05/17	941	mg/L	Woodend	Influent
22/05/17	904	mg/L	Woodend	Influent
30/05/17	671	mg/L	Woodend	Influent
13/06/17	531	mg/L	Woodend	Influent
20/06/17	917	mg/L	Woodend	Influent
27/06/17	1044	mg/L	Woodend	Influent
4/07/17	610	mg/L	Woodend	Influent
11/07/17	739	mg/L	Woodend	Influent
18/07/17	523	mg/L	Woodend	Influent
25/07/17	1327	mg/L	Woodend	Influent
1/08/17	525	mg/L	Woodend	Influent

8/08/17	220	mg/L	Woodend	Influent
15/08/17	665	mg/L	Woodend	Influent
22/08/17	472	mg/L	Woodend	Influent
29/08/17	325	mg/L	Woodend	Influent
5/09/17	571	mg/L	Woodend	Influent
12/09/17	477	mg/L	Woodend	Influent
19/09/17	301	mg/L	Woodend	Influent
26/09/17	2267	mg/L	Woodend	Influent
3/10/17	582	mg/L	Woodend	Influent
10/10/17	1197	mg/L	Woodend	Influent
17/10/17	637	mg/L	Woodend	Influent
24/10/17	560	mg/L	Woodend	Influent
31/10/17	511	mg/L	Woodend	Influent
13/11/17	275	mg/L	Woodend	Influent
21/11/17	646	mg/L	Woodend	Influent
28/11/17	979	mg/L	Woodend	Influent
5/12/17	592	mg/L	Woodend	Influent
12/12/17	1258	mg/L	Woodend	Influent
19/12/17	1068	mg/L	Woodend	Influent
9/01/18	351	mg/L	Woodend	Influent
16/01/18	1271	mg/L	Woodend	Influent
23/01/18	1069	mg/L	Woodend	Influent
30/01/18	509	mg/L	Woodend	Influent
6/02/18	705	mg/L	Woodend	Influent
13/02/18	799	mg/L	Woodend	Influent
20/02/18	938	mg/L	Woodend	Influent
27/02/18	748	mg/L	Woodend	Influent
6/03/18	561	mg/L	Woodend	Influent
13/03/18	1179	mg/L	Woodend	Influent
20/03/18	955	mg/L	Woodend	Influent
27/03/18	827	mg/L	Woodend	Influent
4/04/17	54	mg/L	Woodend	Effluent
11/04/17	51	mg/L	Woodend	Effluent
18/04/17	45	mg/L	Woodend	Effluent
24/04/17	139	mg/L	Woodend	Effluent
9/05/17	41	mg/L	Woodend	Effluent
16/05/17	54	mg/L	Woodend	Effluent
22/05/17	58	mg/L	Woodend	Effluent
30/05/17	43	mg/L	Woodend	Effluent
13/06/17	48	mg/L	Woodend	Effluent
20/06/17	48	mg/L	Woodend	Effluent
27/06/17	53	mg/L	Woodend	Effluent
4/07/17	30	mg/L	Woodend	Effluent
11/07/17	63	mg/L	Woodend	Effluent
18/07/17	38	mg/L	Woodend	Effluent
25/07/17	45	mg/L	Woodend	Effluent
1/08/17	56	mg/L	Woodend	Effluent
9/08/17	61	mg/L	Woodend	Effluent

15/08/17	52	mg/L	Woodend	Effluent
22/08/17	58	mg/L	Woodend	Effluent
29/08/17	27	mg/L	Woodend	Effluent
8/09/17	28	mg/L	Woodend	Effluent
12/09/17	92	mg/L	Woodend	Effluent
19/09/17	33	mg/L	Woodend	Effluent
26/09/17	51	mg/L	Woodend	Effluent
3/10/17	44	mg/L	Woodend	Effluent
10/10/17	53	mg/L	Woodend	Effluent
17/10/17	62	mg/L	Woodend	Effluent
24/10/17	42	mg/L	Woodend	Effluent
31/10/17	52	mg/L	Woodend	Effluent
13/11/17	57	mg/L	Woodend	Effluent
21/11/17	66	mg/L	Woodend	Effluent
28/11/17	49	mg/L	Woodend	Effluent
5/12/17	42	mg/L	Woodend	Effluent
12/12/17	65	mg/L	Woodend	Effluent
19/12/17	30	mg/L	Woodend	Effluent
9/01/18	80	mg/L	Woodend	Effluent
16/01/18	110	mg/L	Woodend	Effluent
23/01/18	69	mg/L	Woodend	Effluent
30/01/18	47	mg/L	Woodend	Effluent
6/02/18	69	mg/L	Woodend	Effluent
20/02/18	89	mg/L	Woodend	Effluent
27/02/18	64	mg/L	Woodend	Effluent
6/03/18	52	mg/L	Woodend	Effluent
13/03/18	54	mg/L	Woodend	Effluent
20/03/18	54	mg/L	Woodend	Effluent
27/03/18	39	mg/L	Woodend	Effluent

Electrical conductivity

18/04/17	934	uS/cm	Woodend	Influent
1/08/17	1027	uS/cm	Woodend	Influent
8/08/17	710	uS/cm	Woodend	Influent
15/08/17	933	uS/cm	Woodend	Influent
22/08/17	724	uS/cm	Woodend	Influent
29/08/17	721	uS/cm	Woodend	Influent
5/09/17	743	uS/cm	Woodend	Influent
12/09/17	930	uS/cm	Woodend	Influent
19/09/17	776	uS/cm	Woodend	Influent
27/09/17	925	uS/cm	Woodend	Influent
3/10/17	1056	uS/cm	Woodend	Influent
10/10/17	944	uS/cm	Woodend	Influent
10/10/17	966	uS/cm	Woodend	Influent
17/10/17	1005	uS/cm	Woodend	Influent
24/10/17	974	uS/cm	Woodend	Influent
31/10/17	990	uS/cm	Woodend	Influent
13/11/17	955	uS/cm	Woodend	Influent
21/11/17	931	uS/cm	Woodend	Influent

28/11/17	980	uS/cm	Woodend	Influent
5/12/17	736	uS/cm	Woodend	Influent
12/12/17	871	uS/cm	Woodend	Influent
13/12/17	967	uS/cm	Woodend	Influent
19/12/17	864	uS/cm	Woodend	Influent
9/01/18	772	uS/cm	Woodend	Influent
16/01/18	1170	uS/cm	Woodend	Influent
23/01/18	957	uS/cm	Woodend	Influent
30/01/18	734	uS/cm	Woodend	Influent
6/02/18	864	uS/cm	Woodend	Influent
13/02/18	979	uS/cm	Woodend	Influent
20/02/18	992	uS/cm	Woodend	Influent
27/02/18	931	uS/cm	Woodend	Influent
6/03/18	881	uS/cm	Woodend	Influent
13/03/18	1036	uS/cm	Woodend	Influent
20/03/18	1115	uS/cm	Woodend	Influent
27/03/18	1079	uS/cm	Woodend	Influent
11/04/17	648	uS/cm	Woodend	Effluent
18/04/17	674	uS/cm	Woodend	Effluent
28/04/17	667	uS/cm	Woodend	Effluent
17/05/17	675	uS/cm	Woodend	Effluent
16/06/17	743	uS/cm	Woodend	Effluent
7/07/17	698	uS/cm	Woodend	Effluent
27/07/17	692	uS/cm	Woodend	Effluent
1/08/17	632	uS/cm	Woodend	Effluent
8/08/17	652	uS/cm	Woodend	Effluent
15/08/17	668	uS/cm	Woodend	Effluent
22/08/17	635	uS/cm	Woodend	Effluent
29/08/17	610	uS/cm	Woodend	Effluent
5/09/17	577	uS/cm	Woodend	Effluent
12/09/17	620	uS/cm	Woodend	Effluent
19/09/17	594	uS/cm	Woodend	Effluent
26/09/17	530	uS/cm	Woodend	Effluent
3/10/17	552	uS/cm	Woodend	Effluent
10/10/17	631	uS/cm	Woodend	Effluent
10/10/17	553	uS/cm	Woodend	Effluent
17/10/17	555	uS/cm	Woodend	Effluent
24/10/17	564	uS/cm	Woodend	Effluent
31/10/17	566	uS/cm	Woodend	Effluent
13/11/17	586	uS/cm	Woodend	Effluent
21/11/17	569	uS/cm	Woodend	Effluent
28/11/17	584	uS/cm	Woodend	Effluent
5/12/17	589	uS/cm	Woodend	Effluent
12/12/17	578	uS/cm	Woodend	Effluent
13/12/17	683	uS/cm	Woodend	Effluent
19/12/17	602	uS/cm	Woodend	Effluent
9/01/18	583	uS/cm	Woodend	Effluent
16/01/18	608	uS/cm	Woodend	Effluent

	23/01/18	624	uS/cm	Woodend	Effluent
	30/01/18	613	uS/cm	Woodend	Effluent
	6/02/18	628	uS/cm	Woodend	Effluent
	20/02/18	640	uS/cm	Woodend	Effluent
	27/02/18	669	uS/cm	Woodend	Effluent
	6/03/18	665	uS/cm	Woodend	Effluent
	13/03/18	692	uS/cm	Woodend	Effluent
	20/03/18	702	uS/cm	Woodend	Effluent
	27/03/18	679	uS/cm	Woodend	Effluent
SUS solids					
	22/08/17	262	mg/L	Woodend	Influent
	29/08/17	196	mg/L	Woodend	Influent
	6/09/17	250	mg/L	Woodend	Influent
	12/09/17	228	mg/L	Woodend	Influent
	19/09/17	142	mg/L	Woodend	Influent
	27/09/17	270	mg/L	Woodend	Influent
	3/10/17	288	mg/L	Woodend	Influent
	11/10/17	442	mg/L	Woodend	Influent
	17/10/17	236	mg/L	Woodend	Influent
	24/10/17	312	mg/L	Woodend	Influent
	31/10/17	266	mg/L	Woodend	Influent
	13/11/17	166	mg/L	Woodend	Influent
	21/11/17	424	mg/L	Woodend	Influent
	28/11/17	356	mg/L	Woodend	Influent
	5/12/17	756	mg/L	Woodend	Influent
	13/12/17	380	mg/L	Woodend	Influent
	22/12/17	485	mg/L	Woodend	Influent
	11/01/18	174	mg/L	Woodend	Influent
	17/01/18	504	mg/L	Woodend	Influent
	23/01/18	588	mg/L	Woodend	Influent
	30/01/18	256	mg/L	Woodend	Influent
	6/02/18	356	mg/L	Woodend	Influent
	13/02/18	394	mg/L	Woodend	Influent
	20/02/18	432	mg/L	Woodend	Influent
	27/02/18	370	mg/L	Woodend	Influent
	7/03/18	260	mg/L	Woodend	Influent
	13/03/18	548	mg/L	Woodend	Influent
	20/03/18	520	mg/L	Woodend	Influent
	27/03/18	350	mg/L	Woodend	Influent
	27/09/17	4700	mg/L	Woodend	Sludge
	2/10/17	6140	mg/L	Woodend	Sludge
	2/10/17	6140	mg/L	Woodend	Sludge
	6/10/17	6190	mg/L	Woodend	Sludge
	10/10/17	5880	mg/L	Woodend	Sludge
	11/10/17	6100	mg/L	Woodend	Sludge
	11/10/17	4470	mg/L	Woodend	Sludge
	16/10/17	6470	mg/L	Woodend	Sludge
	31/10/17	6900	mg/L	Woodend	Sludge

6/11/17	6337	mg/L	Woodend	Sludge
8/11/17	6500	mg/L	Woodend	Sludge
8/11/17	6500	mg/L	Woodend	Sludge
13/11/17	6700	mg/L	Woodend	Sludge
14/11/17	6530	mg/L	Woodend	Sludge
21/11/17	5445	mg/L	Woodend	Sludge
4/12/17	5180	mg/L	Woodend	Sludge
6/12/17	3554	mg/L	Woodend	Sludge
7/12/17	3560	mg/L	Woodend	Sludge
8/12/17	3686	mg/L	Woodend	Sludge
14/12/17	3980	mg/L	Woodend	Sludge
18/12/17	4400	mg/L	Woodend	Sludge
19/12/17	4500	mg/L	Woodend	Sludge
21/12/17	4412	mg/L	Woodend	Sludge
22/12/17	4330	mg/L	Woodend	Sludge
29/12/17	4240	mg/L	Woodend	Sludge
3/01/18	4270	mg/L	Woodend	Sludge
4/01/18	4240	mg/L	Woodend	Sludge
1/02/18	6270	mg/L	Woodend	Sludge
2/02/18	6200	mg/L	Woodend	Sludge
7/02/18	5950	mg/L	Woodend	Sludge
8/02/18	6250	mg/L	Woodend	Sludge
12/02/18	6410	mg/L	Woodend	Sludge
14/02/18	6930	mg/L	Woodend	Sludge
15/02/18	6240	mg/L	Woodend	Sludge
20/02/18	3853	mg/L	Woodend	Sludge
20/02/18	4890	mg/L	Woodend	Sludge
23/02/18	5143	mg/L	Woodend	Sludge
28/02/18	5160	mg/L	Woodend	Sludge
6/03/18	5563	mg/L	Woodend	Sludge
9/03/18	6030	mg/L	Woodend	Sludge
9/03/18	5608	mg/L	Woodend	Sludge
13/03/18	6430	mg/L	Woodend	Sludge
14/03/18	5589	mg/L	Woodend	Sludge
15/03/18	5910	mg/L	Woodend	Sludge
20/03/18	5037	mg/L	Woodend	Sludge
21/03/18	5900	mg/L	Woodend	Sludge
22/03/18	5595	mg/L	Woodend	Sludge
27/03/18	5180	mg/L	Woodend	Sludge
3/04/18	4040	mg/L	Woodend	Sludge
6/04/18	4680	mg/L	Woodend	Sludge
10/04/18	4800	mg/L	Woodend	Sludge
11/04/18	3954	mg/L	Woodend	Sludge
12/04/18	4950	mg/L	Woodend	Sludge
16/04/18	5060	mg/L	Woodend	Sludge
18/04/18	5510	mg/L	Woodend	Sludge
20/04/18	5624	mg/L	Woodend	Sludge
24/04/18	5836	mg/L	Woodend	Sludge

26/04/18	5800	mg/L	Woodend	Sludge
10/05/18	5600	mg/L	Woodend	Sludge
11/05/18	5849	mg/L	Woodend	Sludge
17/05/18	5780	mg/L	Woodend	Sludge
18/05/18	5570	mg/L	Woodend	Sludge
22/05/18	5410	mg/L	Woodend	Sludge
23/05/18	6910	mg/L	Woodend	Sludge
24/05/18	5400	mg/L	Woodend	Sludge
31/05/18	7106	mg/L	Woodend	Sludge
6/06/18	5290	mg/L	Woodend	Sludge
14/06/18	4911	mg/L	Woodend	Sludge
18/06/18	4682	mg/L	Woodend	Sludge
19/06/18	4650	mg/L	Woodend	Sludge
21/06/18	4491	mg/L	Woodend	Sludge
25/06/18	4660	mg/L	Woodend	Sludge
3/07/18	4720	mg/L	Woodend	Sludge
4/07/18	4138	mg/L	Woodend	Sludge
10/07/18	4720	mg/L	Woodend	Sludge
12/07/18	4601	mg/L	Woodend	Sludge
18/07/18	7106	mg/L	Woodend	Sludge
20/07/18	4890	mg/L	Woodend	Sludge
20/07/18	4910	mg/L	Woodend	Sludge
11/04/17	11	mg/L	Woodend	Effluent
28/04/17	14	mg/L	Woodend	Effluent
17/05/17	12	mg/L	Woodend	Effluent
16/06/17	13	mg/L	Woodend	Effluent
7/07/17	5	mg/L	Woodend	Effluent
27/07/17	111	mg/L	Woodend	Effluent
3/08/17	3	mg/L	Woodend	Effluent
8/08/17	11	mg/L	Woodend	Effluent
15/08/17	16	mg/L	Woodend	Effluent
22/08/17	18	mg/L	Woodend	Effluent
29/08/17	10	mg/L	Woodend	Effluent
6/09/17	12	mg/L	Woodend	Effluent
12/09/17	9	mg/L	Woodend	Effluent
19/09/17	10	mg/L	Woodend	Effluent
26/09/17	14	mg/L	Woodend	Effluent
3/10/17	6	mg/L	Woodend	Effluent
10/10/17	16	mg/L	Woodend	Effluent
11/10/17	8	mg/L	Woodend	Effluent
17/10/17	14	mg/L	Woodend	Effluent
24/10/17	7	mg/L	Woodend	Effluent
31/10/17	14	mg/L	Woodend	Effluent
13/11/17	8	mg/L	Woodend	Effluent
21/11/17	2	mg/L	Woodend	Effluent
28/11/17	34	mg/L	Woodend	Effluent
5/12/17	12	mg/L	Woodend	Effluent
13/12/17	19	mg/L	Woodend	Effluent

20/12/17	20	mg/L	Woodend	Effluent
11/01/18	35	mg/L	Woodend	Effluent
17/01/18	40	mg/L	Woodend	Effluent
23/01/18	12	mg/L	Woodend	Effluent
30/01/18	17	mg/L	Woodend	Effluent
6/02/18	18	mg/L	Woodend	Effluent
20/02/18	50	mg/L	Woodend	Effluent
27/02/18	42	mg/L	Woodend	Effluent
6/03/18	34	mg/L	Woodend	Effluent
13/03/18	22	mg/L	Woodend	Effluent
20/03/18	12	mg/L	Woodend	Effluent
27/03/18	2	mg/L	Woodend	Effluent

30 min sets

4/10/17	850		Woodend	Sludge
10/10/17	760		Woodend	Sludge
17/10/17	880		Woodend	Sludge
31/10/17	880		Woodend	Sludge
6/11/17	850		Woodend	Sludge
13/11/17	880		Woodend	Sludge
21/11/17	720		Woodend	Sludge
5/12/17	470		Woodend	Sludge
6/12/17	510		Woodend	Sludge
6/12/17	510		Woodend	Sludge
8/12/17	490		Woodend	Sludge
14/12/17	660		Woodend	Sludge
18/12/17	820		Woodend	Sludge
21/12/17	800		Woodend	Sludge
29/12/17	790		Woodend	Sludge
3/01/18	800		Woodend	Sludge
4/01/18	790		Woodend	Sludge
9/01/18	930		Woodend	Sludge
23/01/18	810		Woodend	Sludge
1/02/18	910		Woodend	Sludge
7/02/18	860		Woodend	Sludge
8/02/18	810		Woodend	Sludge
12/02/18	800		Woodend	Sludge
14/02/18	820		Woodend	Sludge
15/02/18	850		Woodend	Sludge
20/02/18	680		Woodend	Sludge
20/02/18	650		Woodend	Sludge
23/02/18	670		Woodend	Sludge
28/02/18	750		Woodend	Sludge
6/03/18	570		Woodend	Sludge
8/03/18	800		Woodend	Sludge
9/03/18	790		Woodend	Sludge
13/03/18	750		Woodend	Sludge
15/03/18	770		Woodend	Sludge
20/03/18	750		Woodend	Sludge

21/03/18	690		Woodend	Sludge
22/03/18	700		Woodend	Sludge
3/04/18	470		Woodend	Sludge
6/04/18	470		Woodend	Sludge
10/04/18	450		Woodend	Sludge
11/04/18	280		Woodend	Sludge
12/04/18	520		Woodend	Sludge
17/04/18	600		Woodend	Sludge
18/04/18	480		Woodend	Sludge
20/04/18	720		Woodend	Sludge
24/04/18	790		Woodend	Sludge
26/04/18	700		Woodend	Sludge
8/05/18	800		Woodend	Sludge
10/05/18	750		Woodend	Sludge
11/05/18	850		Woodend	Sludge
15/05/18	820		Woodend	Sludge
17/05/18	850		Woodend	Sludge
22/05/18	720		Woodend	Sludge
23/05/18	880		Woodend	Sludge
30/05/18	940		Woodend	Sludge
31/05/18	850		Woodend	Sludge
5/06/18	780		Woodend	Sludge
6/06/18	850		Woodend	Sludge
13/06/18	580		Woodend	Sludge
14/06/18	850		Woodend	Sludge
18/06/18	390		Woodend	Sludge
19/06/18	430		Woodend	Sludge
21/06/18	450		Woodend	Sludge
27/06/18	400		Woodend	Sludge
3/07/18	500		Woodend	Sludge
4/07/18	850		Woodend	Sludge
10/07/18	590		Woodend	Sludge
12/07/18	460		Woodend	Sludge
17/07/18	680		Woodend	Sludge
18/07/18	590		Woodend	Sludge
20/07/18	750		Woodend	Sludge

SVI

10/10/17	130	unitless	Woodend	Sludge
11/10/17	130	unitless	Woodend	Sludge
31/10/17	128	unitless	Woodend	Sludge
6/11/17	134	unitless	Woodend	Sludge
13/11/17	131	unitless	Woodend	Sludge
21/11/17	132	unitless	Woodend	Sludge
5/12/17	121	unitless	Woodend	Sludge
6/12/17	145	unitless	Woodend	Sludge
6/12/17	145	unitless	Woodend	Sludge
8/12/17	138	unitless	Woodend	Sludge
14/12/17	166	unitless	Woodend	Sludge

18/12/17	186	unitless	Woodend	Sludge
21/12/17	181	unitless	Woodend	Sludge
29/12/17	186	unitless	Woodend	Sludge
3/01/18	187	unitless	Woodend	Sludge
4/01/18	187	unitless	Woodend	Sludge
11/01/18	158	unitless	Woodend	Sludge
1/02/18	145	unitless	Woodend	Sludge
7/02/18	145	unitless	Woodend	Sludge
8/02/18	130	unitless	Woodend	Sludge
12/02/18	124.3	unitless	Woodend	Sludge
14/02/18	132	unitless	Woodend	Sludge
15/02/18	135.1	unitless	Woodend	Sludge
20/02/18	132.1	unitless	Woodend	Sludge
21/02/18	86	unitless	Woodend	Sludge
23/02/18	131	unitless	Woodend	Sludge
28/02/18	145.2	unitless	Woodend	Sludge
6/03/18	102.3	unitless	Woodend	Sludge
9/03/18	132.6	unitless	Woodend	Sludge
9/03/18	141	unitless	Woodend	Sludge
13/03/18	116.3	unitless	Woodend	Sludge
14/03/18	135	unitless	Woodend	Sludge
15/03/18	130	unitless	Woodend	Sludge
20/03/18	149	unitless	Woodend	Sludge
21/03/18	117	unitless	Woodend	Sludge
22/03/18	125	unitless	Woodend	Sludge
3/04/18	116.3	unitless	Woodend	Sludge
6/04/18	100.4	unitless	Woodend	Sludge
10/04/18	93.7	unitless	Woodend	Sludge
11/04/18	70	unitless	Woodend	Sludge
12/04/18	105	unitless	Woodend	Sludge
18/04/18	87.1	unitless	Woodend	Sludge
20/04/18	128.3	unitless	Woodend	Sludge
24/04/18	135	unitless	Woodend	Sludge
26/04/18	121	unitless	Woodend	Sludge
8/05/18	126	unitless	Woodend	Sludge
10/05/18	133.9	unitless	Woodend	Sludge
11/05/18	145.3	unitless	Woodend	Sludge
17/05/18	147.3	unitless	Woodend	Sludge
22/05/18	138	unitless	Woodend	Sludge
23/05/18	127.3	unitless	Woodend	Sludge
31/05/18	119.3	unitless	Woodend	Sludge
6/06/18	165.3	unitless	Woodend	Sludge
14/06/18	173.3	unitless	Woodend	Sludge
18/06/18	83.2	unitless	Woodend	Sludge
19/06/18	92.4	unitless	Woodend	Sludge
21/06/18	100.2	unitless	Woodend	Sludge
4/07/18	123.6	unitless	Woodend	Sludge
10/07/18	124.3	unitless	Woodend	Sludge

	12/07/18	99.9	unitless	Woodend	Sludge
	18/07/18	83	unitless	Woodend	Sludge
Antimony					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
Arsenic					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
Barium					
	24/08/17	0.05	mg/L	Woodend	Influent
	28/11/17	0.06	mg/L	Woodend	Influent
	23/02/18	0.03	mg/L	Woodend	Influent
Berylium					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
BOD					
	19/05/17	150	mg/L	Woodend	Influent
	24/08/17	49	mg/L	Woodend	Influent
	28/11/17	180	mg/L	Woodend	Influent
	23/02/18	110	mg/L	Woodend	Influent
Boron					
	24/08/17	0.2	mg/L	Woodend	Influent
	28/11/17	0.2	mg/L	Woodend	Influent
	23/02/18	0.2	mg/L	Woodend	Influent
Cadmium					
	24/08/17	0.002	mg/L	Woodend	Influent
	28/11/17	0.002	mg/L	Woodend	Influent
	23/02/18	0.002	mg/L	Woodend	Influent
Bicarbonate					
	19/05/17	240	mg/L	Woodend	Influent
	24/08/17	140	mg/L	Woodend	Influent
	28/11/17	220	mg/L	Woodend	Influent
	23/02/18	330	mg/L	Woodend	Influent
Carbonate					
	19/05/17	2	mg/L	Woodend	Influent
	24/08/17	2	mg/L	Woodend	Influent
	28/11/17	2	mg/L	Woodend	Influent
	23/02/18	2	mg/L	Woodend	Influent
Chemical oxygen demand					
	19/05/17	950	mg/L	Woodend	Influent
	24/08/17	600	mg/L	Woodend	Influent
	28/11/17	1100	mg/L	Woodend	Influent
	23/02/18	880	mg/L	Woodend	Influent
Chromium					
	24/08/17	0.01	mg/L	Woodend	Influent

	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
Cobalt					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
Copper					
	24/08/17	0.08	mg/L	Woodend	Influent
	28/11/17	0.14	mg/L	Woodend	Influent
	23/02/18	0.07	mg/L	Woodend	Influent
Hydroxide					
	19/05/17	2	mg/L	Woodend	Influent
	24/08/17	2	mg/L	Woodend	Influent
	28/11/17	2	mg/L	Woodend	Influent
	23/02/18	2	mg/L	Woodend	Influent
Iron					
	24/08/17	1	mg/L	Woodend	Influent
	28/11/17	1.4	mg/L	Woodend	Influent
	23/02/18	0.8	mg/L	Woodend	Influent
Kjeldahl Nitrogen					
	19/05/17	63	mg/L	Woodend	Influent
	24/08/17	38	mg/L	Woodend	Influent
	28/11/17	56	mg/L	Woodend	Influent
	23/02/18	91	mg/L	Woodend	Influent
Lead					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
Manganese					
	24/08/17	0.07	mg/L	Woodend	Influent
	28/11/17	0.13	mg/L	Woodend	Influent
	23/02/18	0.07	mg/L	Woodend	Influent
Mercury					
	24/08/17	0.001	mg/L	Woodend	Influent
	28/11/17	0.001	mg/L	Woodend	Influent
	23/02/18	0.001	mg/L	Woodend	Influent
Molybdenum					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
Nickel					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
Selenium					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent

Silver					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
Sodium absorption rate					
	19/05/17	4.4	units	Woodend	Influent
	24/08/17	2.9	units	Woodend	Influent
	28/11/17	4	units	Woodend	Influent
	23/02/18	3.9	units	Woodend	Influent
Sodium					
	19/05/17	94	mg/L	Woodend	Influent
	24/08/17	68	mg/L	Woodend	Influent
	28/11/17	94	mg/L	Woodend	Influent
	23/02/18	77	mg/L	Woodend	Influent
Strontium					
	24/08/17	0.08	mg/L	Woodend	Influent
	28/11/17	0.09	mg/L	Woodend	Influent
	23/02/18	0.06	mg/L	Woodend	Influent
Sulphide					
	19/05/17	2.4	mg/L	Woodend	Influent
	24/08/17	0.1	mg/L	Woodend	Influent
	28/11/17	0.2	mg/L	Woodend	Influent
	23/02/18	0.1	mg/L	Woodend	Influent
Thallium					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
Tin					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
Titanium					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.02	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
Total dissolved solids					
	19/05/17	410	mg/L	Woodend	Influent
	24/08/17	360	mg/L	Woodend	Influent
	28/11/17	500	mg/L	Woodend	Influent
	23/02/18	400	mg/L	Woodend	Influent
Vanadium					
	24/08/17	0.01	mg/L	Woodend	Influent
	28/11/17	0.01	mg/L	Woodend	Influent
	23/02/18	0.01	mg/L	Woodend	Influent
Zinc					
	24/08/17	0.18	mg/L	Woodend	Influent
	28/11/17	0.28	mg/L	Woodend	Influent
	23/02/18	0.22	mg/L	Woodend	Influent

Dissolved oxygen

	11/04/17	9.84	mg/L	Woodend	Effluent
	19/04/17	13.13	mg/L	Woodend	Effluent
	7/07/17	9.94	mg/L	Woodend	Effluent
	27/07/17	9.47	mg/L	Woodend	Effluent
	3/08/17	10.81	mg/L	Woodend	Effluent
	8/08/17	11.13	mg/L	Woodend	Effluent
	11/10/17	14	mg/L	Woodend	Effluent
	8/12/17	12.29	mg/L	Woodend	Effluent
E. coli/100mL					
	4/04/17	1	orgs/100mL	Woodend	Effluent
	11/04/17	8	orgs/100mL	Woodend	Effluent
	18/04/17	43	orgs/100mL	Woodend	Effluent
	24/04/17	2	orgs/100mL	Woodend	Effluent
	9/05/17	155	orgs/100mL	Woodend	Effluent
	30/05/17	4	orgs/100mL	Woodend	Effluent
	7/06/17	1	orgs/100mL	Woodend	Effluent
	21/06/17	9	orgs/100mL	Woodend	Effluent
	27/06/17	24	orgs/100mL	Woodend	Effluent
	4/07/17	48	orgs/100mL	Woodend	Effluent
	11/07/17	25	orgs/100mL	Woodend	Effluent
	18/07/17	1	orgs/100mL	Woodend	Effluent
	8/08/17	68	orgs/100mL	Woodend	Effluent
	15/08/17	30	orgs/100mL	Woodend	Effluent
	22/08/17	3	orgs/100mL	Woodend	Effluent
	29/08/17	5	orgs/100mL	Woodend	Effluent
	5/09/17	8	orgs/100mL	Woodend	Effluent
	12/09/17	93	orgs/100mL	Woodend	Effluent
	19/09/17	26	orgs/100mL	Woodend	Effluent
	26/09/17	4	orgs/100mL	Woodend	Effluent
	3/10/17	80	orgs/100mL	Woodend	Effluent
	17/10/17	18	orgs/100mL	Woodend	Effluent
	24/10/17	260	orgs/100mL	Woodend	Effluent
	31/10/17	80	orgs/100mL	Woodend	Effluent
	13/11/17	155	orgs/100mL	Woodend	Effluent
	21/11/17	133	orgs/100mL	Woodend	Effluent
	28/11/17	20	orgs/100mL	Woodend	Effluent
	5/12/17	220	orgs/100mL	Woodend	Effluent
	12/12/17	32	orgs/100mL	Woodend	Effluent
	19/12/17	32	orgs/100mL	Woodend	Effluent
	9/01/18	480	orgs/100mL	Woodend	Effluent
	16/01/18	3850	orgs/100mL	Woodend	Effluent
	23/01/18	90	orgs/100mL	Woodend	Effluent
	30/01/18	228	orgs/100mL	Woodend	Effluent
	6/02/18	128	orgs/100mL	Woodend	Effluent
	20/02/18	680	orgs/100mL	Woodend	Effluent
	27/02/18	44	orgs/100mL	Woodend	Effluent
	6/03/18	62	orgs/100mL	Woodend	Effluent

13/03/18	54	orgs/100mL	Woodend	Effluent
20/03/18	110	orgs/100mL	Woodend	Effluent
27/03/18	310	orgs/100mL	Woodend	Effluent

2.2 Operational data for the Melton wastewater treatment plant

Parameter	Date	amount	unit	plant	water type
Ammonia					
	3/04/17	4.79	mg N/L	Melton	Mixed liquor
	4/04/17	5.5	mg N/L	Melton	Mixed liquor
	5/04/17	4.8	mg N/L	Melton	Mixed liquor
	6/04/17	6.39	mg N/L	Melton	Mixed liquor
	7/04/17	5.75	mg N/L	Melton	Mixed liquor
	10/04/17	12.8	mg N/L	Melton	Mixed liquor
	11/04/17	14.8	mg N/L	Melton	Mixed liquor
	12/04/17	11.9	mg N/L	Melton	Mixed liquor
	18/04/17	9.12	mg N/L	Melton	Mixed liquor
	19/04/17	7.09	mg N/L	Melton	Mixed liquor
	20/04/17	5.42	mg N/L	Melton	Mixed liquor
	21/04/17	5.76	mg N/L	Melton	Mixed liquor
	24/04/17	4.79	mg N/L	Melton	Mixed liquor
	26/04/17	6.24	mg N/L	Melton	Mixed liquor
	27/04/17	3.63	mg N/L	Melton	Mixed liquor
	28/04/17	8.22	mg N/L	Melton	Mixed liquor
	1/05/17	5.33	mg N/L	Melton	Mixed liquor
	2/05/17	3.4	mg N/L	Melton	Mixed liquor
	3/05/17	4.91	mg N/L	Melton	Mixed liquor
	4/05/17	5.22	mg N/L	Melton	Mixed liquor
	5/05/17	4.2	mg N/L	Melton	Mixed liquor
	8/05/17	3.48	mg N/L	Melton	Mixed liquor
	9/05/17	5.92	mg N/L	Melton	Mixed liquor
	10/05/17	3.24	mg N/L	Melton	Mixed liquor
	11/05/17	2.74	mg N/L	Melton	Mixed liquor
	15/05/17	5.54	mg N/L	Melton	Mixed liquor
	16/05/17	5.44	mg N/L	Melton	Mixed liquor
	17/05/17	4.52	mg N/L	Melton	Mixed liquor
	18/05/17	3.96	mg N/L	Melton	Mixed liquor
	19/05/17	4	mg N/L	Melton	Mixed liquor
	22/05/17	1.65	mg N/L	Melton	Mixed liquor
	23/05/17	4.38	mg N/L	Melton	Mixed liquor
	24/05/17	3.98	mg N/L	Melton	Mixed liquor
	25/05/17	3.61	mg N/L	Melton	Mixed liquor
	29/05/17	5.32	mg N/L	Melton	Mixed liquor
	30/05/17	5.21	mg N/L	Melton	Mixed liquor
	31/05/17	6.71	mg N/L	Melton	Mixed liquor
	1/06/17	6.18	mg N/L	Melton	Mixed liquor

5/06/17	9.79	mg N/L	Melton	Mixed liquor
6/06/17	8.27	mg N/L	Melton	Mixed liquor
7/06/17	6.64	mg N/L	Melton	Mixed liquor
8/06/17	2.71	mg N/L	Melton	Mixed liquor
13/06/17	12.3	mg N/L	Melton	Mixed liquor
15/06/17	2.14	mg N/L	Melton	Mixed liquor
16/06/17	3.39	mg N/L	Melton	Mixed liquor
19/06/17	2.89	mg N/L	Melton	Mixed liquor
20/06/17	3.88	mg N/L	Melton	Mixed liquor
21/06/17	3.51	mg N/L	Melton	Mixed liquor
22/06/17	1.96	mg N/L	Melton	Mixed liquor
23/06/17	4.81	mg N/L	Melton	Mixed liquor
26/06/17	3.27	mg N/L	Melton	Mixed liquor
27/06/17	8.15	mg N/L	Melton	Mixed liquor
28/06/17	7.98	mg N/L	Melton	Mixed liquor
29/06/17	7.27	mg N/L	Melton	Mixed liquor
30/06/17	5.36	mg N/L	Melton	Mixed liquor
3/07/17	11.5	mg N/L	Melton	Mixed liquor
5/07/17	5.16	mg N/L	Melton	Mixed liquor
6/07/17	9.07	mg N/L	Melton	Mixed liquor
7/07/17	10.5	mg N/L	Melton	Mixed liquor
10/07/17	10.4	mg N/L	Melton	Mixed liquor
11/07/17	9.12	mg N/L	Melton	Mixed liquor
12/07/17	7.55	mg N/L	Melton	Mixed liquor
13/07/17	10.6	mg N/L	Melton	Mixed liquor
14/07/17	6.35	mg N/L	Melton	Mixed liquor
17/07/17	7.03	mg N/L	Melton	Mixed liquor
18/07/17	10.5	mg N/L	Melton	Mixed liquor
19/07/17	12.1	mg N/L	Melton	Mixed liquor
20/07/17	14.5	mg N/L	Melton	Mixed liquor
21/07/17	15	mg N/L	Melton	Mixed liquor
24/07/17	7.37	mg N/L	Melton	Mixed liquor
25/07/17	8.16	mg N/L	Melton	Mixed liquor
26/07/17	7.99	mg N/L	Melton	Mixed liquor
27/07/17	6.48	mg N/L	Melton	Mixed liquor
31/07/17	10.5	mg N/L	Melton	Mixed liquor
1/08/17	11.8	mg N/L	Melton	Mixed liquor
2/08/17	8.82	mg N/L	Melton	Mixed liquor
3/08/17	8.95	mg N/L	Melton	Mixed liquor
4/08/17	12.3	mg N/L	Melton	Mixed liquor
7/08/17	12.2	mg N/L	Melton	Mixed liquor
8/08/17	11.6	mg N/L	Melton	Mixed liquor
9/08/17	15.7	mg N/L	Melton	Mixed liquor
10/08/17	14.2	mg N/L	Melton	Mixed liquor
11/08/17	19.7	mg N/L	Melton	Mixed liquor
14/08/17	21.1	mg N/L	Melton	Mixed liquor
15/08/17	17.2	mg N/L	Melton	Mixed liquor
16/08/17	24.6	mg N/L	Melton	Mixed liquor

17/08/17	22.8	mg N/L	Melton	Mixed liquor
18/08/17	23.7	mg N/L	Melton	Mixed liquor
21/08/17	17.1	mg N/L	Melton	Mixed liquor
22/08/17	16.2	mg N/L	Melton	Mixed liquor
23/08/17	15.3	mg N/L	Melton	Mixed liquor
24/08/17	12.3	mg N/L	Melton	Mixed liquor
25/08/17	12.7	mg N/L	Melton	Mixed liquor
28/08/17	13.6	mg N/L	Melton	Mixed liquor
29/08/17	13.6	mg N/L	Melton	Mixed liquor
30/08/17	8.96	mg N/L	Melton	Mixed liquor
31/08/17	12.5	mg N/L	Melton	Mixed liquor
4/09/17	9.2	mg N/L	Melton	Mixed liquor
5/09/17	9.61	mg N/L	Melton	Mixed liquor
8/09/17	12.8	mg N/L	Melton	Mixed liquor
11/09/17	12.7	mg N/L	Melton	Mixed liquor
12/09/17	11.4	mg N/L	Melton	Mixed liquor
13/09/17	12.5	mg N/L	Melton	Mixed liquor
14/09/17	12.3	mg N/L	Melton	Mixed liquor
15/09/17	11.5	mg N/L	Melton	Mixed liquor
18/09/17	11.8	mg N/L	Melton	Mixed liquor
19/09/17	10.8	mg N/L	Melton	Mixed liquor
20/09/17	10.2	mg N/L	Melton	Mixed liquor
21/09/17	11.8	mg N/L	Melton	Mixed liquor
22/09/17	10	mg N/L	Melton	Mixed liquor
25/09/17	12.7	mg N/L	Melton	Mixed liquor
26/09/17	11.6	mg N/L	Melton	Mixed liquor
27/09/17	12.9	mg N/L	Melton	Mixed liquor
28/09/17	14.4	mg N/L	Melton	Mixed liquor
2/10/17	15.8	mg N/L	Melton	Mixed liquor
3/10/17	17.7	mg N/L	Melton	Mixed liquor
4/10/17	16.5	mg N/L	Melton	Mixed liquor
5/10/17	16	mg N/L	Melton	Mixed liquor
6/10/17	16.8	mg N/L	Melton	Mixed liquor
9/10/17	14.3	mg N/L	Melton	Mixed liquor
10/10/17	11.5	mg N/L	Melton	Mixed liquor
11/10/17	8.51	mg N/L	Melton	Mixed liquor
12/10/17	13.6	mg N/L	Melton	Mixed liquor
13/10/17	13	mg N/L	Melton	Mixed liquor
16/10/17	7.65	mg N/L	Melton	Mixed liquor
17/10/17	7.42	mg N/L	Melton	Mixed liquor
18/10/17	7.83	mg N/L	Melton	Mixed liquor
19/10/17	9.59	mg N/L	Melton	Mixed liquor
20/10/17	8.88	mg N/L	Melton	Mixed liquor
23/10/17	6.21	mg N/L	Melton	Mixed liquor
24/10/17	10.7	mg N/L	Melton	Mixed liquor
25/10/17	10	mg N/L	Melton	Mixed liquor
26/10/17	11.2	mg N/L	Melton	Mixed liquor
30/10/17	13.4	mg N/L	Melton	Mixed liquor

31/10/17	13	mg N/L	Melton	Mixed liquor
1/11/17	14.9	mg N/L	Melton	Mixed liquor
2/11/17	16.9	mg N/L	Melton	Mixed liquor
3/11/17	17.5	mg N/L	Melton	Mixed liquor
6/11/17	12.8	mg N/L	Melton	Mixed liquor
8/11/17	15.9	mg N/L	Melton	Mixed liquor
9/11/17	14.7	mg N/L	Melton	Mixed liquor
10/11/17	12.6	mg N/L	Melton	Mixed liquor
13/11/17	9.96	mg N/L	Melton	Mixed liquor
14/11/17	9.27	mg N/L	Melton	Mixed liquor
15/11/17	6.95	mg N/L	Melton	Mixed liquor
16/11/17	11	mg N/L	Melton	Mixed liquor
17/11/17	13.1	mg N/L	Melton	Mixed liquor
20/11/17	7.97	mg N/L	Melton	Mixed liquor
21/11/17	13.7	mg N/L	Melton	Mixed liquor
22/11/17	9.69	mg N/L	Melton	Mixed liquor
23/11/17	7.2	mg N/L	Melton	Mixed liquor
24/11/17	5.51	mg N/L	Melton	Mixed liquor
27/11/17	7.83	mg N/L	Melton	Mixed liquor
28/11/17	13.7	mg N/L	Melton	Mixed liquor
29/11/17	14.5	mg N/L	Melton	Mixed liquor
30/11/17	13.2	mg N/L	Melton	Mixed liquor
1/12/17	10.4	mg N/L	Melton	Mixed liquor
4/12/17	5.84	mg N/L	Melton	Mixed liquor
5/12/17	12	mg N/L	Melton	Mixed liquor
6/12/17	11.1	mg N/L	Melton	Mixed liquor
7/12/17	13.5	mg N/L	Melton	Mixed liquor
11/12/17	6.39	mg N/L	Melton	Mixed liquor
12/12/17	7.28	mg N/L	Melton	Mixed liquor
14/12/17	4.96	mg N/L	Melton	Mixed liquor
15/12/17	13.3	mg N/L	Melton	Mixed liquor
18/12/17	4.1	mg N/L	Melton	Mixed liquor
20/12/17	10	mg N/L	Melton	Mixed liquor
21/12/17	6.5	mg N/L	Melton	Mixed liquor
22/12/17	9.35	mg N/L	Melton	Mixed liquor
8/01/18	14.4	mg N/L	Melton	Mixed liquor
9/01/18	15	mg N/L	Melton	Mixed liquor
10/01/18	14.71	mg N/L	Melton	Mixed liquor
11/01/18	18.2	mg N/L	Melton	Mixed liquor
12/01/18	16	mg N/L	Melton	Mixed liquor
15/01/18	13.2	mg N/L	Melton	Mixed liquor
16/01/18	13.8	mg N/L	Melton	Mixed liquor
17/01/18	17.1	mg N/L	Melton	Mixed liquor
18/01/18	13.1	mg N/L	Melton	Mixed liquor
19/01/18	17	mg N/L	Melton	Mixed liquor
22/01/18	13	mg N/L	Melton	Mixed liquor
23/01/18	17.6	mg N/L	Melton	Mixed liquor
24/01/18	17.4	mg N/L	Melton	Mixed liquor

25/01/18	18.2	mg N/L	Melton	Mixed liquor
30/01/18	15.1	mg N/L	Melton	Mixed liquor
31/01/18	15.5	mg N/L	Melton	Mixed liquor
1/02/18	20.7	mg N/L	Melton	Mixed liquor
5/02/18	16.6	mg N/L	Melton	Mixed liquor
6/02/18	16.6	mg N/L	Melton	Mixed liquor
7/02/18	13	mg N/L	Melton	Mixed liquor
8/02/18	12.7	mg N/L	Melton	Mixed liquor
9/02/18	15.7	mg N/L	Melton	Mixed liquor
12/02/18	11.7	mg N/L	Melton	Mixed liquor
13/02/18	9.13	mg N/L	Melton	Mixed liquor
13/02/18	7.71	mg N/L	Melton	Mixed liquor
16/02/18	10.6	mg N/L	Melton	Mixed liquor
19/02/18	5.55	mg N/L	Melton	Mixed liquor
20/02/18	4.8	mg N/L	Melton	Mixed liquor
21/02/18	8.32	mg N/L	Melton	Mixed liquor
22/02/18	10.3	mg N/L	Melton	Mixed liquor
23/02/18	8.57	mg N/L	Melton	Mixed liquor
26/02/18	9.23	mg N/L	Melton	Mixed liquor
27/02/18	12.8	mg N/L	Melton	Mixed liquor
28/02/18	15.7	mg N/L	Melton	Mixed liquor
1/03/18	9.76	mg N/L	Melton	Mixed liquor
2/03/18	14.5	mg N/L	Melton	Mixed liquor
5/03/18	9.79	mg N/L	Melton	Mixed liquor
6/03/18	13.7	mg N/L	Melton	Mixed liquor
7/03/18	14.2	mg N/L	Melton	Mixed liquor
8/03/18	12.5	mg N/L	Melton	Mixed liquor
9/03/18	14.7	mg N/L	Melton	Mixed liquor
13/03/18	12.2	mg N/L	Melton	Mixed liquor
14/03/18	12.1	mg N/L	Melton	Mixed liquor
15/03/18	14.2	mg N/L	Melton	Mixed liquor
16/03/18	13.4	mg N/L	Melton	Mixed liquor
19/03/18	11.3	mg N/L	Melton	Mixed liquor
20/03/18	12.5	mg N/L	Melton	Mixed liquor
21/03/18	14.4	mg N/L	Melton	Mixed liquor
22/03/18	15.5	mg N/L	Melton	Mixed liquor
23/03/18	13.9	mg N/L	Melton	Mixed liquor
26/03/18	10	mg N/L	Melton	Mixed liquor
27/03/18	12	mg N/L	Melton	Mixed liquor
28/03/18	13.9	mg N/L	Melton	Mixed liquor
29/03/18	14.8	mg N/L	Melton	Mixed liquor
3/04/18	12.1	mg N/L	Melton	Mixed liquor
4/04/18	10.2	mg N/L	Melton	Mixed liquor
5/04/18	11	mg N/L	Melton	Mixed liquor
6/04/18	12.7	mg N/L	Melton	Mixed liquor
9/04/18	11.6	mg N/L	Melton	Mixed liquor
10/04/18	12.2	mg N/L	Melton	Mixed liquor
12/04/18	13.5	mg N/L	Melton	Mixed liquor

16/04/18	14.6	mg N/L	Melton	Mixed liquor
17/04/18	16.3	mg N/L	Melton	Mixed liquor
18/04/18	17	mg N/L	Melton	Mixed liquor
19/04/18	12.9	mg N/L	Melton	Mixed liquor
20/04/18	12.4	mg N/L	Melton	Mixed liquor
23/04/18	10	mg N/L	Melton	Mixed liquor
24/04/18	15.9	mg N/L	Melton	Mixed liquor
26/04/18	9.84	mg N/L	Melton	Mixed liquor
27/04/18	15.6	mg N/L	Melton	Mixed liquor
30/04/18	10.2	mg N/L	Melton	Mixed liquor
1/05/18	14.1	mg N/L	Melton	Mixed liquor
2/05/18	13.9	mg N/L	Melton	Mixed liquor
3/05/18	15.6	mg N/L	Melton	Mixed liquor
4/05/18	19.6	mg N/L	Melton	Mixed liquor
7/05/18	7.42	mg N/L	Melton	Mixed liquor
8/05/18	11.6	mg N/L	Melton	Mixed liquor
9/05/18	11.8	mg N/L	Melton	Mixed liquor
10/05/18	18.2	mg N/L	Melton	Mixed liquor
11/05/18	18.1	mg N/L	Melton	Mixed liquor
14/05/18	14.6	mg N/L	Melton	Mixed liquor
15/05/18	16.6	mg N/L	Melton	Mixed liquor
16/05/18	17.4	mg N/L	Melton	Mixed liquor
17/05/18	16.8	mg N/L	Melton	Mixed liquor
21/05/18	10.2	mg N/L	Melton	Mixed liquor
22/05/18	17.2	mg N/L	Melton	Mixed liquor
23/05/18	17.2	mg N/L	Melton	Mixed liquor
24/05/18	16.6	mg N/L	Melton	Mixed liquor
25/05/18	16.1	mg N/L	Melton	Mixed liquor
28/05/18	11.7	mg N/L	Melton	Mixed liquor
29/05/18	10.7	mg N/L	Melton	Mixed liquor
30/05/18	12.1	mg N/L	Melton	Mixed liquor
31/05/18	11.9	mg N/L	Melton	Mixed liquor
1/06/18	18.2	mg N/L	Melton	Mixed liquor
3/04/17	4	mg N/L	Melton	Effluent
4/04/17	3.29	mg N/L	Melton	Effluent
5/04/17	2.76	mg N/L	Melton	Effluent
6/04/17	4.15	mg N/L	Melton	Effluent
7/04/17	3.25	mg N/L	Melton	Effluent
10/04/17	2.26	mg N/L	Melton	Effluent
11/04/17	9.49	mg N/L	Melton	Effluent
12/04/17	9.65	mg N/L	Melton	Effluent
18/04/17	5.79	mg N/L	Melton	Effluent
19/04/17	6.17	mg N/L	Melton	Effluent
20/04/17	6.32	mg N/L	Melton	Effluent
21/04/17	6.73	mg N/L	Melton	Effluent
24/04/17	5.87	mg N/L	Melton	Effluent
26/04/17	5.96	mg N/L	Melton	Effluent
27/04/17	6.93	mg N/L	Melton	Effluent

28/04/17	7.3	mg N/L	Melton	Effluent
1/05/17	5.46	mg N/L	Melton	Effluent
2/05/17	5.18	mg N/L	Melton	Effluent
3/05/17	5.95	mg N/L	Melton	Effluent
4/05/17	6.77	mg N/L	Melton	Effluent
5/05/17	6.87	mg N/L	Melton	Effluent
8/05/17	5.52	mg N/L	Melton	Effluent
9/05/17	6.11	mg N/L	Melton	Effluent
10/05/17	4.57	mg N/L	Melton	Effluent
11/05/17	4.61	mg N/L	Melton	Effluent
15/05/17	3.46	mg N/L	Melton	Effluent
16/05/17	4.31	mg N/L	Melton	Effluent
17/05/17	3.44	mg N/L	Melton	Effluent
18/05/17	3.37	mg N/L	Melton	Effluent
19/05/17	3.94	mg N/L	Melton	Effluent
22/05/17	2.5	mg N/L	Melton	Effluent
23/05/17	2.81	mg N/L	Melton	Effluent
24/05/17	2.53	mg N/L	Melton	Effluent
25/05/17	3.21	mg N/L	Melton	Effluent
29/05/17	2.61	mg N/L	Melton	Effluent
30/05/17	4.14	mg N/L	Melton	Effluent
31/05/17	2.84	mg N/L	Melton	Effluent
1/06/17	3.96	mg N/L	Melton	Effluent
5/06/17	2.53	mg N/L	Melton	Effluent
6/06/17	2.85	mg N/L	Melton	Effluent
7/06/17	3.01	mg N/L	Melton	Effluent
8/06/17	3.68	mg N/L	Melton	Effluent
13/06/17	2.91	mg N/L	Melton	Effluent
15/06/17	1.51	mg N/L	Melton	Effluent
16/06/17	2.53	mg N/L	Melton	Effluent
19/06/17	2.48	mg N/L	Melton	Effluent
20/06/17	2.98	mg N/L	Melton	Effluent
21/06/17	2.99	mg N/L	Melton	Effluent
22/06/17	2.59	mg N/L	Melton	Effluent
23/06/17	3.43	mg N/L	Melton	Effluent
26/06/17	2.31	mg N/L	Melton	Effluent
27/06/17	4.71	mg N/L	Melton	Effluent
28/06/17	4.71	mg N/L	Melton	Effluent
29/06/17	4.33	mg N/L	Melton	Effluent
30/06/17	3.63	mg N/L	Melton	Effluent
3/07/17	3.91	mg N/L	Melton	Effluent
5/07/17	4.94	mg N/L	Melton	Effluent
6/07/17	4.73	mg N/L	Melton	Effluent
7/07/17	5.44	mg N/L	Melton	Effluent
10/07/17	6.69	mg N/L	Melton	Effluent
11/07/17	6.12	mg N/L	Melton	Effluent
12/07/17	6.97	mg N/L	Melton	Effluent
13/07/17	7.25	mg N/L	Melton	Effluent

14/07/17	6.07	mg N/L	Melton	Effluent
17/07/17	5.98	mg N/L	Melton	Effluent
18/07/17	5.99	mg N/L	Melton	Effluent
19/07/17	6.73	mg N/L	Melton	Effluent
20/07/17	5.81	mg N/L	Melton	Effluent
21/07/17	6.23	mg N/L	Melton	Effluent
24/07/17	5.78	mg N/L	Melton	Effluent
25/07/17	4.57	mg N/L	Melton	Effluent
26/07/17	5.25	mg N/L	Melton	Effluent
27/07/17	3.74	mg N/L	Melton	Effluent
31/07/17	6.35	mg N/L	Melton	Effluent
1/08/17	5.76	mg N/L	Melton	Effluent
2/08/17	6.62	mg N/L	Melton	Effluent
3/08/17	4.23	mg N/L	Melton	Effluent
4/08/17	5.39	mg N/L	Melton	Effluent
7/08/17	5.99	mg N/L	Melton	Effluent
8/08/17	9.18	mg N/L	Melton	Effluent
9/08/17	9.83	mg N/L	Melton	Effluent
10/08/17	8.43	mg N/L	Melton	Effluent
11/08/17	9.25	mg N/L	Melton	Effluent
14/08/17	9.47	mg N/L	Melton	Effluent
15/08/17	11.2	mg N/L	Melton	Effluent
16/08/17	18.5	mg N/L	Melton	Effluent
17/08/17	11.9	mg N/L	Melton	Effluent
18/08/17	17.6	mg N/L	Melton	Effluent
21/08/17	10.6	mg N/L	Melton	Effluent
22/08/17	8.41	mg N/L	Melton	Effluent
23/08/17	11.6	mg N/L	Melton	Effluent
24/08/17	10	mg N/L	Melton	Effluent
25/08/17	11.6	mg N/L	Melton	Effluent
28/08/17	9.15	mg N/L	Melton	Effluent
29/08/17	12.4	mg N/L	Melton	Effluent
30/08/17	13.4	mg N/L	Melton	Effluent
31/08/17	11.5	mg N/L	Melton	Effluent
4/09/17	13.7	mg N/L	Melton	Effluent
5/09/17	14.8	mg N/L	Melton	Effluent
8/09/17	16.1	mg N/L	Melton	Effluent
11/09/17	11.4	mg N/L	Melton	Effluent
12/09/17	12.2	mg N/L	Melton	Effluent
13/09/17	12	mg N/L	Melton	Effluent
14/09/17	10.4	mg N/L	Melton	Effluent
15/09/17	11.9	mg N/L	Melton	Effluent
18/09/17	12	mg N/L	Melton	Effluent
19/09/17	9.22	mg N/L	Melton	Effluent
20/09/17	11.9	mg N/L	Melton	Effluent
21/09/17	10	mg N/L	Melton	Effluent
22/09/17	11.3	mg N/L	Melton	Effluent
25/09/17	13.7	mg N/L	Melton	Effluent

26/09/17	11.8	mg N/L	Melton	Effluent
27/09/17	12.8	mg N/L	Melton	Effluent
28/09/17	10.9	mg N/L	Melton	Effluent
2/10/17	18	mg N/L	Melton	Effluent
3/10/17	15.5	mg N/L	Melton	Effluent
4/10/17	13.9	mg N/L	Melton	Effluent
5/10/17	12.4	mg N/L	Melton	Effluent
6/10/17	15.8	mg N/L	Melton	Effluent
9/10/17	14	mg N/L	Melton	Effluent
10/10/17	11.2	mg N/L	Melton	Effluent
11/10/17	10.5	mg N/L	Melton	Effluent
12/10/17	12.6	mg N/L	Melton	Effluent
13/10/17	13	mg N/L	Melton	Effluent
16/10/17	9.15	mg N/L	Melton	Effluent
17/10/17	9.64	mg N/L	Melton	Effluent
18/10/17	9.49	mg N/L	Melton	Effluent
19/10/17	10.6	mg N/L	Melton	Effluent
20/10/17	11.3	mg N/L	Melton	Effluent
23/10/17	9.4	mg N/L	Melton	Effluent
24/10/17	11.2	mg N/L	Melton	Effluent
25/10/17	10.7	mg N/L	Melton	Effluent
26/10/17	11.4	mg N/L	Melton	Effluent
30/10/17	13.1	mg N/L	Melton	Effluent
31/10/17	16	mg N/L	Melton	Effluent
1/11/17	15.3	mg N/L	Melton	Effluent
2/11/17	15.5	mg N/L	Melton	Effluent
3/11/17	16.8	mg N/L	Melton	Effluent
6/11/17	14.2	mg N/L	Melton	Effluent
8/11/17	14.4	mg N/L	Melton	Effluent
9/11/17	14.5	mg N/L	Melton	Effluent
10/11/17	13.5	mg N/L	Melton	Effluent
13/11/17	13.1	mg N/L	Melton	Effluent
14/11/17	11.7	mg N/L	Melton	Effluent
15/11/17	9.34	mg N/L	Melton	Effluent
16/11/17	12.2	mg N/L	Melton	Effluent
17/11/17	13.4	mg N/L	Melton	Effluent
20/11/17	10.4	mg N/L	Melton	Effluent
21/11/17	13.4	mg N/L	Melton	Effluent
22/11/17	13.5	mg N/L	Melton	Effluent
23/11/17	9.4	mg N/L	Melton	Effluent
24/11/17	7.49	mg N/L	Melton	Effluent
27/11/17	9.98	mg N/L	Melton	Effluent
28/11/17	12	mg N/L	Melton	Effluent
29/11/17	13	mg N/L	Melton	Effluent
30/11/17	13.2	mg N/L	Melton	Effluent
1/12/17	14.8	mg N/L	Melton	Effluent
4/12/17	9.85	mg N/L	Melton	Effluent
5/12/17	11.8	mg N/L	Melton	Effluent

6/12/17	12.1	mg N/L	Melton	Effluent
7/12/17	12.3	mg N/L	Melton	Effluent
11/12/17	10.8	mg N/L	Melton	Effluent
12/12/17	11.6	mg N/L	Melton	Effluent
14/12/17	12.2	mg N/L	Melton	Effluent
15/12/17	9.42	mg N/L	Melton	Effluent
18/12/17	9.55	mg N/L	Melton	Effluent
19/12/17	9.31	mg N/L	Melton	Effluent
20/12/17	7.8	mg N/L	Melton	Effluent
21/12/17	9.52	mg N/L	Melton	Effluent
22/12/17	9.26	mg N/L	Melton	Effluent
8/01/18	14.3	mg N/L	Melton	Effluent
9/01/18	16.6	mg N/L	Melton	Effluent
10/01/18	17	mg N/L	Melton	Effluent
11/01/18	16.2	mg N/L	Melton	Effluent
12/01/18	17.4	mg N/L	Melton	Effluent
15/01/18	16.6	mg N/L	Melton	Effluent
16/01/18	19	mg N/L	Melton	Effluent
17/01/18	15.3	mg N/L	Melton	Effluent
18/01/18	15.9	mg N/L	Melton	Effluent
19/01/18	15.9	mg N/L	Melton	Effluent
22/01/18	19.7	mg N/L	Melton	Effluent
23/01/18	19.3	mg N/L	Melton	Effluent
24/01/18	17.6	mg N/L	Melton	Effluent
25/01/18	16.9	mg N/L	Melton	Effluent
29/01/18	20	mg N/L	Melton	Effluent
30/01/18	8.4	mg N/L	Melton	Effluent
31/01/18	14.1	mg N/L	Melton	Effluent
1/02/18	15.1	mg N/L	Melton	Effluent
2/02/18	14.2	mg N/L	Melton	Effluent
5/02/18	15	mg N/L	Melton	Effluent
6/02/18	16.2	mg N/L	Melton	Effluent
7/02/18	17.3	mg N/L	Melton	Effluent
8/02/18	11.2	mg N/L	Melton	Effluent
9/02/18	12.7	mg N/L	Melton	Effluent
12/02/18	10.3	mg N/L	Melton	Effluent
13/02/18	8.4	mg N/L	Melton	Effluent
15/02/18	7.54	mg N/L	Melton	Effluent
16/02/18	5.28	mg N/L	Melton	Effluent
19/02/18	6.82	mg N/L	Melton	Effluent
20/02/18	7.84	mg N/L	Melton	Effluent
21/02/18	6.96	mg N/L	Melton	Effluent
22/02/18	7.61	mg N/L	Melton	Effluent
23/02/18	7.35	mg N/L	Melton	Effluent
26/02/18	7.76	mg N/L	Melton	Effluent
27/02/18	8.82	mg N/L	Melton	Effluent
28/02/18	13.2	mg N/L	Melton	Effluent
1/03/18	9.15	mg N/L	Melton	Effluent

2/03/18	14.8	mg N/L	Melton	Effluent
5/03/18	10.5	mg N/L	Melton	Effluent
6/03/18	13	mg N/L	Melton	Effluent
7/03/18	11.9	mg N/L	Melton	Effluent
8/03/18	12.4	mg N/L	Melton	Effluent
9/03/18	10.2	mg N/L	Melton	Effluent
13/03/18	12.3	mg N/L	Melton	Effluent
14/03/18	12.7	mg N/L	Melton	Effluent
15/03/18	12	mg N/L	Melton	Effluent
16/03/18	11.7	mg N/L	Melton	Effluent
19/03/18	12	mg N/L	Melton	Effluent
20/03/18	11.6	mg N/L	Melton	Effluent
21/03/18	12.7	mg N/L	Melton	Effluent
22/03/18	13.1	mg N/L	Melton	Effluent
23/03/18	11.7	mg N/L	Melton	Effluent
26/03/18	7.56	mg N/L	Melton	Effluent
27/03/18	11.7	mg N/L	Melton	Effluent
28/03/18	11.6	mg N/L	Melton	Effluent
29/03/18	12.1	mg N/L	Melton	Effluent
3/04/18	11.9	mg N/L	Melton	Effluent
4/04/18	11.4	mg N/L	Melton	Effluent
5/04/18	12.9	mg N/L	Melton	Effluent
6/04/18	14.9	mg N/L	Melton	Effluent
9/04/18	11.6	mg N/L	Melton	Effluent
10/04/18	13	mg N/L	Melton	Effluent
12/04/18	9.4	mg N/L	Melton	Effluent
16/04/18	14.5	mg N/L	Melton	Effluent
17/04/18	16	mg N/L	Melton	Effluent
18/04/18	15.3	mg N/L	Melton	Effluent
19/04/18	11.5	mg N/L	Melton	Effluent
20/04/18	12.2	mg N/L	Melton	Effluent
23/04/18	13.3	mg N/L	Melton	Effluent
24/04/18	14.5	mg N/L	Melton	Effluent
26/04/18	13.3	mg N/L	Melton	Effluent
27/04/18	15.1	mg N/L	Melton	Effluent
30/04/18	14.7	mg N/L	Melton	Effluent
1/05/18	14.6	mg N/L	Melton	Effluent
2/05/18	13.4	mg N/L	Melton	Effluent
3/05/18	12.4	mg N/L	Melton	Effluent
4/05/18	14.9	mg N/L	Melton	Effluent
7/05/18	10.6	mg N/L	Melton	Effluent
8/05/18	11.9	mg N/L	Melton	Effluent
9/05/18	12.9	mg N/L	Melton	Effluent
10/05/18	15.6	mg N/L	Melton	Effluent
11/05/18	12.4	mg N/L	Melton	Effluent
14/05/18	16.2	mg N/L	Melton	Effluent
15/05/18	15.3	mg N/L	Melton	Effluent
16/05/18	17.8	mg N/L	Melton	Effluent

	17/05/18	18.1	mg N/L	Melton	Effluent
	21/05/18	13.2	mg N/L	Melton	Effluent
	22/05/18	17.2	mg N/L	Melton	Effluent
	23/05/18	17	mg N/L	Melton	Effluent
	24/05/18	15.9	mg N/L	Melton	Effluent
	25/05/18	16.6	mg N/L	Melton	Effluent
	28/05/18	13.7	mg N/L	Melton	Effluent
	29/05/18	10.8	mg N/L	Melton	Effluent
	30/05/18	13	mg N/L	Melton	Effluent
	31/05/18	15.8	mg N/L	Melton	Effluent
	1/06/18	18.9	mg N/L	Melton	Effluent
Nitrate					
	3/04/17	4.79	mg N/L	Melton	Mixed liquor
	4/04/17	5.5	mg N/L	Melton	Mixed liquor
	5/04/17	4.8	mg N/L	Melton	Mixed liquor
	6/04/17	6.39	mg N/L	Melton	Mixed liquor
	7/04/17	5.75	mg N/L	Melton	Mixed liquor
	10/04/17	12.8	mg N/L	Melton	Mixed liquor
	11/04/17	14.8	mg N/L	Melton	Mixed liquor
	12/04/17	11.9	mg N/L	Melton	Mixed liquor
	18/04/17	9.12	mg N/L	Melton	Mixed liquor
	19/04/17	7.09	mg N/L	Melton	Mixed liquor
	20/04/17	5.42	mg N/L	Melton	Mixed liquor
	21/04/17	5.76	mg N/L	Melton	Mixed liquor
	24/04/17	4.79	mg N/L	Melton	Mixed liquor
	26/04/17	6.24	mg N/L	Melton	Mixed liquor
	27/04/17	3.63	mg N/L	Melton	Mixed liquor
	28/04/17	8.22	mg N/L	Melton	Mixed liquor
	1/05/17	5.33	mg N/L	Melton	Mixed liquor
	2/05/17	3.4	mg N/L	Melton	Mixed liquor
	3/05/17	4.91	mg N/L	Melton	Mixed liquor
	4/05/17	5.22	mg N/L	Melton	Mixed liquor
	5/05/17	4.2	mg N/L	Melton	Mixed liquor
	8/05/17	3.48	mg N/L	Melton	Mixed liquor
	9/05/17	5.92	mg N/L	Melton	Mixed liquor
	10/05/17	3.24	mg N/L	Melton	Mixed liquor
	11/05/17	2.74	mg N/L	Melton	Mixed liquor
	15/05/17	5.54	mg N/L	Melton	Mixed liquor
	16/05/17	5.44	mg N/L	Melton	Mixed liquor
	17/05/17	4.52	mg N/L	Melton	Mixed liquor
	18/05/17	3.96	mg N/L	Melton	Mixed liquor
	19/05/17	4	mg N/L	Melton	Mixed liquor
	22/05/17	1.65	mg N/L	Melton	Mixed liquor
	23/05/17	4.38	mg N/L	Melton	Mixed liquor
	24/05/17	3.98	mg N/L	Melton	Mixed liquor
	25/05/17	3.61	mg N/L	Melton	Mixed liquor
	29/05/17	5.32	mg N/L	Melton	Mixed liquor
	30/05/17	5.21	mg N/L	Melton	Mixed liquor

31/05/17	6.71	mg N/L	Melton	Mixed liquor
1/06/17	6.18	mg N/L	Melton	Mixed liquor
5/06/17	9.79	mg N/L	Melton	Mixed liquor
6/06/17	8.27	mg N/L	Melton	Mixed liquor
7/06/17	6.64	mg N/L	Melton	Mixed liquor
8/06/17	2.71	mg N/L	Melton	Mixed liquor
13/06/17	12.3	mg N/L	Melton	Mixed liquor
15/06/17	2.14	mg N/L	Melton	Mixed liquor
16/06/17	3.39	mg N/L	Melton	Mixed liquor
19/06/17	2.89	mg N/L	Melton	Mixed liquor
20/06/17	3.88	mg N/L	Melton	Mixed liquor
21/06/17	3.51	mg N/L	Melton	Mixed liquor
22/06/17	1.96	mg N/L	Melton	Mixed liquor
23/06/17	4.81	mg N/L	Melton	Mixed liquor
26/06/17	3.27	mg N/L	Melton	Mixed liquor
27/06/17	8.15	mg N/L	Melton	Mixed liquor
28/06/17	7.98	mg N/L	Melton	Mixed liquor
29/06/17	7.27	mg N/L	Melton	Mixed liquor
30/06/17	5.36	mg N/L	Melton	Mixed liquor
3/07/17	11.5	mg N/L	Melton	Mixed liquor
5/07/17	5.16	mg N/L	Melton	Mixed liquor
6/07/17	9.07	mg N/L	Melton	Mixed liquor
7/07/17	10.5	mg N/L	Melton	Mixed liquor
10/07/17	10.4	mg N/L	Melton	Mixed liquor
11/07/17	9.12	mg N/L	Melton	Mixed liquor
12/07/17	7.55	mg N/L	Melton	Mixed liquor
13/07/17	10.6	mg N/L	Melton	Mixed liquor
14/07/17	6.35	mg N/L	Melton	Mixed liquor
17/07/17	7.03	mg N/L	Melton	Mixed liquor
18/07/17	10.5	mg N/L	Melton	Mixed liquor
19/07/17	12.1	mg N/L	Melton	Mixed liquor
20/07/17	14.5	mg N/L	Melton	Mixed liquor
21/07/17	15	mg N/L	Melton	Mixed liquor
24/07/17	7.37	mg N/L	Melton	Mixed liquor
25/07/17	8.16	mg N/L	Melton	Mixed liquor
26/07/17	7.99	mg N/L	Melton	Mixed liquor
27/07/17	6.48	mg N/L	Melton	Mixed liquor
31/07/17	10.5	mg N/L	Melton	Mixed liquor
1/08/17	11.8	mg N/L	Melton	Mixed liquor
2/08/17	8.82	mg N/L	Melton	Mixed liquor
3/08/17	8.95	mg N/L	Melton	Mixed liquor
4/08/17	12.3	mg N/L	Melton	Mixed liquor
7/08/17	12.2	mg N/L	Melton	Mixed liquor
8/08/17	11.6	mg N/L	Melton	Mixed liquor
9/08/17	15.7	mg N/L	Melton	Mixed liquor
10/08/17	14.2	mg N/L	Melton	Mixed liquor
11/08/17	19.7	mg N/L	Melton	Mixed liquor
14/08/17	21.1	mg N/L	Melton	Mixed liquor

15/08/17	17.2	mg N/L	Melton	Mixed liquor
16/08/17	24.6	mg N/L	Melton	Mixed liquor
17/08/17	22.8	mg N/L	Melton	Mixed liquor
18/08/17	23.7	mg N/L	Melton	Mixed liquor
21/08/17	17.1	mg N/L	Melton	Mixed liquor
22/08/17	16.2	mg N/L	Melton	Mixed liquor
23/08/17	15.3	mg N/L	Melton	Mixed liquor
24/08/17	12.3	mg N/L	Melton	Mixed liquor
25/08/17	12.7	mg N/L	Melton	Mixed liquor
28/08/17	13.6	mg N/L	Melton	Mixed liquor
29/08/17	13.6	mg N/L	Melton	Mixed liquor
30/08/17	8.96	mg N/L	Melton	Mixed liquor
31/08/17	12.5	mg N/L	Melton	Mixed liquor
4/09/17	9.2	mg N/L	Melton	Mixed liquor
5/09/17	9.61	mg N/L	Melton	Mixed liquor
8/09/17	12.8	mg N/L	Melton	Mixed liquor
11/09/17	12.7	mg N/L	Melton	Mixed liquor
12/09/17	11.4	mg N/L	Melton	Mixed liquor
13/09/17	12.5	mg N/L	Melton	Mixed liquor
14/09/17	12.3	mg N/L	Melton	Mixed liquor
15/09/17	11.5	mg N/L	Melton	Mixed liquor
18/09/17	11.8	mg N/L	Melton	Mixed liquor
19/09/17	10.8	mg N/L	Melton	Mixed liquor
20/09/17	10.2	mg N/L	Melton	Mixed liquor
21/09/17	11.8	mg N/L	Melton	Mixed liquor
22/09/17	10	mg N/L	Melton	Mixed liquor
25/09/17	12.7	mg N/L	Melton	Mixed liquor
26/09/17	11.6	mg N/L	Melton	Mixed liquor
27/09/17	12.9	mg N/L	Melton	Mixed liquor
28/09/17	14.4	mg N/L	Melton	Mixed liquor
2/10/17	15.8	mg N/L	Melton	Mixed liquor
3/10/17	17.7	mg N/L	Melton	Mixed liquor
4/10/17	16.5	mg N/L	Melton	Mixed liquor
5/10/17	16	mg N/L	Melton	Mixed liquor
6/10/17	16.8	mg N/L	Melton	Mixed liquor
9/10/17	14.3	mg N/L	Melton	Mixed liquor
10/10/17	11.5	mg N/L	Melton	Mixed liquor
11/10/17	8.51	mg N/L	Melton	Mixed liquor
12/10/17	13.6	mg N/L	Melton	Mixed liquor
13/10/17	13	mg N/L	Melton	Mixed liquor
16/10/17	7.65	mg N/L	Melton	Mixed liquor
17/10/17	7.42	mg N/L	Melton	Mixed liquor
18/10/17	7.83	mg N/L	Melton	Mixed liquor
19/10/17	9.59	mg N/L	Melton	Mixed liquor
20/10/17	8.88	mg N/L	Melton	Mixed liquor
23/10/17	6.21	mg N/L	Melton	Mixed liquor
24/10/17	10.7	mg N/L	Melton	Mixed liquor
25/10/17	10	mg N/L	Melton	Mixed liquor

26/10/17	11.2	mg N/L	Melton	Mixed liquor
30/10/17	13.4	mg N/L	Melton	Mixed liquor
31/10/17	13	mg N/L	Melton	Mixed liquor
1/11/17	14.9	mg N/L	Melton	Mixed liquor
2/11/17	16.9	mg N/L	Melton	Mixed liquor
3/11/17	17.5	mg N/L	Melton	Mixed liquor
6/11/17	12.8	mg N/L	Melton	Mixed liquor
8/11/17	15.9	mg N/L	Melton	Mixed liquor
9/11/17	14.7	mg N/L	Melton	Mixed liquor
10/11/17	12.6	mg N/L	Melton	Mixed liquor
13/11/17	9.96	mg N/L	Melton	Mixed liquor
14/11/17	9.27	mg N/L	Melton	Mixed liquor
15/11/17	6.95	mg N/L	Melton	Mixed liquor
16/11/17	11	mg N/L	Melton	Mixed liquor
17/11/17	13.1	mg N/L	Melton	Mixed liquor
20/11/17	7.97	mg N/L	Melton	Mixed liquor
21/11/17	13.7	mg N/L	Melton	Mixed liquor
22/11/17	9.69	mg N/L	Melton	Mixed liquor
23/11/17	7.2	mg N/L	Melton	Mixed liquor
24/11/17	5.51	mg N/L	Melton	Mixed liquor
27/11/17	7.83	mg N/L	Melton	Mixed liquor
28/11/17	13.7	mg N/L	Melton	Mixed liquor
29/11/17	14.5	mg N/L	Melton	Mixed liquor
30/11/17	13.2	mg N/L	Melton	Mixed liquor
1/12/17	10.4	mg N/L	Melton	Mixed liquor
4/12/17	5.84	mg N/L	Melton	Mixed liquor
5/12/17	12	mg N/L	Melton	Mixed liquor
6/12/17	11.1	mg N/L	Melton	Mixed liquor
7/12/17	13.5	mg N/L	Melton	Mixed liquor
11/12/17	6.39	mg N/L	Melton	Mixed liquor
12/12/17	7.28	mg N/L	Melton	Mixed liquor
14/12/17	4.96	mg N/L	Melton	Mixed liquor
15/12/17	13.3	mg N/L	Melton	Mixed liquor
18/12/17	4.1	mg N/L	Melton	Mixed liquor
20/12/17	10	mg N/L	Melton	Mixed liquor
21/12/17	6.5	mg N/L	Melton	Mixed liquor
22/12/17	9.35	mg N/L	Melton	Mixed liquor
8/01/18	14.4	mg N/L	Melton	Mixed liquor
9/01/18	15	mg N/L	Melton	Mixed liquor
10/01/18	14.71	mg N/L	Melton	Mixed liquor
11/01/18	18.2	mg N/L	Melton	Mixed liquor
12/01/18	16	mg N/L	Melton	Mixed liquor
15/01/18	13.2	mg N/L	Melton	Mixed liquor
16/01/18	13.8	mg N/L	Melton	Mixed liquor
17/01/18	17.1	mg N/L	Melton	Mixed liquor
18/01/18	13.1	mg N/L	Melton	Mixed liquor
19/01/18	17	mg N/L	Melton	Mixed liquor
22/01/18	13	mg N/L	Melton	Mixed liquor

23/01/18	17.6	mg N/L	Melton	Mixed liquor
24/01/18	17.4	mg N/L	Melton	Mixed liquor
25/01/18	18.2	mg N/L	Melton	Mixed liquor
30/01/18	15.1	mg N/L	Melton	Mixed liquor
31/01/18	15.5	mg N/L	Melton	Mixed liquor
1/02/18	20.7	mg N/L	Melton	Mixed liquor
5/02/18	16.6	mg N/L	Melton	Mixed liquor
6/02/18	16.6	mg N/L	Melton	Mixed liquor
7/02/18	13	mg N/L	Melton	Mixed liquor
8/02/18	12.7	mg N/L	Melton	Mixed liquor
9/02/18	15.7	mg N/L	Melton	Mixed liquor
12/02/18	11.7	mg N/L	Melton	Mixed liquor
13/02/18	9.13	mg N/L	Melton	Mixed liquor
13/02/18	7.71	mg N/L	Melton	Mixed liquor
16/02/18	10.6	mg N/L	Melton	Mixed liquor
19/02/18	5.55	mg N/L	Melton	Mixed liquor
20/02/18	4.8	mg N/L	Melton	Mixed liquor
21/02/18	8.32	mg N/L	Melton	Mixed liquor
22/02/18	10.3	mg N/L	Melton	Mixed liquor
23/02/18	8.57	mg N/L	Melton	Mixed liquor
26/02/18	9.23	mg N/L	Melton	Mixed liquor
27/02/18	12.8	mg N/L	Melton	Mixed liquor
28/02/18	15.7	mg N/L	Melton	Mixed liquor
1/03/18	9.76	mg N/L	Melton	Mixed liquor
2/03/18	14.5	mg N/L	Melton	Mixed liquor
5/03/18	9.79	mg N/L	Melton	Mixed liquor
6/03/18	13.7	mg N/L	Melton	Mixed liquor
7/03/18	14.2	mg N/L	Melton	Mixed liquor
8/03/18	12.5	mg N/L	Melton	Mixed liquor
9/03/18	14.7	mg N/L	Melton	Mixed liquor
13/03/18	12.2	mg N/L	Melton	Mixed liquor
14/03/18	12.1	mg N/L	Melton	Mixed liquor
15/03/18	14.2	mg N/L	Melton	Mixed liquor
16/03/18	13.4	mg N/L	Melton	Mixed liquor
19/03/18	11.3	mg N/L	Melton	Mixed liquor
20/03/18	12.5	mg N/L	Melton	Mixed liquor
21/03/18	14.4	mg N/L	Melton	Mixed liquor
22/03/18	15.5	mg N/L	Melton	Mixed liquor
23/03/18	13.9	mg N/L	Melton	Mixed liquor
26/03/18	10	mg N/L	Melton	Mixed liquor
27/03/18	12	mg N/L	Melton	Mixed liquor
28/03/18	13.9	mg N/L	Melton	Mixed liquor
29/03/18	14.8	mg N/L	Melton	Mixed liquor
3/04/18	12.1	mg N/L	Melton	Mixed liquor
4/04/18	10.2	mg N/L	Melton	Mixed liquor
5/04/18	11	mg N/L	Melton	Mixed liquor
6/04/18	12.7	mg N/L	Melton	Mixed liquor
9/04/18	11.6	mg N/L	Melton	Mixed liquor

10/04/18	12.2	mg N/L	Melton	Mixed liquor
12/04/18	13.5	mg N/L	Melton	Mixed liquor
16/04/18	14.6	mg N/L	Melton	Mixed liquor
17/04/18	16.3	mg N/L	Melton	Mixed liquor
18/04/18	17	mg N/L	Melton	Mixed liquor
19/04/18	12.9	mg N/L	Melton	Mixed liquor
20/04/18	12.4	mg N/L	Melton	Mixed liquor
23/04/18	10	mg N/L	Melton	Mixed liquor
24/04/18	15.9	mg N/L	Melton	Mixed liquor
26/04/18	9.84	mg N/L	Melton	Mixed liquor
27/04/18	15.6	mg N/L	Melton	Mixed liquor
30/04/18	10.2	mg N/L	Melton	Mixed liquor
1/05/18	14.1	mg N/L	Melton	Mixed liquor
2/05/18	13.9	mg N/L	Melton	Mixed liquor
3/05/18	15.6	mg N/L	Melton	Mixed liquor
4/05/18	19.6	mg N/L	Melton	Mixed liquor
7/05/18	7.42	mg N/L	Melton	Mixed liquor
8/05/18	11.6	mg N/L	Melton	Mixed liquor
9/05/18	11.8	mg N/L	Melton	Mixed liquor
10/05/18	18.2	mg N/L	Melton	Mixed liquor
11/05/18	18.1	mg N/L	Melton	Mixed liquor
14/05/18	14.6	mg N/L	Melton	Mixed liquor
15/05/18	16.6	mg N/L	Melton	Mixed liquor
16/05/18	17.4	mg N/L	Melton	Mixed liquor
17/05/18	16.8	mg N/L	Melton	Mixed liquor
21/05/18	10.2	mg N/L	Melton	Mixed liquor
22/05/18	17.2	mg N/L	Melton	Mixed liquor
23/05/18	17.2	mg N/L	Melton	Mixed liquor
24/05/18	16.6	mg N/L	Melton	Mixed liquor
25/05/18	16.1	mg N/L	Melton	Mixed liquor
28/05/18	11.7	mg N/L	Melton	Mixed liquor
29/05/18	10.7	mg N/L	Melton	Mixed liquor
30/05/18	12.1	mg N/L	Melton	Mixed liquor
31/05/18	11.9	mg N/L	Melton	Mixed liquor
1/06/18	18.2	mg N/L	Melton	Mixed liquor
3/04/17	4	mg N/L	Melton	Effluent
4/04/17	3.29	mg N/L	Melton	Effluent
5/04/17	2.76	mg N/L	Melton	Effluent
6/04/17	4.15	mg N/L	Melton	Effluent
7/04/17	3.25	mg N/L	Melton	Effluent
10/04/17	2.26	mg N/L	Melton	Effluent
11/04/17	9.49	mg N/L	Melton	Effluent
12/04/17	9.65	mg N/L	Melton	Effluent
18/04/17	5.79	mg N/L	Melton	Effluent
19/04/17	6.17	mg N/L	Melton	Effluent
20/04/17	6.32	mg N/L	Melton	Effluent
21/04/17	6.73	mg N/L	Melton	Effluent
24/04/17	5.87	mg N/L	Melton	Effluent

26/04/17	5.96	mg N/L	Melton	Effluent
27/04/17	6.93	mg N/L	Melton	Effluent
28/04/17	7.3	mg N/L	Melton	Effluent
1/05/17	5.46	mg N/L	Melton	Effluent
2/05/17	5.18	mg N/L	Melton	Effluent
3/05/17	5.95	mg N/L	Melton	Effluent
4/05/17	6.77	mg N/L	Melton	Effluent
5/05/17	6.87	mg N/L	Melton	Effluent
8/05/17	5.52	mg N/L	Melton	Effluent
9/05/17	6.11	mg N/L	Melton	Effluent
10/05/17	4.57	mg N/L	Melton	Effluent
11/05/17	4.61	mg N/L	Melton	Effluent
15/05/17	3.46	mg N/L	Melton	Effluent
16/05/17	4.31	mg N/L	Melton	Effluent
17/05/17	3.44	mg N/L	Melton	Effluent
18/05/17	3.37	mg N/L	Melton	Effluent
19/05/17	3.94	mg N/L	Melton	Effluent
22/05/17	2.5	mg N/L	Melton	Effluent
23/05/17	2.81	mg N/L	Melton	Effluent
24/05/17	2.53	mg N/L	Melton	Effluent
25/05/17	3.21	mg N/L	Melton	Effluent
29/05/17	2.61	mg N/L	Melton	Effluent
30/05/17	4.14	mg N/L	Melton	Effluent
31/05/17	2.84	mg N/L	Melton	Effluent
1/06/17	3.96	mg N/L	Melton	Effluent
5/06/17	2.53	mg N/L	Melton	Effluent
6/06/17	2.85	mg N/L	Melton	Effluent
7/06/17	3.01	mg N/L	Melton	Effluent
8/06/17	3.68	mg N/L	Melton	Effluent
13/06/17	2.91	mg N/L	Melton	Effluent
15/06/17	1.51	mg N/L	Melton	Effluent
16/06/17	2.53	mg N/L	Melton	Effluent
19/06/17	2.48	mg N/L	Melton	Effluent
20/06/17	2.98	mg N/L	Melton	Effluent
21/06/17	2.99	mg N/L	Melton	Effluent
22/06/17	2.59	mg N/L	Melton	Effluent
23/06/17	3.43	mg N/L	Melton	Effluent
26/06/17	2.31	mg N/L	Melton	Effluent
27/06/17	4.71	mg N/L	Melton	Effluent
28/06/17	4.71	mg N/L	Melton	Effluent
29/06/17	4.33	mg N/L	Melton	Effluent
30/06/17	3.63	mg N/L	Melton	Effluent
3/07/17	3.91	mg N/L	Melton	Effluent
5/07/17	4.94	mg N/L	Melton	Effluent
6/07/17	4.73	mg N/L	Melton	Effluent
7/07/17	5.44	mg N/L	Melton	Effluent
10/07/17	6.69	mg N/L	Melton	Effluent
11/07/17	6.12	mg N/L	Melton	Effluent

12/07/17	6.97	mg N/L	Melton	Effluent
13/07/17	7.25	mg N/L	Melton	Effluent
14/07/17	6.07	mg N/L	Melton	Effluent
17/07/17	5.98	mg N/L	Melton	Effluent
18/07/17	5.99	mg N/L	Melton	Effluent
19/07/17	6.73	mg N/L	Melton	Effluent
20/07/17	5.81	mg N/L	Melton	Effluent
21/07/17	6.23	mg N/L	Melton	Effluent
24/07/17	5.78	mg N/L	Melton	Effluent
25/07/17	4.57	mg N/L	Melton	Effluent
26/07/17	5.25	mg N/L	Melton	Effluent
27/07/17	3.74	mg N/L	Melton	Effluent
31/07/17	6.35	mg N/L	Melton	Effluent
1/08/17	5.76	mg N/L	Melton	Effluent
2/08/17	6.62	mg N/L	Melton	Effluent
3/08/17	4.23	mg N/L	Melton	Effluent
4/08/17	5.39	mg N/L	Melton	Effluent
7/08/17	5.99	mg N/L	Melton	Effluent
8/08/17	9.18	mg N/L	Melton	Effluent
9/08/17	9.83	mg N/L	Melton	Effluent
10/08/17	8.43	mg N/L	Melton	Effluent
11/08/17	9.25	mg N/L	Melton	Effluent
14/08/17	9.47	mg N/L	Melton	Effluent
15/08/17	11.2	mg N/L	Melton	Effluent
16/08/17	18.5	mg N/L	Melton	Effluent
17/08/17	11.9	mg N/L	Melton	Effluent
18/08/17	17.6	mg N/L	Melton	Effluent
21/08/17	10.6	mg N/L	Melton	Effluent
22/08/17	8.41	mg N/L	Melton	Effluent
23/08/17	11.6	mg N/L	Melton	Effluent
24/08/17	10	mg N/L	Melton	Effluent
25/08/17	11.6	mg N/L	Melton	Effluent
28/08/17	9.15	mg N/L	Melton	Effluent
29/08/17	12.4	mg N/L	Melton	Effluent
30/08/17	13.4	mg N/L	Melton	Effluent
31/08/17	11.5	mg N/L	Melton	Effluent
4/09/17	13.7	mg N/L	Melton	Effluent
5/09/17	14.8	mg N/L	Melton	Effluent
8/09/17	16.1	mg N/L	Melton	Effluent
11/09/17	11.4	mg N/L	Melton	Effluent
12/09/17	12.2	mg N/L	Melton	Effluent
13/09/17	12	mg N/L	Melton	Effluent
14/09/17	10.4	mg N/L	Melton	Effluent
15/09/17	11.9	mg N/L	Melton	Effluent
18/09/17	12	mg N/L	Melton	Effluent
19/09/17	9.22	mg N/L	Melton	Effluent
20/09/17	11.9	mg N/L	Melton	Effluent
21/09/17	10	mg N/L	Melton	Effluent

22/09/17	11.3	mg N/L	Melton	Effluent
25/09/17	13.7	mg N/L	Melton	Effluent
26/09/17	11.8	mg N/L	Melton	Effluent
27/09/17	12.8	mg N/L	Melton	Effluent
28/09/17	10.9	mg N/L	Melton	Effluent
2/10/17	18	mg N/L	Melton	Effluent
3/10/17	15.5	mg N/L	Melton	Effluent
4/10/17	13.9	mg N/L	Melton	Effluent
5/10/17	12.4	mg N/L	Melton	Effluent
6/10/17	15.8	mg N/L	Melton	Effluent
9/10/17	14	mg N/L	Melton	Effluent
10/10/17	11.2	mg N/L	Melton	Effluent
11/10/17	10.5	mg N/L	Melton	Effluent
12/10/17	12.6	mg N/L	Melton	Effluent
13/10/17	13	mg N/L	Melton	Effluent
16/10/17	9.15	mg N/L	Melton	Effluent
17/10/17	9.64	mg N/L	Melton	Effluent
18/10/17	9.49	mg N/L	Melton	Effluent
19/10/17	10.6	mg N/L	Melton	Effluent
20/10/17	11.3	mg N/L	Melton	Effluent
23/10/17	9.4	mg N/L	Melton	Effluent
24/10/17	11.2	mg N/L	Melton	Effluent
25/10/17	10.7	mg N/L	Melton	Effluent
26/10/17	11.4	mg N/L	Melton	Effluent
30/10/17	13.1	mg N/L	Melton	Effluent
31/10/17	16	mg N/L	Melton	Effluent
1/11/17	15.3	mg N/L	Melton	Effluent
2/11/17	15.5	mg N/L	Melton	Effluent
3/11/17	16.8	mg N/L	Melton	Effluent
6/11/17	14.2	mg N/L	Melton	Effluent
8/11/17	14.4	mg N/L	Melton	Effluent
9/11/17	14.5	mg N/L	Melton	Effluent
10/11/17	13.5	mg N/L	Melton	Effluent
13/11/17	13.1	mg N/L	Melton	Effluent
14/11/17	11.7	mg N/L	Melton	Effluent
15/11/17	9.34	mg N/L	Melton	Effluent
16/11/17	12.2	mg N/L	Melton	Effluent
17/11/17	13.4	mg N/L	Melton	Effluent
20/11/17	10.4	mg N/L	Melton	Effluent
21/11/17	13.4	mg N/L	Melton	Effluent
22/11/17	13.5	mg N/L	Melton	Effluent
23/11/17	9.4	mg N/L	Melton	Effluent
24/11/17	7.49	mg N/L	Melton	Effluent
27/11/17	9.98	mg N/L	Melton	Effluent
28/11/17	12	mg N/L	Melton	Effluent
29/11/17	13	mg N/L	Melton	Effluent
30/11/17	13.2	mg N/L	Melton	Effluent
1/12/17	14.8	mg N/L	Melton	Effluent

4/12/17	9.85	mg N/L	Melton	Effluent
5/12/17	11.8	mg N/L	Melton	Effluent
6/12/17	12.1	mg N/L	Melton	Effluent
7/12/17	12.3	mg N/L	Melton	Effluent
11/12/17	10.8	mg N/L	Melton	Effluent
12/12/17	11.6	mg N/L	Melton	Effluent
14/12/17	12.2	mg N/L	Melton	Effluent
15/12/17	9.42	mg N/L	Melton	Effluent
18/12/17	9.55	mg N/L	Melton	Effluent
19/12/17	9.31	mg N/L	Melton	Effluent
20/12/17	7.8	mg N/L	Melton	Effluent
21/12/17	9.52	mg N/L	Melton	Effluent
22/12/17	9.26	mg N/L	Melton	Effluent
8/01/18	14.3	mg N/L	Melton	Effluent
9/01/18	16.6	mg N/L	Melton	Effluent
10/01/18	17	mg N/L	Melton	Effluent
11/01/18	16.2	mg N/L	Melton	Effluent
12/01/18	17.4	mg N/L	Melton	Effluent
15/01/18	16.6	mg N/L	Melton	Effluent
16/01/18	19	mg N/L	Melton	Effluent
17/01/18	15.3	mg N/L	Melton	Effluent
18/01/18	15.9	mg N/L	Melton	Effluent
19/01/18	15.9	mg N/L	Melton	Effluent
22/01/18	19.7	mg N/L	Melton	Effluent
23/01/18	19.3	mg N/L	Melton	Effluent
24/01/18	17.6	mg N/L	Melton	Effluent
25/01/18	16.9	mg N/L	Melton	Effluent
29/01/18	20	mg N/L	Melton	Effluent
30/01/18	8.4	mg N/L	Melton	Effluent
31/01/18	14.1	mg N/L	Melton	Effluent
1/02/18	15.1	mg N/L	Melton	Effluent
2/02/18	14.2	mg N/L	Melton	Effluent
5/02/18	15	mg N/L	Melton	Effluent
6/02/18	16.2	mg N/L	Melton	Effluent
7/02/18	17.3	mg N/L	Melton	Effluent
8/02/18	11.2	mg N/L	Melton	Effluent
9/02/18	12.7	mg N/L	Melton	Effluent
12/02/18	10.3	mg N/L	Melton	Effluent
13/02/18	8.4	mg N/L	Melton	Effluent
15/02/18	7.54	mg N/L	Melton	Effluent
16/02/18	5.28	mg N/L	Melton	Effluent
19/02/18	6.82	mg N/L	Melton	Effluent
20/02/18	7.84	mg N/L	Melton	Effluent
21/02/18	6.96	mg N/L	Melton	Effluent
22/02/18	7.61	mg N/L	Melton	Effluent
23/02/18	7.35	mg N/L	Melton	Effluent
26/02/18	7.76	mg N/L	Melton	Effluent
27/02/18	8.82	mg N/L	Melton	Effluent

28/02/18	13.2	mg N/L	Melton	Effluent
1/03/18	9.15	mg N/L	Melton	Effluent
2/03/18	14.8	mg N/L	Melton	Effluent
5/03/18	10.5	mg N/L	Melton	Effluent
6/03/18	13	mg N/L	Melton	Effluent
7/03/18	11.9	mg N/L	Melton	Effluent
8/03/18	12.4	mg N/L	Melton	Effluent
9/03/18	10.2	mg N/L	Melton	Effluent
13/03/18	12.3	mg N/L	Melton	Effluent
14/03/18	12.7	mg N/L	Melton	Effluent
15/03/18	12	mg N/L	Melton	Effluent
16/03/18	11.7	mg N/L	Melton	Effluent
19/03/18	12	mg N/L	Melton	Effluent
20/03/18	11.6	mg N/L	Melton	Effluent
21/03/18	12.7	mg N/L	Melton	Effluent
22/03/18	13.1	mg N/L	Melton	Effluent
23/03/18	11.7	mg N/L	Melton	Effluent
26/03/18	7.56	mg N/L	Melton	Effluent
27/03/18	11.7	mg N/L	Melton	Effluent
28/03/18	11.6	mg N/L	Melton	Effluent
29/03/18	12.1	mg N/L	Melton	Effluent
3/04/18	11.9	mg N/L	Melton	Effluent
4/04/18	11.4	mg N/L	Melton	Effluent
5/04/18	12.9	mg N/L	Melton	Effluent
6/04/18	14.9	mg N/L	Melton	Effluent
9/04/18	11.6	mg N/L	Melton	Effluent
10/04/18	13	mg N/L	Melton	Effluent
12/04/18	9.4	mg N/L	Melton	Effluent
16/04/18	14.5	mg N/L	Melton	Effluent
17/04/18	16	mg N/L	Melton	Effluent
18/04/18	15.3	mg N/L	Melton	Effluent
19/04/18	11.5	mg N/L	Melton	Effluent
20/04/18	12.2	mg N/L	Melton	Effluent
23/04/18	13.3	mg N/L	Melton	Effluent
24/04/18	14.5	mg N/L	Melton	Effluent
26/04/18	13.3	mg N/L	Melton	Effluent
27/04/18	15.1	mg N/L	Melton	Effluent
30/04/18	14.7	mg N/L	Melton	Effluent
1/05/18	14.6	mg N/L	Melton	Effluent
2/05/18	13.4	mg N/L	Melton	Effluent
3/05/18	12.4	mg N/L	Melton	Effluent
4/05/18	14.9	mg N/L	Melton	Effluent
7/05/18	10.6	mg N/L	Melton	Effluent
8/05/18	11.9	mg N/L	Melton	Effluent
9/05/18	12.9	mg N/L	Melton	Effluent
10/05/18	15.6	mg N/L	Melton	Effluent
11/05/18	12.4	mg N/L	Melton	Effluent
14/05/18	16.2	mg N/L	Melton	Effluent

15/05/18	15.3	mg N/L	Melton	Effluent
16/05/18	17.8	mg N/L	Melton	Effluent
17/05/18	18.1	mg N/L	Melton	Effluent
21/05/18	13.2	mg N/L	Melton	Effluent
22/05/18	17.2	mg N/L	Melton	Effluent
23/05/18	17	mg N/L	Melton	Effluent
24/05/18	15.9	mg N/L	Melton	Effluent
25/05/18	16.6	mg N/L	Melton	Effluent
28/05/18	13.7	mg N/L	Melton	Effluent
29/05/18	10.8	mg N/L	Melton	Effluent
30/05/18	13	mg N/L	Melton	Effluent
31/05/18	15.8	mg N/L	Melton	Effluent
1/06/18	18.9	mg N/L	Melton	Effluent

pH

7/04/17	7.52	units	Melton	Influent
12/04/17	7.92	units	Melton	Influent
20/04/17	7.79	units	Melton	Influent
27/04/17	7.79	units	Melton	Influent
3/05/17	7.92	units	Melton	Influent
11/05/17	7.9	units	Melton	Influent
17/05/17	8.21	units	Melton	Influent
25/05/17	7.94	units	Melton	Influent
1/06/17	7.94	units	Melton	Influent
15/06/17	7.59	units	Melton	Influent
16/06/17	7.59	units	Melton	Influent
23/06/17	8.13	units	Melton	Influent
28/06/17	7.81	units	Melton	Influent
5/07/17	7.94	units	Melton	Influent
10/07/17	7.98	units	Melton	Influent
21/07/17	7.53	units	Melton	Influent
10/08/17	7.83	units	Melton	Influent
17/08/17	8.11	units	Melton	Influent
23/08/17	7.56	units	Melton	Influent
1/09/17	8.49	units	Melton	Influent
8/09/17	7.76	units	Melton	Influent
14/09/17	8.16	units	Melton	Influent
20/09/17	7.54	units	Melton	Influent
28/09/17	7.87	units	Melton	Influent
4/10/17	7.77	units	Melton	Influent
13/10/17	7.66	units	Melton	Influent
20/10/17	8.25	units	Melton	Influent
26/10/17	8.07	units	Melton	Influent
2/11/17	7.96	units	Melton	Influent
10/11/17	7.91	units	Melton	Influent
16/11/17	8.03	units	Melton	Influent
23/11/17	8.01	units	Melton	Influent
30/11/17	8.01	units	Melton	Influent
7/12/17	7.73	units	Melton	Influent

14/12/17	8.01	units	Melton	Influent
21/12/17	8.12	units	Melton	Influent
12/01/18	7.46	units	Melton	Influent
18/01/18	7.58	units	Melton	Influent
25/01/18	7.73	units	Melton	Influent
25/01/18	7.73	units	Melton	Influent
2/02/18	8.14	units	Melton	Influent
8/02/18	7.9	units	Melton	Influent
16/02/18	8.04	units	Melton	Influent
23/02/18	7.93	units	Melton	Influent
2/03/18	7.74	units	Melton	Influent
9/03/18	7.92	units	Melton	Influent
15/03/18	7.97	units	Melton	Influent
23/03/18	7.49	units	Melton	Influent
29/03/18	7.62	units	Melton	Influent
5/04/18	7.6	units	Melton	Influent
11/04/18	7.5	units	Melton	Influent
20/04/18	7.86	units	Melton	Influent
26/04/18	8.01	units	Melton	Influent
3/05/18	7.81	units	Melton	Influent
10/05/18	7.78	units	Melton	Influent
25/05/18	8.16	units	Melton	Influent
31/05/18	8.11	units	Melton	Influent
3/04/17	6.83	units	Melton	Mixed liquor
10/04/17	6.67	units	Melton	Mixed liquor
18/04/17	6.73	units	Melton	Mixed liquor
24/04/17	6.95	units	Melton	Mixed liquor
1/05/17	6.86	units	Melton	Mixed liquor
8/05/17	6.99	units	Melton	Mixed liquor
15/05/17	6.71	units	Melton	Mixed liquor
22/05/17	7.01	units	Melton	Mixed liquor
29/05/17	6.84	units	Melton	Mixed liquor
5/06/17	6.69	units	Melton	Mixed liquor
13/06/17	6.52	units	Melton	Mixed liquor
19/06/17	6.88	units	Melton	Mixed liquor
26/06/17	6.9	units	Melton	Mixed liquor
3/07/17	6.65	units	Melton	Mixed liquor
10/07/17	6.63	units	Melton	Mixed liquor
17/07/17	6.76	units	Melton	Mixed liquor
24/07/17	6.74	units	Melton	Mixed liquor
3/08/17	6.33	units	Melton	Mixed liquor
7/08/17	6.3	units	Melton	Mixed liquor
14/08/17	7.12	units	Melton	Mixed liquor
21/08/17	6.52	units	Melton	Mixed liquor
28/08/17	6.42	units	Melton	Mixed liquor
4/09/17	6.52	units	Melton	Mixed liquor
11/09/17	6.77	units	Melton	Mixed liquor
18/09/17	6.72	units	Melton	Mixed liquor

25/09/17	6.65	units	Melton	Mixed liquor
2/10/17	6.61	units	Melton	Mixed liquor
9/10/17	6.42	units	Melton	Mixed liquor
16/10/17	6.84	units	Melton	Mixed liquor
23/10/17	6.7	units	Melton	Mixed liquor
30/10/17	6.91	units	Melton	Mixed liquor
6/11/17	6.61	units	Melton	Mixed liquor
13/11/17	6.74	units	Melton	Mixed liquor
20/11/17	6.65	units	Melton	Mixed liquor
27/11/17	6.67	units	Melton	Mixed liquor
4/12/17	6.63	units	Melton	Mixed liquor
11/12/17	6.62	units	Melton	Mixed liquor
20/12/17	6.66	units	Melton	Mixed liquor
12/01/18	6.5	units	Melton	Mixed liquor
17/01/18	6.61	units	Melton	Mixed liquor
22/01/18	6.2	units	Melton	Mixed liquor
29/01/18	6.15	units	Melton	Mixed liquor
5/02/18	6.59	units	Melton	Mixed liquor
12/02/18	6.8	units	Melton	Mixed liquor
19/02/18	6.72	units	Melton	Mixed liquor
26/02/18	6.52	units	Melton	Mixed liquor
5/03/18	6.43	units	Melton	Mixed liquor
14/03/18	6.4	units	Melton	Mixed liquor
20/03/18	6.79	units	Melton	Mixed liquor
26/03/18	6.72	units	Melton	Mixed liquor
3/04/18	6.53	units	Melton	Mixed liquor
9/04/18	6.6	units	Melton	Mixed liquor
17/04/18	6.12	units	Melton	Mixed liquor
23/04/18	6.4	units	Melton	Mixed liquor
30/04/18	6.5	units	Melton	Mixed liquor
7/05/18	6.71	units	Melton	Mixed liquor
14/05/18	6.53	units	Melton	Mixed liquor
21/05/18	6.68	units	Melton	Mixed liquor
28/05/18	6.25	units	Melton	Mixed liquor
3/04/17	7.05	units	Melton	Effluent
4/04/17	7.06	units	Melton	Effluent
5/04/17	6.98	units	Melton	Effluent
6/04/17	6.88	units	Melton	Effluent
7/04/17	7.01	units	Melton	Effluent
10/04/17	7.14	units	Melton	Effluent
11/04/17	7.2	units	Melton	Effluent
12/04/17	7.1	units	Melton	Effluent
18/04/17	6.91	units	Melton	Effluent
19/04/17	6.85	units	Melton	Effluent
20/04/17	7.09	units	Melton	Effluent
21/04/17	6.91	units	Melton	Effluent
24/04/17	6.82	units	Melton	Effluent
26/04/17	7.17	units	Melton	Effluent

27/04/17	7.07	units	Melton	Effluent
28/04/17	6.92	units	Melton	Effluent
1/05/17	7.18	units	Melton	Effluent
2/05/17	7.06	units	Melton	Effluent
3/05/17	6.95	units	Melton	Effluent
4/05/17	6.97	units	Melton	Effluent
5/05/17	6.98	units	Melton	Effluent
8/05/17	7.15	units	Melton	Effluent
9/05/17	6.9	units	Melton	Effluent
10/05/17	7.09	units	Melton	Effluent
11/05/17	7.1	units	Melton	Effluent
15/05/17	6.91	units	Melton	Effluent
16/05/17	6.83	units	Melton	Effluent
17/05/17	7.12	units	Melton	Effluent
18/05/17	6.85	units	Melton	Effluent
19/05/17	6.98	units	Melton	Effluent
22/05/17	7.04	units	Melton	Effluent
23/05/17	6.92	units	Melton	Effluent
24/05/17	6.91	units	Melton	Effluent
25/05/17	6.86	units	Melton	Effluent
29/05/17	7.07	units	Melton	Effluent
30/05/17	6.94	units	Melton	Effluent
31/05/17	7.02	units	Melton	Effluent
1/06/17	6.85	units	Melton	Effluent
5/06/17	7.12	units	Melton	Effluent
6/06/17	7.19	units	Melton	Effluent
7/06/17	6.94	units	Melton	Effluent
8/06/17	6.87	units	Melton	Effluent
13/06/17	7.03	units	Melton	Effluent
15/06/17	7.25	units	Melton	Effluent
16/06/17	6.99	units	Melton	Effluent
19/06/17	7.22	units	Melton	Effluent
20/06/17	7.64	units	Melton	Effluent
21/06/17	7.33	units	Melton	Effluent
22/06/17	7.27	units	Melton	Effluent
23/06/17	7.23	units	Melton	Effluent
26/06/17	7.19	units	Melton	Effluent
27/06/17	7.14	units	Melton	Effluent
28/06/17	7.02	units	Melton	Effluent
29/06/17	7.16	units	Melton	Effluent
30/06/17	7.21	units	Melton	Effluent
3/07/17	7.09	units	Melton	Effluent
4/07/17	7.14	units	Melton	Effluent
5/07/17	7.16	units	Melton	Effluent
6/07/17	7.17	units	Melton	Effluent
7/07/17	7.18	units	Melton	Effluent
10/07/17	6.71	units	Melton	Effluent
11/07/17	6.98	units	Melton	Effluent

12/07/17	7.18	units	Melton	Effluent
13/07/17	6.91	units	Melton	Effluent
14/07/17	7.06	units	Melton	Effluent
17/07/17	6.94	units	Melton	Effluent
18/07/17	6.97	units	Melton	Effluent
19/07/17	7.07	units	Melton	Effluent
20/07/17	7.06	units	Melton	Effluent
21/07/17	7.05	units	Melton	Effluent
24/07/17	6.97	units	Melton	Effluent
25/07/17	7.29	units	Melton	Effluent
26/07/17	7.24	units	Melton	Effluent
27/07/17	7.24	units	Melton	Effluent
31/07/17	6.74	units	Melton	Effluent
2/08/17	7.05	units	Melton	Effluent
3/08/17	6.9	units	Melton	Effluent
4/08/17	6.85	units	Melton	Effluent
5/08/17	6.96	units	Melton	Effluent
6/08/17	6.98	units	Melton	Effluent
7/08/17	6.89	units	Melton	Effluent
8/08/17	6.79	units	Melton	Effluent
9/08/17	6.88	units	Melton	Effluent
10/08/17	6.92	units	Melton	Effluent
11/08/17	6.82	units	Melton	Effluent
14/08/17	7.38	units	Melton	Effluent
15/08/17	7.16	units	Melton	Effluent
16/08/17	6.96	units	Melton	Effluent
17/08/17	7.09	units	Melton	Effluent
18/08/17	6.83	units	Melton	Effluent
19/08/17	6.8	units	Melton	Effluent
21/08/17	6.72	units	Melton	Effluent
22/08/17	6.74	units	Melton	Effluent
23/08/17	6.75	units	Melton	Effluent
24/08/17	6.94	units	Melton	Effluent
25/08/17	6.94	units	Melton	Effluent
26/08/17	6.57	units	Melton	Effluent
27/08/17	6.76	units	Melton	Effluent
28/08/17	6.61	units	Melton	Effluent
29/08/17	6.58	units	Melton	Effluent
30/08/17	6.82	units	Melton	Effluent
31/08/17	6.71	units	Melton	Effluent
1/09/17	6.55	units	Melton	Effluent
4/09/17	6.51	units	Melton	Effluent
5/09/17	6.51	units	Melton	Effluent
6/09/17	6.56	units	Melton	Effluent
8/09/17	6.56	units	Melton	Effluent
11/09/17	6.76	units	Melton	Effluent
12/09/17	6.85	units	Melton	Effluent
13/09/17	7.03	units	Melton	Effluent

14/09/17	6.96	units	Melton	Effluent
15/09/17	6.62	units	Melton	Effluent
18/09/17	6.79	units	Melton	Effluent
19/09/17	6.9	units	Melton	Effluent
20/09/17	6.8	units	Melton	Effluent
21/09/17	6.95	units	Melton	Effluent
22/09/17	6.78	units	Melton	Effluent
25/09/17	6.97	units	Melton	Effluent
26/09/17	6.96	units	Melton	Effluent
27/09/17	6.69	units	Melton	Effluent
28/09/17	6.8	units	Melton	Effluent
3/10/17	6.9	units	Melton	Effluent
4/10/17	6.83	units	Melton	Effluent
5/10/17	6.71	units	Melton	Effluent
6/10/17	6.63	units	Melton	Effluent
9/10/17	6.91	units	Melton	Effluent
10/10/17	6.72	units	Melton	Effluent
11/10/17	6.63	units	Melton	Effluent
12/10/17	6.93	units	Melton	Effluent
13/10/17	6.59	units	Melton	Effluent
16/10/17	6.97	units	Melton	Effluent
18/10/17	7.01	units	Melton	Effluent
19/10/17	7.12	units	Melton	Effluent
20/10/17	6.96	units	Melton	Effluent
23/10/17	6.9	units	Melton	Effluent
24/10/17	6.63	units	Melton	Effluent
25/10/17	6.74	units	Melton	Effluent
26/10/17	6.68	units	Melton	Effluent
30/10/17	6.97	units	Melton	Effluent
31/10/17	6.81	units	Melton	Effluent
1/11/17	6.54	units	Melton	Effluent
2/11/17	6.78	units	Melton	Effluent
3/11/17	6.58	units	Melton	Effluent
6/11/17	7.05	units	Melton	Effluent
9/11/17	6.77	units	Melton	Effluent
10/11/17	6.79	units	Melton	Effluent
13/11/17	6.71	units	Melton	Effluent
14/11/17	6.75	units	Melton	Effluent
15/11/17	6.86	units	Melton	Effluent
16/11/17	6.85	units	Melton	Effluent
17/11/17	6.58	units	Melton	Effluent
20/11/17	6.84	units	Melton	Effluent
21/11/17	6.85	units	Melton	Effluent
22/11/17	6.92	units	Melton	Effluent
23/11/17	6.73	units	Melton	Effluent
24/11/17	6.81	units	Melton	Effluent
27/11/17	7.1	units	Melton	Effluent
28/11/17	6.9	units	Melton	Effluent

29/11/17	6.84	units	Melton	Effluent
30/11/17	6.59	units	Melton	Effluent
1/12/17	6.73	units	Melton	Effluent
4/12/17	6.97	units	Melton	Effluent
5/12/17	6.79	units	Melton	Effluent
6/12/17	6.75	units	Melton	Effluent
7/12/17	6.62	units	Melton	Effluent
11/12/17	6.95	units	Melton	Effluent
12/12/17	6.74	units	Melton	Effluent
14/12/17	6.87	units	Melton	Effluent
15/12/17	6.68	units	Melton	Effluent
18/12/17	6.64	units	Melton	Effluent
20/12/17	6.82	units	Melton	Effluent
21/12/17	6.85	units	Melton	Effluent
22/12/17	6.67	units	Melton	Effluent
8/01/18	6.54	units	Melton	Effluent
11/01/18	6.5	units	Melton	Effluent
12/01/18	6.5	units	Melton	Effluent
15/01/18	6.67	units	Melton	Effluent
16/01/18	6.5	units	Melton	Effluent
17/01/18	6.79	units	Melton	Effluent
18/01/18	6.53	units	Melton	Effluent
19/01/18	6.47	units	Melton	Effluent
22/01/18	6.57	units	Melton	Effluent
23/01/18	6.67	units	Melton	Effluent
24/01/18	6.5	units	Melton	Effluent
25/01/18	6.5	units	Melton	Effluent
29/01/18	6.8	units	Melton	Effluent
30/01/18	6.8	units	Melton	Effluent
31/01/18	6.82	units	Melton	Effluent
1/02/18	6.98	units	Melton	Effluent
2/02/18	6.92	units	Melton	Effluent
5/02/18	6.96	units	Melton	Effluent
6/02/18	6.8	units	Melton	Effluent
7/02/18	6.96	units	Melton	Effluent
8/02/18	7.01	units	Melton	Effluent
9/02/18	6.86	units	Melton	Effluent
12/02/18	7.02	units	Melton	Effluent
13/02/18	7.19	units	Melton	Effluent
15/02/18	7.06	units	Melton	Effluent
16/02/18	7	units	Melton	Effluent
19/02/18	7.05	units	Melton	Effluent
20/02/18	6.81	units	Melton	Effluent
21/02/18	7.11	units	Melton	Effluent
22/02/18	7.07	units	Melton	Effluent
23/02/18	7.11	units	Melton	Effluent
26/02/18	7.11	units	Melton	Effluent
27/02/18	7.01	units	Melton	Effluent

28/02/18	7.17	units	Melton	Effluent
1/03/18	7.03	units	Melton	Effluent
2/03/18	6.8	units	Melton	Effluent
5/03/18	6.94	units	Melton	Effluent
6/03/18	6.57	units	Melton	Effluent
7/03/18	6.81	units	Melton	Effluent
8/03/18	6.7	units	Melton	Effluent
9/03/18	6.64	units	Melton	Effluent
13/03/18	6.51	units	Melton	Effluent
14/03/18	6.69	units	Melton	Effluent
15/03/18	7	units	Melton	Effluent
16/03/18	6.88	units	Melton	Effluent
19/03/18	6.65	units	Melton	Effluent
20/03/18	6.54	units	Melton	Effluent
21/03/18	7.54	units	Melton	Effluent
22/03/18	6.76	units	Melton	Effluent
23/03/18	6.85	units	Melton	Effluent
26/03/18	6.84	units	Melton	Effluent
27/03/18	6.82	units	Melton	Effluent
28/03/18	6.8	units	Melton	Effluent
29/03/18	6.7	units	Melton	Effluent
3/04/18	6.53	units	Melton	Effluent
4/04/18	6.56	units	Melton	Effluent
5/04/18	6.54	units	Melton	Effluent
6/04/18	6.57	units	Melton	Effluent
9/04/18	6.67	units	Melton	Effluent
10/04/18	6.76	units	Melton	Effluent
11/04/18	6.52	units	Melton	Effluent
12/04/18	6.68	units	Melton	Effluent
16/04/18	6.45	units	Melton	Effluent
17/04/18	6.22	units	Melton	Effluent
18/04/18	6.61	units	Melton	Effluent
19/04/18	6.81	units	Melton	Effluent
20/04/18	6.7	units	Melton	Effluent
23/04/18	6.3	units	Melton	Effluent
24/04/18	6.41	units	Melton	Effluent
26/04/18	6.61	units	Melton	Effluent
27/04/18	6.77	units	Melton	Effluent
30/04/18	6.62	units	Melton	Effluent
1/05/18	6.58	units	Melton	Effluent
2/05/18	6.7	units	Melton	Effluent
3/05/18	6.89	units	Melton	Effluent
4/05/18	7.68	units	Melton	Effluent
7/05/18	6.58	units	Melton	Effluent
8/05/18	6.8	units	Melton	Effluent
9/05/18	6.6	units	Melton	Effluent
10/05/18	6.71	units	Melton	Effluent
11/05/18	6.56	units	Melton	Effluent

14/05/18	6.59	units	Melton	Effluent
15/05/18	6.57	units	Melton	Effluent
16/05/18	6.54	units	Melton	Effluent
17/05/18	6.57	units	Melton	Effluent
21/05/18	6.8	units	Melton	Effluent
22/05/18	6.77	units	Melton	Effluent
23/05/18	6.64	units	Melton	Effluent
24/05/18	6.55	units	Melton	Effluent
25/05/18	6.5	units	Melton	Effluent
28/05/18	6.5	units	Melton	Effluent
29/05/18	6.54	units	Melton	Effluent
30/05/18	6.56	units	Melton	Effluent
31/05/18	6.59	units	Melton	Effluent
1/06/18	6.54	units	Melton	Effluent
4/04/17	7.96	units	Gisborne	Influent
18/04/17	7.56	units	Gisborne	Influent
24/04/17	7.56	units	Gisborne	Influent
3/05/17	7.85	units	Gisborne	Influent
9/05/17	8.23	units	Gisborne	Influent
15/05/17	8.26	units	Gisborne	Influent
23/05/17	7.53	units	Gisborne	Influent
30/05/17	8.05	units	Gisborne	Influent
6/06/17	7.9	units	Gisborne	Influent
13/06/17	7.7	units	Gisborne	Influent
19/06/17	8.22	units	Gisborne	Influent
27/06/17	8.05	units	Gisborne	Influent
3/07/17	8.04	units	Gisborne	Influent
24/07/17	7.93	units	Gisborne	Influent
31/07/17	7.96	units	Gisborne	Influent
8/08/17	7.97	units	Gisborne	Influent
15/08/17	7.86	units	Gisborne	Influent
29/08/17	8.09	units	Gisborne	Influent
5/09/17	7.93	units	Gisborne	Influent
12/09/17	7.33	units	Gisborne	Influent
18/09/17	7.82	units	Gisborne	Influent
26/09/17	8.05	units	Gisborne	Influent
3/10/17	7.81	units	Gisborne	Influent
10/10/17	7.62	units	Gisborne	Influent
17/10/17	8.3	units	Gisborne	Influent
24/10/17	7.3	units	Gisborne	Influent
31/10/17	7.28	units	Gisborne	Influent
13/11/17	7.76	units	Gisborne	Influent
20/11/17	7.66	units	Gisborne	Influent
5/12/17	7.16	units	Gisborne	Influent
12/12/17	7.34	units	Gisborne	Influent
9/01/18	7.57	units	Gisborne	Influent
15/01/18	7.66	units	Gisborne	Influent
23/01/18	7.45	units	Gisborne	Influent

29/01/18	7.59	units	Gisborne	Influent
6/02/18	7.72	units	Gisborne	Influent
13/02/18	8.04	units	Gisborne	Influent
19/02/18	8.23	units	Gisborne	Influent
28/02/18	7.74	units	Gisborne	Influent
6/03/18	7.89	units	Gisborne	Influent
20/03/18	7.69	units	Gisborne	Influent
27/03/18	8.02	units	Gisborne	Influent
Phosphorous				
3/05/17	12.6	mg/L	Melton	Influent
15/06/17	11.6	mg/L	Melton	Influent
10/07/17	12.1	mg/L	Melton	Influent
17/08/17	17.6	mg/L	Melton	Influent
20/09/17	11.7	mg/L	Melton	Influent
13/10/17	11	mg/L	Melton	Influent
13/10/17	11	mg/L	Melton	Influent
16/11/17	12.9	mg/L	Melton	Influent
14/12/17	14.1	mg/L	Melton	Influent
18/01/18	15.9	mg/L	Melton	Influent
23/02/18	13.7	mg/L	Melton	Influent
29/03/18	10.7	mg/L	Melton	Influent
26/04/18	12.2	mg/L	Melton	Influent
30/05/18	13.6	mg/L	Melton	Influent
3/04/17	9.6	mg/L	Melton	Effluent
10/04/17	4.7	mg/L	Melton	Effluent
18/04/17	7.9	mg/L	Melton	Effluent
24/04/17	3.3	mg/L	Melton	Effluent
2/05/17	3.1	mg/L	Melton	Effluent
10/05/17	5	mg/L	Melton	Effluent
17/05/17	9	mg/L	Melton	Effluent
22/05/17	9.5	mg/L	Melton	Effluent
5/06/17	10.2	mg/L	Melton	Effluent
19/06/17	9.3	mg/L	Melton	Effluent
26/06/17	7.3	mg/L	Melton	Effluent
3/07/17	3.91	mg/L	Melton	Effluent
10/07/17	3.8	mg/L	Melton	Effluent
18/07/17	6.4	mg/L	Melton	Effluent
24/07/17	7.3	mg/L	Melton	Effluent
31/07/17	7.9	mg/L	Melton	Effluent
7/08/17	9.1	mg/L	Melton	Effluent
14/08/17	8.2	mg/L	Melton	Effluent
21/08/17	6.4	mg/L	Melton	Effluent
28/08/17	5.7	mg/L	Melton	Effluent
4/09/17	5.9	mg/L	Melton	Effluent
11/09/17	5.28	mg/L	Melton	Effluent
26/09/17	3.6	mg/L	Melton	Effluent
4/10/17	5.4	mg/L	Melton	Effluent
10/10/17	6.6	mg/L	Melton	Effluent

17/10/17	7.3	mg/L	Melton	Effluent
25/10/17	7.7	mg/L	Melton	Effluent
3/11/17	7.8	mg/L	Melton	Effluent
6/11/17	7.7	mg/L	Melton	Effluent
16/11/17	5.6	mg/L	Melton	Effluent
20/11/17	6.3	mg/L	Melton	Effluent
27/11/17	5.4	mg/L	Melton	Effluent
4/12/17	5.3	mg/L	Melton	Effluent
11/12/17	6.1	mg/L	Melton	Effluent
18/12/17	7.6	mg/L	Melton	Effluent
8/01/18	8.3	mg/L	Melton	Effluent
15/01/18	8.4	mg/L	Melton	Effluent
25/01/18	10	mg/L	Melton	Effluent
29/01/18	9.7	mg/L	Melton	Effluent
5/02/18	8	mg/L	Melton	Effluent
12/02/18	5.5	mg/L	Melton	Effluent
19/02/18	4.8	mg/L	Melton	Effluent
5/03/18	5.9	mg/L	Melton	Effluent
17/03/18	6.9	mg/L	Melton	Effluent
19/03/18	6.9	mg/L	Melton	Effluent
26/03/18	6	mg/L	Melton	Effluent
3/04/18	8.4	mg/L	Melton	Effluent
12/04/18	8.1	mg/L	Melton	Effluent
19/04/18	8.2	mg/L	Melton	Effluent
23/04/18	7.5	mg/L	Melton	Effluent
30/04/18	7.9	mg/L	Melton	Effluent
7/05/18	5	mg/L	Melton	Effluent
14/05/18	6.4	mg/L	Melton	Effluent
21/05/18	7	mg/L	Melton	Effluent
28/05/18	6.9	mg/L	Melton	Effluent

2.3 Operational data for the Gisborne wastewater treatment plant

Parameter	**Result Date**	**Result**	**Unit**	**Plant**	**Water type**
%vss	4/04/17	87	%	Gisborne	Influent
	18/04/17	75	%	Gisborne	Influent
	24/04/17	83	%	Gisborne	Influent
	2/05/17	87	%	Gisborne	Influent
	9/05/17	85	%	Gisborne	Influent
	15/05/17	80	%	Gisborne	Influent

23/05/17		67	%	Gisborne	Influent
30/05/17		78	%	Gisborne	Influent
6/06/17		83	%	Gisborne	Influent
14/06/17		76	%	Gisborne	Influent
19/06/17		83	%	Gisborne	Influent
27/06/17		88	%	Gisborne	Influent
3/07/17		80	%	Gisborne	Influent
24/07/17		82	%	Gisborne	Influent
31/07/17		88	%	Gisborne	Influent
8/08/17		91	%	Gisborne	Influent
15/08/17		88	%	Gisborne	Influent
29/08/17		88	%	Gisborne	Influent
8/09/17		88	%	Gisborne	Influent
12/09/17		90	%	Gisborne	Influent
18/09/17		77	%	Gisborne	Influent
26/09/17		83	%	Gisborne	Influent
3/10/17		87	%	Gisborne	Influent
10/10/17		80	%	Gisborne	Influent
17/10/17		86	%	Gisborne	Influent
24/10/17		97	%	Gisborne	Influent
31/10/17		92	%	Gisborne	Influent
13/11/17		88	%	Gisborne	Influent
20/11/17		82	%	Gisborne	Influent
5/12/17		76	%	Gisborne	Influent
14/12/17		88	%	Gisborne	Influent
11/01/18		86	%	Gisborne	Influent
16/01/18		93	%	Gisborne	Influent
23/01/18		94	%	Gisborne	Influent
29/01/18		89	%	Gisborne	Influent
6/02/18		91	%	Gisborne	Influent
15/02/18		92	%	Gisborne	Influent
21/02/18		96	%	Gisborne	Influent
28/02/18		97	%	Gisborne	Influent
7/03/18		90	%	Gisborne	Influent
20/03/18		93	%	Gisborne	Influent
16/01/18	71		%	Gisborne	Mixed liquor
23/01/18	72		%	Gisborne	Mixed liquor
29/01/18	71		%	Gisborne	Mixed liquor
6/02/18	68		%	Gisborne	Mixed liquor
15/02/18	71		%	Gisborne	Mixed liquor
21/02/18	72		%	Gisborne	Mixed liquor
7/03/18	70		%	Gisborne	Mixed liquor

	19/03/18	74	%	Gisborne	Mixed liquor
	28/03/18	69	%	Gisborne	Mixed liquor
	17/04/18	73	%	Gisborne	Mixed liquor
	1/05/18	73	%	Gisborne	Mixed liquor
	10/05/18	73	%	Gisborne	Mixed liquor
Alkalinity, Total as CaCO3	28/03/18	94	%	Gisborne	Influent
	4/04/17	320	mg/L	Gisborne	Influent
	18/04/17	270	mg/L	Gisborne	Influent
	24/04/17	290	mg/L	Gisborne	Influent
	2/05/17	205	mg/L	Gisborne	Influent
	9/05/17	320	mg/L	Gisborne	Influent
	15/05/17	360	mg/L	Gisborne	Influent
	23/05/17	210	mg/L	Gisborne	Influent
	30/05/17	285	mg/L	Gisborne	Influent
	6/06/17	230	mg/L	Gisborne	Influent
	13/06/17	280	mg/L	Gisborne	Influent
	19/06/17	330	mg/L	Gisborne	Influent
	27/06/17	300	mg/L	Gisborne	Influent
	3/07/17	200	mg/L	Gisborne	Influent
	24/07/17	250	mg/L	Gisborne	Influent
	31/07/17	290	mg/L	Gisborne	Influent
	8/08/17	210	mg/L	Gisborne	Influent
	15/08/17	350	mg/L	Gisborne	Influent
	29/08/17	270	mg/L	Gisborne	Influent
	5/09/17	260	mg/L	Gisborne	Influent
	12/09/17	270	mg/L	Gisborne	Influent
	18/09/17	260	mg/L	Gisborne	Influent
	26/09/17	310	mg/L	Gisborne	Influent
	3/10/17	290	mg/L	Gisborne	Influent
	10/10/17	210	mg/L	Gisborne	Influent
	17/10/17	350	mg/L	Gisborne	Influent
	24/10/17	140	mg/L	Gisborne	Influent
	31/10/17	170	mg/L	Gisborne	Influent
	13/11/17	310	mg/L	Gisborne	Influent
	20/11/17	290	mg/L	Gisborne	Influent
	5/12/17	210	mg/L	Gisborne	Influent
	12/12/17	210	mg/L	Gisborne	Influent
	9/01/18	310	mg/L	Gisborne	Influent
	16/01/18	300	mg/L	Gisborne	Influent
	23/01/18	300	mg/L	Gisborne	Influent
	29/01/18	310	mg/L	Gisborne	Influent
	6/02/18	360	mg/L	Gisborne	Influent
	13/02/18	350	mg/L	Gisborne	Influent
	19/02/18	370	mg/L	Gisborne	Influent

27/02/18	300	mg/L	Gisborne	Influent
6/03/18	360	mg/L	Gisborne	Influent
20/03/18	300	mg/L	Gisborne	Influent
3/04/17	121	mg/L	Gisborne	Mixed liquor
5/04/17	118	mg/L	Gisborne	Mixed liquor
6/04/17	116	mg/L	Gisborne	Mixed liquor
15/05/17	121	mg/L	Gisborne	Mixed liquor
17/05/17	128.9	mg/L	Gisborne	Mixed liquor
18/05/17	117	mg/L	Gisborne	Mixed liquor
24/05/17	149	mg/L	Gisborne	Mixed liquor
8/06/17	152	mg/L	Gisborne	Mixed liquor
9/06/17	152	mg/L	Gisborne	Mixed liquor
13/06/17	176	mg/L	Gisborne	Mixed liquor
14/06/17	182	mg/L	Gisborne	Mixed liquor
15/06/17	189	mg/L	Gisborne	Mixed liquor
10/07/17	91	mg/L	Gisborne	Mixed liquor
11/07/17	170	mg/L	Gisborne	Mixed liquor
13/07/17	192	mg/L	Gisborne	Mixed liquor
14/07/17	182	mg/L	Gisborne	Mixed liquor
17/07/17	182	mg/L	Gisborne	Mixed liquor
19/07/17	161	mg/L	Gisborne	Mixed liquor
20/07/17	161	mg/L	Gisborne	Mixed liquor
26/07/17	234	mg/L	Gisborne	Mixed liquor
27/07/17	216	mg/L	Gisborne	Mixed liquor
28/07/17	206	mg/L	Gisborne	Mixed liquor
31/07/17	298	mg/L	Gisborne	Mixed liquor
3/08/17	219	mg/L	Gisborne	Mixed liquor
8/08/17	214	mg/L	Gisborne	Mixed liquor

28/08/17	152	mg/L	Gisborne	Mixed liquor
29/08/17	167.2	mg/L	Gisborne	Mixed liquor
14/09/17	202.8	mg/L	Gisborne	Mixed liquor
21/09/17	159	mg/L	Gisborne	Mixed liquor
25/09/17	146	mg/L	Gisborne	Mixed liquor
27/09/17	7.12	mg/L	Gisborne	Mixed liquor
4/10/17	194	mg/L	Gisborne	Mixed liquor
10/10/17	187	mg/L	Gisborne	Mixed liquor
19/10/17	196	mg/L	Gisborne	Mixed liquor
3/11/17	149	mg/L	Gisborne	Mixed liquor
6/11/17	98	mg/L	Gisborne	Mixed liquor
8/11/17	153.5	mg/L	Gisborne	Mixed liquor
9/11/17	153.5	mg/L	Gisborne	Mixed liquor
13/11/17	153	mg/L	Gisborne	Mixed liquor
16/11/17	152	mg/L	Gisborne	Mixed liquor
17/11/17	130	mg/L	Gisborne	Mixed liquor
21/11/17	188.2	mg/L	Gisborne	Mixed liquor
24/11/17	182	mg/L	Gisborne	Mixed liquor
28/11/17	188	mg/L	Gisborne	Mixed liquor
29/11/17	183	mg/L	Gisborne	Mixed liquor
30/11/17	175	mg/L	Gisborne	Mixed liquor
6/12/17	177.6	mg/L	Gisborne	Mixed liquor
15/12/17	278	mg/L	Gisborne	Mixed liquor
21/12/17	283	mg/L	Gisborne	Mixed liquor
22/12/17	310	mg/L	Gisborne	Mixed liquor
28/12/17	280	mg/L	Gisborne	Mixed liquor
29/12/17	225	mg/L	Gisborne	Mixed liquor

2/01/18	165	mg/L	Gisborne	Mixed liquor
5/01/18	305	mg/L	Gisborne	Mixed liquor
9/01/18	220	mg/L	Gisborne	Mixed liquor
10/01/18	282	mg/L	Gisborne	Mixed liquor
11/01/18	364	mg/L	Gisborne	Mixed liquor
12/01/18	434	mg/L	Gisborne	Mixed liquor
15/01/18	386	mg/L	Gisborne	Mixed liquor
16/01/18	368	mg/L	Gisborne	Mixed liquor
17/01/18	402	mg/L	Gisborne	Mixed liquor
18/01/18	422	mg/L	Gisborne	Mixed liquor
19/01/18	386	mg/L	Gisborne	Mixed liquor
22/01/18	242	mg/L	Gisborne	Mixed liquor
23/01/18	329	mg/L	Gisborne	Mixed liquor
24/01/18	329	mg/L	Gisborne	Mixed liquor
25/01/18	381	mg/L	Gisborne	Mixed liquor
29/01/18	225	mg/L	Gisborne	Mixed liquor
30/01/18	292	mg/L	Gisborne	Mixed liquor
31/01/18	343	mg/L	Gisborne	Mixed liquor
1/02/18	396	mg/L	Gisborne	Mixed liquor
6/02/18	365	mg/L	Gisborne	Mixed liquor
7/02/18	333	mg/L	Gisborne	Mixed liquor
8/02/18	326	mg/L	Gisborne	Mixed liquor
14/02/18	407.6	mg/L	Gisborne	Mixed liquor
16/02/18	412	mg/L	Gisborne	Mixed liquor
19/02/18	253	mg/L	Gisborne	Mixed liquor
21/02/18	407.6	mg/L	Gisborne	Mixed liquor
1/03/18	420	mg/L	Gisborne	Mixed liquor

2/03/18	401.9	mg/L	Gisborne	Mixed liquor
6/03/18	403	mg/L	Gisborne	Mixed liquor
7/03/18	402.3	mg/L	Gisborne	Mixed liquor
9/03/18	380	mg/L	Gisborne	Mixed liquor
14/03/18	376	mg/L	Gisborne	Mixed liquor
15/03/18	372	mg/L	Gisborne	Mixed liquor
16/03/18	347	mg/L	Gisborne	Mixed liquor
19/03/18	232	mg/L	Gisborne	Mixed liquor
21/03/18	375	mg/L	Gisborne	Mixed liquor
22/03/18	378	mg/L	Gisborne	Mixed liquor
23/03/18	395	mg/L	Gisborne	Mixed liquor
27/03/18	356	mg/L	Gisborne	Mixed liquor
28/03/18	382	mg/L	Gisborne	Mixed liquor
29/03/18	340	mg/L	Gisborne	Mixed liquor
12/04/18	259	mg/L	Gisborne	Mixed liquor
13/04/18	320	mg/L	Gisborne	Mixed liquor
18/04/18	415	mg/L	Gisborne	Mixed liquor
19/04/18	404	mg/L	Gisborne	Mixed liquor
23/04/18	463	mg/L	Gisborne	Mixed liquor
27/04/18	346	mg/L	Gisborne	Mixed liquor
1/05/18	320	mg/L	Gisborne	Mixed liquor
4/05/18	418	mg/L	Gisborne	Mixed liquor
7/05/18	351	mg/L	Gisborne	Mixed liquor
8/05/18	399	mg/L	Gisborne	Mixed liquor
10/05/18	424	mg/L	Gisborne	Mixed liquor
22/05/18	392	mg/L	Gisborne	Mixed liquor
23/05/18	401	mg/L	Gisborne	Mixed liquor

	29/05/18	396	mg/L	Gisborne	Mixed liquor
	1/06/18	342	mg/L	Gisborne	Mixed liquor
	13/06/17	60	mg/L	Gisborne	Effluent
	27/06/17	50	mg/L	Gisborne	Effluent
	3/07/17	75	mg/L	Gisborne	Effluent
	24/07/17	75	mg/L	Gisborne	Effluent
	31/07/17	100	mg/L	Gisborne	Effluent
	8/08/17	100	mg/L	Gisborne	Effluent
	15/08/17	80	mg/L	Gisborne	Effluent
	29/08/17	75	mg/L	Gisborne	Effluent
	5/09/17	150	mg/L	Gisborne	Effluent
	12/09/17	83	mg/L	Gisborne	Effluent
	18/09/17	70	mg/L	Gisborne	Effluent
	26/09/17	100	mg/L	Gisborne	Effluent
	3/10/17	90	mg/L	Gisborne	Effluent
	10/10/17	125	mg/L	Gisborne	Effluent
	17/10/17	120	mg/L	Gisborne	Effluent
	24/10/17	100	mg/L	Gisborne	Effluent
	31/10/17	100	mg/L	Gisborne	Effluent
	13/11/17	50	mg/L	Gisborne	Effluent
	20/11/17	50	mg/L	Gisborne	Effluent
	28/11/17	117	mg/L	Gisborne	Effluent
	5/12/17	125	mg/L	Gisborne	Effluent
	12/12/17	90	mg/L	Gisborne	Effluent
	9/01/18	117	mg/L	Gisborne	Effluent
	15/01/18	192	mg/L	Gisborne	Effluent
	16/01/18	187	mg/L	Gisborne	Effluent
	17/01/18	199	mg/L	Gisborne	Effluent
	17/01/18	183	mg/L	Gisborne	Effluent
	18/01/18	221	mg/L	Gisborne	Effluent
	19/01/18	185	mg/L	Gisborne	Effluent
	23/01/18	175	mg/L	Gisborne	Effluent
	29/01/18	233	mg/L	Gisborne	Effluent
	6/02/18	200	mg/L	Gisborne	Effluent
	13/02/18	225	mg/L	Gisborne	Effluent
	19/02/18	250	mg/L	Gisborne	Effluent
	27/02/18	240	mg/L	Gisborne	Effluent
	7/03/18	233	mg/L	Gisborne	Effluent
	20/03/18	240	mg/L	Gisborne	Effluent
	27/03/18	260	mg/L	Gisborne	Effluent
Aluminium, Total as Al	27/03/18	330	mg/L	Gisborne	Influent
	4/04/17	0.03	mg/L	Gisborne	Influent
	19/04/17	0.225	mg/L	Gisborne	Influent
	24/04/17	0.041	mg/L	Gisborne	Influent
	2/05/17	0.014	mg/L	Gisborne	Influent
	9/05/17	0.008	mg/L	Gisborne	Influent
	30/05/17	0.444	mg/L	Gisborne	Influent

6/06/17	0.002	mg/L	Gisborne	Influent
14/06/17	0.01	mg/L	Gisborne	Influent
19/06/17	0.157	mg/L	Gisborne	Influent
27/06/17	0.035	mg/L	Gisborne	Influent
3/07/17	0.045	mg/L	Gisborne	Influent
24/07/17	0.026	mg/L	Gisborne	Influent
8/08/17	0.022	mg/L	Gisborne	Influent
15/08/17	0.075	mg/L	Gisborne	Influent
28/08/17	0.02	mg/L	Gisborne	Influent
8/09/17	0.17	mg/L	Gisborne	Influent
12/09/17	0.026	mg/L	Gisborne	Influent
18/09/17	0.017	mg/L	Gisborne	Influent
26/09/17	0.099	mg/L	Gisborne	Influent
3/10/17	0.018	mg/L	Gisborne	Influent
10/10/17	0.151	mg/L	Gisborne	Influent
17/10/17	0.07	mg/L	Gisborne	Influent
24/10/17	0.146	mg/L	Gisborne	Influent
31/10/17	0.027	mg/L	Gisborne	Influent
13/11/17	0.081	mg/L	Gisborne	Influent
20/11/17	0.18	mg/L	Gisborne	Influent
7/12/17	0.355	mg/L	Gisborne	Influent
14/12/17	0.325	mg/L	Gisborne	Influent
11/01/18	0.711	mg/L	Gisborne	Influent
18/01/18	0.261	mg/L	Gisborne	Influent
23/01/18	0.013	mg/L	Gisborne	Influent
29/01/18	0.02	mg/L	Gisborne	Influent
6/02/18	0.005	mg/L	Gisborne	Influent
13/02/18	0.011	mg/L	Gisborne	Influent
19/02/18	0.02	mg/L	Gisborne	Influent
27/02/18	0.035	mg/L	Gisborne	Influent
7/03/18	0.013	mg/L	Gisborne	Influent
20/03/18	0.016	mg/L	Gisborne	Influent
4/04/17	0.02	mg/L	Gisborne	Effluent
19/04/17	0.039	mg/L	Gisborne	Effluent
24/04/17	0.028	mg/L	Gisborne	Effluent
2/05/17	0.042	mg/L	Gisborne	Effluent
9/05/17	0.024	mg/L	Gisborne	Effluent
15/05/17	0.03	mg/L	Gisborne	Effluent
23/05/17	0.026	mg/L	Gisborne	Effluent
30/05/17	0.033	mg/L	Gisborne	Effluent
6/06/17	0.155	mg/L	Gisborne	Effluent
14/06/17	0.042	mg/L	Gisborne	Effluent
27/06/17	0.034	mg/L	Gisborne	Effluent
3/07/17	0.033	mg/L	Gisborne	Effluent
24/07/17	0.066	mg/L	Gisborne	Effluent
15/08/17	0.006	mg/L	Gisborne	Effluent
28/08/17	0.016	mg/L	Gisborne	Effluent
8/09/17	0.007	mg/L	Gisborne	Effluent

	12/09/17	0.048	mg/L	Gisborne	Effluent
	18/09/17	0.036	mg/L	Gisborne	Effluent
	26/09/17	0.034	mg/L	Gisborne	Effluent
	3/10/17	0.008	mg/L	Gisborne	Effluent
	17/10/17	0.018	mg/L	Gisborne	Effluent
	31/10/17	0.032	mg/L	Gisborne	Effluent
	13/11/17	0.039	mg/L	Gisborne	Effluent
	20/11/17	0.031	mg/L	Gisborne	Effluent
	28/11/17	0.037	mg/L	Gisborne	Effluent
	5/12/17	0.037	mg/L	Gisborne	Effluent
	12/12/17	0.017	mg/L	Gisborne	Effluent
	11/01/18	0.02	mg/L	Gisborne	Effluent
	18/01/18	0.022	mg/L	Gisborne	Effluent
	23/01/18	0.037	mg/L	Gisborne	Effluent
	29/01/18	0.014	mg/L	Gisborne	Effluent
	6/02/18	0.046	mg/L	Gisborne	Effluent
	13/02/18	0.013	mg/L	Gisborne	Effluent
	19/02/18	0.017	mg/L	Gisborne	Effluent
	28/02/18	0.046	mg/L	Gisborne	Effluent
	7/03/18	0.017	mg/L	Gisborne	Effluent
	20/03/18	0	mg/L	Gisborne	Effluent
	27/03/18	0.032	mg/L	Gisborne	Effluent
Ammonia	27/03/18	0.014	mg/L	Gisborne	Influent
	4/04/17	50.4	mg/L	Gisborne	Influent
	18/04/17	35.8	mg/L	Gisborne	Influent
	24/04/17	45	mg/L	Gisborne	Influent
	2/05/17	30.8	mg/L	Gisborne	Influent
	9/05/17	46.6	mg/L	Gisborne	Influent
	15/05/17	48.8	mg/L	Gisborne	Influent
	23/05/17	40	mg/L	Gisborne	Influent
	30/05/17	50.7	mg/L	Gisborne	Influent
	6/06/17	36.2	mg/L	Gisborne	Influent
	13/06/17	49.3	mg/L	Gisborne	Influent
	19/06/17	44.1	mg/L	Gisborne	Influent
	27/06/17	35.2	mg/L	Gisborne	Influent
	3/07/17	27	mg/L	Gisborne	Influent
	24/07/17	34.6	mg/L	Gisborne	Influent
	31/07/17	40.2	mg/L	Gisborne	Influent
	8/08/17	31.8	mg/L	Gisborne	Influent
	15/08/17	44.6	mg/L	Gisborne	Influent
	29/08/17	42.8	mg/L	Gisborne	Influent
	5/09/17	58.9	mg/L	Gisborne	Influent
	12/09/17	18.5	mg/L	Gisborne	Influent
	18/09/17	27.3	mg/L	Gisborne	Influent
	26/09/17	40.8	mg/L	Gisborne	Influent
	3/10/17	38.4	mg/L	Gisborne	Influent
	10/10/17	29.5	mg/L	Gisborne	Influent
	17/10/17	43.5	mg/L	Gisborne	Influent

24/10/17	28.6	mg/L	Gisborne	Influent
31/10/17	24	mg/L	Gisborne	Influent
13/11/17	35.9	mg/L	Gisborne	Influent
20/11/17	48	mg/L	Gisborne	Influent
5/12/17	20.4	mg/L	Gisborne	Influent
12/12/17	27.5	mg/L	Gisborne	Influent
9/01/18	48	mg/L	Gisborne	Influent
16/01/18	30.2	mg/L	Gisborne	Influent
23/01/18	24.9	mg/L	Gisborne	Influent
29/01/18	30	mg/L	Gisborne	Influent
6/02/18	42.5	mg/L	Gisborne	Influent
13/02/18	29.7	mg/L	Gisborne	Influent
19/02/18	36.9	mg/L	Gisborne	Influent
27/02/18	24.8	mg/L	Gisborne	Influent
6/03/18	30.7	mg/L	Gisborne	Influent
20/03/18	38.6	mg/L	Gisborne	Influent
3/04/17	0.613	mg/L	Gisborne	Mixed liquor
5/04/17	0.67	mg/L	Gisborne	Mixed liquor
6/04/17	0.065	mg/L	Gisborne	Mixed liquor
18/04/17	0.421	mg/L	Gisborne	Mixed liquor
15/05/17	2.8	mg/L	Gisborne	Mixed liquor
18/05/17	0.063	mg/L	Gisborne	Mixed liquor
24/05/17	2.15	mg/L	Gisborne	Mixed liquor
8/06/17	0.216	mg/L	Gisborne	Mixed liquor
9/06/17	0.316	mg/L	Gisborne	Mixed liquor
13/06/17	0.12	mg/L	Gisborne	Mixed liquor
14/06/17	0.14	mg/L	Gisborne	Mixed liquor
15/06/17	4.13	mg/L	Gisborne	Mixed liquor
19/06/17	0.105	mg/L	Gisborne	Mixed liquor
10/07/17	0.616	mg/L	Gisborne	Mixed liquor
11/07/17	7.78	mg/L	Gisborne	Mixed liquor
13/07/17	0.215	mg/L	Gisborne	Mixed liquor
14/07/17	0.352	mg/L	Gisborne	Mixed liquor
17/07/17	0.56	mg/L	Gisborne	Mixed liquor

17/07/17	0.56	mg/L	Gisborne	Mixed liquor
19/07/17	0.097	mg/L	Gisborne	Mixed liquor
20/07/17	0.081	mg/L	Gisborne	Mixed liquor
26/07/17	2.9	mg/L	Gisborne	Mixed liquor
27/07/17	1.81	mg/L	Gisborne	Mixed liquor
28/07/17	4.23	mg/L	Gisborne	Mixed liquor
31/07/17	0.088	mg/L	Gisborne	Mixed liquor
3/08/17	9.48	mg/L	Gisborne	Mixed liquor
8/08/17	4.24	mg/L	Gisborne	Mixed liquor
28/08/17	10.2	mg/L	Gisborne	Mixed liquor
29/08/17	10.8	mg/L	Gisborne	Mixed liquor
14/09/17	12.5	mg/L	Gisborne	Mixed liquor
21/09/17	1	mg/L	Gisborne	Mixed liquor
25/09/17	4.29	mg/L	Gisborne	Mixed liquor
27/09/17	3.72	mg/L	Gisborne	Mixed liquor
27/09/17	3.72139	mg/L	Gisborne	Mixed liquor
2/10/17	6.9	mg/L	Gisborne	Mixed liquor
4/10/17	6.2	mg/L	Gisborne	Mixed liquor
10/10/17	0.201	mg/L	Gisborne	Mixed liquor
16/10/17	0.11	mg/L	Gisborne	Mixed liquor
16/10/17	6.95	mg/L	Gisborne	Mixed liquor
16/10/17	7.3	mg/L	Gisborne	Mixed liquor
18/10/17	0.9	mg/L	Gisborne	Mixed liquor
19/10/17	0.015	mg/L	Gisborne	Mixed liquor
3/11/17	1.21	mg/L	Gisborne	Mixed liquor
6/11/17	2.45	mg/L	Gisborne	Mixed liquor
8/11/17	0.72499999	mg/L	Gisborne	Mixed liquor

13/11/17	3	mg/L	Gisborne	Mixed liquor
16/11/17	1.13	mg/L	Gisborne	Mixed liquor
17/11/17	4.93	mg/L	Gisborne	Mixed liquor
21/11/17	3.5	mg/L	Gisborne	Mixed liquor
21/11/17	3.5	mg/L	Gisborne	Mixed liquor
24/11/17	1.31	mg/L	Gisborne	Mixed liquor
29/11/17	2.8	mg/L	Gisborne	Mixed liquor
30/11/17	4.33	mg/L	Gisborne	Mixed liquor
6/12/17	9.92999999	mg/L	Gisborne	Mixed liquor
15/12/17	8.92	mg/L	Gisborne	Mixed liquor
21/12/17	9.62	mg/L	Gisborne	Mixed liquor
22/12/17	13.2	mg/L	Gisborne	Mixed liquor
28/12/17	7.07	mg/L	Gisborne	Mixed liquor
29/12/17	6.13	mg/L	Gisborne	Mixed liquor
2/01/18	5.15	mg/L	Gisborne	Mixed liquor
4/01/18	8.61999999	mg/L	Gisborne	Mixed liquor
5/01/18	8.6	mg/L	Gisborne	Mixed liquor
9/01/18	7.16	mg/L	Gisborne	Mixed liquor
10/01/18	3.94	mg/L	Gisborne	Mixed liquor
11/01/18	8.3	mg/L	Gisborne	Mixed liquor
12/01/18	7.1	mg/L	Gisborne	Mixed liquor
15/01/18	7	mg/L	Gisborne	Mixed liquor
16/01/18	7.2	mg/L	Gisborne	Mixed liquor
17/01/18	5.18	mg/L	Gisborne	Mixed liquor
18/01/18	6.45	mg/L	Gisborne	Mixed liquor
19/01/18	7.1	mg/L	Gisborne	Mixed liquor
22/01/18	5.67	mg/L	Gisborne	Mixed liquor

23/01/18	8.86	mg/L	Gisborne	Mixed liquor
24/01/18	5.09	mg/L	Gisborne	Mixed liquor
25/01/18	8.79	mg/L	Gisborne	Mixed liquor
29/01/18	6.6	mg/L	Gisborne	Mixed liquor
30/01/18	1.32	mg/L	Gisborne	Mixed liquor
31/01/18	0.126	mg/L	Gisborne	Mixed liquor
1/02/18	3.15	mg/L	Gisborne	Mixed liquor
6/02/18	0.316	mg/L	Gisborne	Mixed liquor
7/02/18	2.01	mg/L	Gisborne	Mixed liquor
8/02/18	2.21	mg/L	Gisborne	Mixed liquor
14/02/18	3.34	mg/L	Gisborne	Mixed liquor
16/02/18	8.55	mg/L	Gisborne	Mixed liquor
19/02/18	4.34	mg/L	Gisborne	Mixed liquor
21/02/18	3.34	mg/L	Gisborne	Mixed liquor
26/02/18	6.63	mg/L	Gisborne	Mixed liquor
28/02/18	0.125	mg/L	Gisborne	Mixed liquor
1/03/18	5.98	mg/L	Gisborne	Mixed liquor
2/03/18	5.98	mg/L	Gisborne	Mixed liquor
6/03/18	8.92	mg/L	Gisborne	Mixed liquor
7/03/18	4.56	mg/L	Gisborne	Mixed liquor
8/03/18	0.652	mg/L	Gisborne	Mixed liquor
9/03/18	10.9	mg/L	Gisborne	Mixed liquor
14/03/18	0.089	mg/L	Gisborne	Mixed liquor
15/03/18	0.31	mg/L	Gisborne	Mixed liquor
16/03/18	0.057	mg/L	Gisborne	Mixed liquor
16/03/18	0.057347	mg/L	Gisborne	Mixed liquor
19/03/18	1.82	mg/L	Gisborne	Mixed liquor

21/03/18	1.78	mg/L	Gisborne	Mixed liquor
22/03/18	1.57	mg/L	Gisborne	Mixed liquor
23/03/18	0.223	mg/L	Gisborne	Mixed liquor
27/03/18	0.36	mg/L	Gisborne	Mixed liquor
28/03/18	0.36	mg/L	Gisborne	Mixed liquor
29/03/18	1.25	mg/L	Gisborne	Mixed liquor
12/04/18	3.59	mg/L	Gisborne	Mixed liquor
13/04/18	1.64	mg/L	Gisborne	Mixed liquor
18/04/18	4.1	mg/L	Gisborne	Mixed liquor
19/04/18	3.13	mg/L	Gisborne	Mixed liquor
23/04/18	1.48	mg/L	Gisborne	Mixed liquor
27/04/18	2.95	mg/L	Gisborne	Mixed liquor
1/05/18	2.01	mg/L	Gisborne	Mixed liquor
4/05/18	1.44	mg/L	Gisborne	Mixed liquor
7/05/18	0.281	mg/L	Gisborne	Mixed liquor
8/05/18	1.83	mg/L	Gisborne	Mixed liquor
10/05/18	6.54	mg/L	Gisborne	Mixed liquor
22/05/18	5.22	mg/L	Gisborne	Mixed liquor
23/05/18	3.02	mg/L	Gisborne	Mixed liquor
29/05/18	4.31	mg/L	Gisborne	Mixed liquor
1/06/18	4.32	mg/L	Gisborne	Mixed liquor
13/06/17	1.85	mg/L	Gisborne	Effluent
19/06/17	1.86	mg/L	Gisborne	Effluent
27/06/17	2.4	mg/L	Gisborne	Effluent
3/07/17	2.71	mg/L	Gisborne	Effluent
24/07/17	1.99	mg/L	Gisborne	Effluent
31/07/17	2.37	mg/L	Gisborne	Effluent
8/08/17	3.25	mg/L	Gisborne	Effluent
15/08/17	2	mg/L	Gisborne	Effluent
29/08/17	4	mg/L	Gisborne	Effluent
5/09/17	3.86	mg/L	Gisborne	Effluent
12/09/17	3.7	mg/L	Gisborne	Effluent

	18/09/17	2 mg/L	Gisborne	Effluent
	26/09/17	1.88 mg/L	Gisborne	Effluent
	3/10/17	2.08 mg/L	Gisborne	Effluent
	10/10/17	2 mg/L	Gisborne	Effluent
	17/10/17	3.58 mg/L	Gisborne	Effluent
	24/10/17	2.99 mg/L	Gisborne	Effluent
	31/10/17	2.57 mg/L	Gisborne	Effluent
	8/11/17	1.98 mg/L	Gisborne	Effluent
	13/11/17	2.53 mg/L	Gisborne	Effluent
	20/11/17	2.94 mg/L	Gisborne	Effluent
	28/11/17	4.1 mg/L	Gisborne	Effluent
	5/12/17	4.3 mg/L	Gisborne	Effluent
	12/12/17	2.6 mg/L	Gisborne	Effluent
	2/01/18	3.34 mg/L	Gisborne	Effluent
	3/01/18	3.06 mg/L	Gisborne	Effluent
	9/01/18	1.67 mg/L	Gisborne	Effluent
	12/01/18	1.44 mg/L	Gisborne	Effluent
	15/01/18	1.32 mg/L	Gisborne	Effluent
	16/01/18	1.31 mg/L	Gisborne	Effluent
	16/01/18	1.38 mg/L	Gisborne	Effluent
	17/01/18	1.32 mg/L	Gisborne	Effluent
	18/01/18	1.23 mg/L	Gisborne	Effluent
	19/01/18	1.28 mg/L	Gisborne	Effluent
	23/01/18	1.4 mg/L	Gisborne	Effluent
	29/01/18	0.54 mg/L	Gisborne	Effluent
	31/01/18	1.17 mg/L	Gisborne	Effluent
	6/02/18	0.813 mg/L	Gisborne	Effluent
	6/02/18	0.8 mg/L	Gisborne	Effluent
	7/02/18	0.902 mg/L	Gisborne	Effluent
	8/02/18	0.83 mg/L	Gisborne	Effluent
	13/02/18	1.06 mg/L	Gisborne	Effluent
	19/02/18	0.81 mg/L	Gisborne	Effluent
	27/02/18	2.85 mg/L	Gisborne	Effluent
	6/03/18	0.93 mg/L	Gisborne	Effluent
	20/03/18	1 mg/L	Gisborne	Effluent
	27/03/18	0.4 mg/L	Gisborne	Effluent
ATP	15/01/18	31.2	Gisborne	Mixed liquor
	16/01/18	28.47	Gisborne	Mixed liquor
	18/01/18	31.68	Gisborne	Mixed liquor
	19/01/18	29.65	Gisborne	Mixed liquor
	22/01/18	29.81	Gisborne	Mixed liquor
	24/01/18	29.45	Gisborne	Mixed liquor
	31/01/18	25.36	Gisborne	Mixed liquor

	6/02/18	26.5		Gisborne	Mixed liquor
	7/02/18	28		Gisborne	Mixed liquor
	16/02/18	34		Gisborne	Mixed liquor
	6/03/18	38		Gisborne	Mixed liquor
	7/03/18	31.5		Gisborne	Mixed liquor
	14/03/18	36		Gisborne	Mixed liquor
	16/03/18	46.8		Gisborne	Mixed liquor
	19/03/18	42.1		Gisborne	Mixed liquor
	27/03/18	35.6		Gisborne	Mixed liquor
	27/04/18	36		Gisborne	Mixed liquor
BOD, 5 Day	27/03/18	41.5	mg/L	Gisborne	Influent
	4/04/17	327	mg/L	Gisborne	Influent
	18/04/17	383	mg/L	Gisborne	Influent
	24/04/17	206	mg/L	Gisborne	Influent
	2/05/17	308	mg/L	Gisborne	Influent
	9/05/17	222	mg/L	Gisborne	Influent
	15/05/17	226	mg/L	Gisborne	Influent
	23/05/17	281	mg/L	Gisborne	Influent
	30/05/17	236	mg/L	Gisborne	Influent
	6/06/17	225	mg/L	Gisborne	Influent
	14/06/17	115	mg/L	Gisborne	Influent
	20/06/17	265	mg/L	Gisborne	Influent
	27/06/17	304	mg/L	Gisborne	Influent
	5/07/17	143	mg/L	Gisborne	Influent
	24/07/17	229	mg/L	Gisborne	Influent
	31/07/17	113	mg/L	Gisborne	Influent
	8/08/17	208	mg/L	Gisborne	Influent
	15/08/17	394	mg/L	Gisborne	Influent
	28/08/17	250	mg/L	Gisborne	Influent
	5/09/17	246	mg/L	Gisborne	Influent
	12/09/17	227	mg/L	Gisborne	Influent
	19/09/17	248	mg/L	Gisborne	Influent
	26/09/17	240	mg/L	Gisborne	Influent
	3/10/17	344	mg/L	Gisborne	Influent
	10/10/17	141	mg/L	Gisborne	Influent
	17/10/17	332	mg/L	Gisborne	Influent
	24/10/17	59	mg/L	Gisborne	Influent
	31/10/17	339	mg/L	Gisborne	Influent
	14/11/17	204	mg/L	Gisborne	Influent
	20/11/17	164	mg/L	Gisborne	Influent
	6/12/17	410	mg/L	Gisborne	Influent

13/12/17	253	mg/L	Gisborne	Influent
10/01/18	290	mg/L	Gisborne	Influent
17/01/18	271	mg/L	Gisborne	Influent
24/01/18	236.5	mg/L	Gisborne	Influent
31/01/18	231	mg/L	Gisborne	Influent
7/02/18	160	mg/L	Gisborne	Influent
14/02/18	358	mg/L	Gisborne	Influent
21/02/18	312	mg/L	Gisborne	Influent
28/02/18	541	mg/L	Gisborne	Influent
6/03/18	320	mg/L	Gisborne	Influent
21/03/18	310.5	mg/L	Gisborne	Influent
4/04/17	5.2	mg/L	Gisborne	Effluent
18/04/17	5.8	mg/L	Gisborne	Effluent
24/04/17	5.1	mg/L	Gisborne	Effluent
2/05/17	3.77	mg/L	Gisborne	Effluent
9/05/17	4.9	mg/L	Gisborne	Effluent
15/05/17	3.5	mg/L	Gisborne	Effluent
23/05/17	6.9	mg/L	Gisborne	Effluent
30/05/17	3.6	mg/L	Gisborne	Effluent
6/06/17	9.4	mg/L	Gisborne	Effluent
14/06/17	14	mg/L	Gisborne	Effluent
20/06/17	7	mg/L	Gisborne	Effluent
27/06/17	11	mg/L	Gisborne	Effluent
8/08/17	13	mg/L	Gisborne	Effluent
15/08/17	8.5	mg/L	Gisborne	Effluent
28/08/17	10	mg/L	Gisborne	Effluent
12/09/17	16	mg/L	Gisborne	Effluent
19/09/17	2	mg/L	Gisborne	Effluent
26/09/17	5	mg/L	Gisborne	Effluent
3/10/17	26	mg/L	Gisborne	Effluent
10/10/17	8.7	mg/L	Gisborne	Effluent
17/10/17	15	mg/L	Gisborne	Effluent
24/10/17	28	mg/L	Gisborne	Effluent
31/10/17	19	mg/L	Gisborne	Effluent
14/11/17	13.2	mg/L	Gisborne	Effluent
20/11/17	22.5	mg/L	Gisborne	Effluent
6/12/17	23.95	mg/L	Gisborne	Effluent
13/12/17	4.95	mg/L	Gisborne	Effluent
10/01/18	15.35	mg/L	Gisborne	Effluent
17/01/18	18.5	mg/L	Gisborne	Effluent
24/01/18	15.8	mg/L	Gisborne	Effluent
31/01/18	8.6	mg/L	Gisborne	Effluent
7/02/18	19.35	mg/L	Gisborne	Effluent
14/02/18	6.11	mg/L	Gisborne	Effluent
21/02/18	12.75	mg/L	Gisborne	Effluent
28/02/18	16.85	mg/L	Gisborne	Effluent
6/03/18	16	mg/L	Gisborne	Effluent
21/03/18	14.13	mg/L	Gisborne	Effluent

	28/03/18	3.8	mg/L	Gisborne	Effluent
COD	28/03/18	472	mg/L	Gisborne	Influent
	4/04/17	830	mg/L	Gisborne	Influent
	18/04/17	1361	mg/L	Gisborne	Influent
	24/04/17	493	mg/L	Gisborne	Influent
	3/05/17	596	mg/L	Gisborne	Influent
	9/05/17	502	mg/L	Gisborne	Influent
	15/05/17	582	mg/L	Gisborne	Influent
	23/05/17	1175	mg/L	Gisborne	Influent
	30/05/17	552	mg/L	Gisborne	Influent
	6/06/17	557	mg/L	Gisborne	Influent
	13/06/17	310	mg/L	Gisborne	Influent
	19/06/17	645	mg/L	Gisborne	Influent
	27/06/17	634	mg/L	Gisborne	Influent
	3/07/17	368	mg/L	Gisborne	Influent
	24/07/17	693	mg/L	Gisborne	Influent
	31/07/17	320	mg/L	Gisborne	Influent
	8/08/17	474	mg/L	Gisborne	Influent
	15/08/17	1174	mg/L	Gisborne	Influent
	29/08/17	672	mg/L	Gisborne	Influent
	5/09/17	575	mg/L	Gisborne	Influent
	12/09/17	543	mg/L	Gisborne	Influent
	18/09/17	605	mg/L	Gisborne	Influent
	26/09/17	600	mg/L	Gisborne	Influent
	3/10/17	732	mg/L	Gisborne	Influent
	10/10/17	394	mg/L	Gisborne	Influent
	17/10/17	685	mg/L	Gisborne	Influent
	24/10/17	142	mg/L	Gisborne	Influent
	31/10/17	746	mg/L	Gisborne	Influent
	13/11/17	617	mg/L	Gisborne	Influent
	20/11/17	469	mg/L	Gisborne	Influent
	5/12/17	1181	mg/L	Gisborne	Influent
	12/12/17	678	mg/L	Gisborne	Influent
	9/01/18	787	mg/L	Gisborne	Influent
	16/01/18	526	mg/L	Gisborne	Influent
	23/01/18	620	mg/L	Gisborne	Influent
	29/01/18	1039	mg/L	Gisborne	Influent
	6/02/18	446	mg/L	Gisborne	Influent
	13/02/18	847	mg/L	Gisborne	Influent
	19/02/18	595	mg/L	Gisborne	Influent
	27/02/18	564	mg/L	Gisborne	Influent
	6/03/18	769	mg/L	Gisborne	Influent
	20/03/18	666	mg/L	Gisborne	Influent
	4/04/17	41	mg/L	Gisborne	Effluent
	18/04/17	53	mg/L	Gisborne	Effluent
	24/04/17	38	mg/L	Gisborne	Effluent
	3/05/17	37	mg/L	Gisborne	Effluent
	9/05/17	40	mg/L	Gisborne	Effluent

	15/05/17	64	mg/L	Gisborne	Effluent
	23/05/17	47	mg/L	Gisborne	Effluent
	30/05/17	33	mg/L	Gisborne	Effluent
	6/06/17	51	mg/L	Gisborne	Effluent
	13/06/17	66	mg/L	Gisborne	Effluent
	19/06/17	50	mg/L	Gisborne	Effluent
	27/06/17	42	mg/L	Gisborne	Effluent
	3/07/17	52	mg/L	Gisborne	Effluent
	24/07/17	55	mg/L	Gisborne	Effluent
	31/07/17	51	mg/L	Gisborne	Effluent
	8/08/17	67	mg/L	Gisborne	Effluent
	15/08/17	55	mg/L	Gisborne	Effluent
	29/08/17	36	mg/L	Gisborne	Effluent
	5/09/17	46	mg/L	Gisborne	Effluent
	12/09/17	65	mg/L	Gisborne	Effluent
	18/09/17	47	mg/L	Gisborne	Effluent
	26/09/17	46	mg/L	Gisborne	Effluent
	3/10/17	77	mg/L	Gisborne	Effluent
	10/10/17	51	mg/L	Gisborne	Effluent
	17/10/17	66	mg/L	Gisborne	Effluent
	24/10/17	77	mg/L	Gisborne	Effluent
	31/10/17	77	mg/L	Gisborne	Effluent
	13/11/17	63	mg/L	Gisborne	Effluent
	20/11/17	65	mg/L	Gisborne	Effluent
	28/11/17	77	mg/L	Gisborne	Effluent
	5/12/17	65	mg/L	Gisborne	Effluent
	12/12/17	67	mg/L	Gisborne	Effluent
	9/01/18	73	mg/L	Gisborne	Effluent
	16/01/18	75	mg/L	Gisborne	Effluent
	23/01/18	69	mg/L	Gisborne	Effluent
	29/01/18	84	mg/L	Gisborne	Effluent
	6/02/18	59	mg/L	Gisborne	Effluent
	13/02/18	51	mg/L	Gisborne	Effluent
	19/02/18	47	mg/L	Gisborne	Effluent
	27/02/18	33	mg/L	Gisborne	Effluent
	6/03/18	36	mg/L	Gisborne	Effluent
	20/03/18	67	mg/L	Gisborne	Effluent
	27/03/18	26	mg/L	Gisborne	Effluent
E.coli orgs/100mL	4/04/17	248	orgs/100mL	Gisborne	Effluent
	18/04/17	520	orgs/100mL	Gisborne	Effluent
	24/04/17	310	orgs/100mL	Gisborne	Effluent
	2/05/17	30	orgs/100mL	Gisborne	Effluent
	9/05/17	14	orgs/100mL	Gisborne	Effluent
	15/05/17	30	orgs/100mL	Gisborne	Effluent

23/05/17	46	orgs/100mL	Gisborne	Effluent
30/05/17	64	orgs/100mL	Gisborne	Effluent
6/06/17	6	orgs/100mL	Gisborne	Effluent
13/06/17	30	orgs/100mL	Gisborne	Effluent
19/06/17	20	orgs/100mL	Gisborne	Effluent
27/06/17	8	orgs/100mL	Gisborne	Effluent
3/07/17	2	orgs/100mL	Gisborne	Effluent
24/07/17	20	orgs/100mL	Gisborne	Effluent
8/08/17	310	orgs/100mL	Gisborne	Effluent
15/08/17	80	orgs/100mL	Gisborne	Effluent
29/08/17	6	orgs/100mL	Gisborne	Effluent
5/09/17	3	orgs/100mL	Gisborne	Effluent
12/09/17	8	orgs/100mL	Gisborne	Effluent
18/09/17	7	orgs/100mL	Gisborne	Effluent
26/09/17	3	orgs/100mL	Gisborne	Effluent
3/10/17	440	orgs/100mL	Gisborne	Effluent
17/10/17	110	orgs/100mL	Gisborne	Effluent
25/10/17	33	orgs/100mL	Gisborne	Effluent
31/10/17	37	orgs/100mL	Gisborne	Effluent
13/11/17	78	orgs/100mL	Gisborne	Effluent
20/11/17	90	orgs/100mL	Gisborne	Effluent
28/11/17	130	orgs/100mL	Gisborne	Effluent
5/12/17	62	orgs/100mL	Gisborne	Effluent
12/12/17	6	orgs/100mL	Gisborne	Effluent
9/01/18	50	orgs/100mL	Gisborne	Effluent
15/01/18	42	orgs/100mL	Gisborne	Effluent
23/01/18	72	orgs/100mL	Gisborne	Effluent

	29/01/18	54	orgs/100mL	Gisborne	Effluent
	6/02/18	26	orgs/100mL	Gisborne	Effluent
	13/02/18	94	orgs/100mL	Gisborne	Effluent
	19/02/18	102	orgs/100mL	Gisborne	Effluent
	27/02/18	2020	orgs/100mL	Gisborne	Effluent
	6/03/18	170	orgs/100mL	Gisborne	Effluent
	20/03/18	48	orgs/100mL	Gisborne	Effluent
	27/03/18	60	orgs/100mL	Gisborne	Effluent
Electrical Conductivity @ 25C	27/03/18	527	mg/L	Gisborne	Influent
	4/04/17	1299	uS/cm	Gisborne	Influent
	18/04/17	1152	uS/cm	Gisborne	Influent
	24/04/17	1228	uS/cm	Gisborne	Influent
	2/05/17	1103	uS/cm	Gisborne	Influent
	9/05/17	1191	uS/cm	Gisborne	Influent
	15/05/17	1264	uS/cm	Gisborne	Influent
	23/05/17	1049	uS/cm	Gisborne	Influent
	30/05/17	1130	uS/cm	Gisborne	Influent
	6/06/17	996	uS/cm	Gisborne	Influent
	13/06/17	1175	uS/cm	Gisborne	Influent
	19/06/17	1136	uS/cm	Gisborne	Influent
	27/06/17	945	uS/cm	Gisborne	Influent
	3/07/17	1092	uS/cm	Gisborne	Influent
	24/07/17	1054	uS/cm	Gisborne	Influent
	31/07/17	1203	uS/cm	Gisborne	Influent
	8/08/17	1011	uS/cm	Gisborne	Influent
	15/08/17	1215	uS/cm	Gisborne	Influent
	29/08/17	1081	uS/cm	Gisborne	Influent
	5/09/17	1100	uS/cm	Gisborne	Influent
	12/09/17	1090	uS/cm	Gisborne	Influent
	18/09/17	1063	uS/cm	Gisborne	Influent
	26/09/17	1179	uS/cm	Gisborne	Influent
	3/10/17	997	uS/cm	Gisborne	Influent
	10/10/17	905	uS/cm	Gisborne	Influent
	17/10/17	1160	uS/cm	Gisborne	Influent
	24/10/17	859	uS/cm	Gisborne	Influent
	31/10/17	893	uS/cm	Gisborne	Influent
	13/11/17	1055	uS/cm	Gisborne	Influent
	20/11/17	1090	uS/cm	Gisborne	Influent
	5/12/17	944	uS/cm	Gisborne	Influent
	12/12/17	853	uS/cm	Gisborne	Influent
	9/01/18	1216	uS/cm	Gisborne	Influent

15/01/18	1142	uS/cm	Gisborne	Influent
23/01/18	1187	uS/cm	Gisborne	Influent
29/01/18	1201	uS/cm	Gisborne	Influent
6/02/18	1300	uS/cm	Gisborne	Influent
13/02/18	1129	uS/cm	Gisborne	Influent
19/02/18	1198	uS/cm	Gisborne	Influent
27/02/18	1083	uS/cm	Gisborne	Influent
6/03/18	1203	uS/cm	Gisborne	Influent
20/03/18	1065	uS/cm	Gisborne	Influent
15/01/18	1307	uS/cm	Gisborne	Mixed liquor
16/01/18	1312	uS/cm	Gisborne	Mixed liquor
17/01/18	1325	uS/cm	Gisborne	Mixed liquor
18/01/18	1311	uS/cm	Gisborne	Mixed liquor
19/01/18	1318	uS/cm	Gisborne	Mixed liquor
4/04/17	872	uS/cm	Gisborne	Effluent
18/04/17	784	uS/cm	Gisborne	Effluent
24/04/17	824	uS/cm	Gisborne	Effluent
2/05/17	790	uS/cm	Gisborne	Effluent
9/05/17	853	uS/cm	Gisborne	Effluent
15/05/17	887	uS/cm	Gisborne	Effluent
23/05/17	908	uS/cm	Gisborne	Effluent
30/05/17	915	uS/cm	Gisborne	Effluent
6/06/17	889	uS/cm	Gisborne	Effluent
13/06/17	871	uS/cm	Gisborne	Effluent
19/06/17	905	uS/cm	Gisborne	Effluent
27/06/17	945	uS/cm	Gisborne	Effluent
3/07/17	957	uS/cm	Gisborne	Effluent
24/07/17	871	uS/cm	Gisborne	Effluent
31/07/17	876	uS/cm	Gisborne	Effluent
8/08/17	891	uS/cm	Gisborne	Effluent
15/08/17	838	uS/cm	Gisborne	Effluent
29/08/17	909	uS/cm	Gisborne	Effluent
5/09/17	859	uS/cm	Gisborne	Effluent
12/09/17	944	uS/cm	Gisborne	Effluent
18/09/17	958	uS/cm	Gisborne	Effluent
26/09/17	862	uS/cm	Gisborne	Effluent
3/10/17	837	uS/cm	Gisborne	Effluent
10/10/17	900	uS/cm	Gisborne	Effluent
17/10/17	902	uS/cm	Gisborne	Effluent
24/10/17	893	uS/cm	Gisborne	Effluent
31/10/17	900	uS/cm	Gisborne	Effluent
13/11/17	900	uS/cm	Gisborne	Effluent
20/11/17	857	uS/cm	Gisborne	Effluent
28/11/17	874	uS/cm	Gisborne	Effluent

	5/12/17	879	uS/cm	Gisborne	Effluent
	12/12/17	824	uS/cm	Gisborne	Effluent
	9/01/18	983	uS/cm	Gisborne	Effluent
	15/01/18	1190	uS/cm	Gisborne	Effluent
	15/01/18	1072	uS/cm	Gisborne	Effluent
	16/01/18	1182	uS/cm	Gisborne	Effluent
	17/01/18	1216	uS/cm	Gisborne	Effluent
	18/01/18	1245	uS/cm	Gisborne	Effluent
	19/01/18	1180	uS/cm	Gisborne	Effluent
	23/01/18	1186	uS/cm	Gisborne	Effluent
	29/01/18	1179	uS/cm	Gisborne	Effluent
	6/02/18	1066	uS/cm	Gisborne	Effluent
	13/02/18	1093	uS/cm	Gisborne	Effluent
	19/02/18	1145	uS/cm	Gisborne	Effluent
	27/02/18	1128	uS/cm	Gisborne	Effluent
	6/03/18	1170	uS/cm	Gisborne	Effluent
	20/03/18	1136	uS/cm	Gisborne	Effluent
	27/03/18	1113	uS/cm	Gisborne	Effluent
	19/10/17	955	uS/cm	Gisborne	Mixed liquor
Iron, Filtered (Soluble)	3/10/17	0.8	mg/L	Gisborne	Effluent
Iron, Reactive	12/01/18	0.98		Gisborne	Effluent
	18/01/18	0.19		Gisborne	Effluent
	31/01/18	0.26		Gisborne	Effluent
	8/02/18	0.55		Gisborne	Effluent
Iron, Total as Fe	4/04/17	1.1	mg/L	Gisborne	Effluent
	18/04/17	1.63	mg/L	Gisborne	Effluent
	24/04/17	1.19	mg/L	Gisborne	Effluent
	3/05/17	2.16	mg/L	Gisborne	Effluent
	9/05/17	1.12	mg/L	Gisborne	Effluent
	15/05/17	1.17	mg/L	Gisborne	Effluent
	23/05/17	1.19	mg/L	Gisborne	Effluent
	30/05/17	1.94	mg/L	Gisborne	Effluent
	6/06/17	2.43	mg/L	Gisborne	Effluent
	14/06/17	2.23	mg/L	Gisborne	Effluent
	19/06/17	1.55	mg/L	Gisborne	Effluent
	27/06/17	2.01	mg/L	Gisborne	Effluent
	3/07/17	2.53	mg/L	Gisborne	Effluent
	24/07/17	2.9	mg/L	Gisborne	Effluent
	31/07/17	1.73	mg/L	Gisborne	Effluent
	8/08/17	1.84	mg/L	Gisborne	Effluent
	15/08/17	1.1	mg/L	Gisborne	Effluent
	29/08/17	1.8	mg/L	Gisborne	Effluent
	8/09/17	2.24	mg/L	Gisborne	Effluent
	12/09/17	2	mg/L	Gisborne	Effluent
	18/09/17	2.52	mg/L	Gisborne	Effluent
	26/09/17	2.49	mg/L	Gisborne	Effluent
	3/10/17	0.8	mg/L	Gisborne	Effluent
	10/10/17	0.04	mg/L	Gisborne	Effluent

	17/10/17	1	mg/L	Gisborne	Effluent
	24/10/17	1.13	mg/L	Gisborne	Effluent
	31/10/17	0.98	mg/L	Gisborne	Effluent
	13/11/17	0.94	mg/L	Gisborne	Effluent
	20/11/17	1.46	mg/L	Gisborne	Effluent
	29/11/17	0.72	mg/L	Gisborne	Effluent
	5/12/17	1.52	mg/L	Gisborne	Effluent
	14/12/17	1.31	mg/L	Gisborne	Effluent
	11/01/18	0.49	mg/L	Gisborne	Effluent
	15/01/18	0.8	mg/L	Gisborne	Effluent
	23/01/18	0.44	mg/L	Gisborne	Effluent
	29/01/18	0.54	mg/L	Gisborne	Effluent
	6/02/18	0.45	mg/L	Gisborne	Effluent
	13/02/18	0.63	mg/L	Gisborne	Effluent
	19/02/18	0.34	mg/L	Gisborne	Effluent
	27/02/18	0.74	mg/L	Gisborne	Effluent
	6/03/18	0.32	mg/L	Gisborne	Effluent
	20/03/18	0.3	mg/L	Gisborne	Effluent
	27/03/18	0.27	mg/L	Gisborne	Effluent
NITRATE (mg N/L)	3/04/17	2.46	mg N/L	Gisborne	Mixed liquor
	5/04/17	5.81	mg N/L	Gisborne	Mixed liquor
	6/04/17	5.34	mg N/L	Gisborne	Mixed liquor
	18/04/17	0.214	mg N/L	Gisborne	Mixed liquor
	15/05/17	7.72	mg N/L	Gisborne	Mixed liquor
	17/05/17	3.82	mg N/L	Gisborne	Mixed liquor
	18/05/17	4.71	mg N/L	Gisborne	Mixed liquor
	24/05/17	4.58	mg N/L	Gisborne	Mixed liquor
	8/06/17	0.872	mg N/L	Gisborne	Mixed liquor
	9/06/17	0.481	mg N/L	Gisborne	Mixed liquor
	13/06/17	4.62	mg N/L	Gisborne	Mixed liquor
	14/06/17	4.58	mg N/L	Gisborne	Mixed liquor
	15/06/17	0.301	mg N/L	Gisborne	Mixed liquor
	19/06/17	1.37	mg N/L	Gisborne	Mixed liquor
	10/07/17	1.42	mg N/L	Gisborne	Mixed liquor
	11/07/17	4.28	mg N/L	Gisborne	Mixed liquor

13/07/17	2.8	mg N/L	Gisborne	Mixed liquor
14/07/17	3.25	mg N/L	Gisborne	Mixed liquor
17/07/17	2.68	mg N/L	Gisborne	Mixed liquor
20/07/17	5.98	mg N/L	Gisborne	Mixed liquor
20/07/17	8.82	mg N/L	Gisborne	Mixed liquor
26/07/17	3.27	mg N/L	Gisborne	Mixed liquor
27/07/17	3.24	mg N/L	Gisborne	Mixed liquor
28/07/17	0.227	mg N/L	Gisborne	Mixed liquor
31/07/17	3.85	mg N/L	Gisborne	Mixed liquor
3/08/17	2.81	mg N/L	Gisborne	Mixed liquor
8/08/17	5.2	mg N/L	Gisborne	Mixed liquor
28/08/17	7.26	mg N/L	Gisborne	Mixed liquor
29/08/17	7.16	mg N/L	Gisborne	Mixed liquor
14/09/17	2	mg N/L	Gisborne	Mixed liquor
21/09/17	4.96	mg N/L	Gisborne	Mixed liquor
25/09/17	3.59	mg N/L	Gisborne	Mixed liquor
27/09/17	3.59	mg N/L	Gisborne	Mixed liquor
2/10/17	2.12	mg N/L	Gisborne	Mixed liquor
4/10/17	2.27	mg N/L	Gisborne	Mixed liquor
10/10/17	2.56	mg N/L	Gisborne	Mixed liquor
16/10/17	1.65	mg N/L	Gisborne	Mixed liquor
18/10/17	0.886	mg N/L	Gisborne	Mixed liquor
3/11/17	1.01	mg N/L	Gisborne	Mixed liquor
6/11/17	0.981	mg N/L	Gisborne	Mixed liquor
8/11/17	1.41999999	mg N/L	Gisborne	Mixed liquor
13/11/17	3.68	mg N/L	Gisborne	Mixed liquor
16/11/17	2.81	mg N/L	Gisborne	Mixed liquor

17/11/17	6.03	mg N/L	Gisborne	Mixed liquor
21/11/17	3.9	mg N/L	Gisborne	Mixed liquor
21/11/17	3.89999999	mg N/L	Gisborne	Mixed liquor
24/11/17	2.1	mg N/L	Gisborne	Mixed liquor
29/11/17	3.06	mg N/L	Gisborne	Mixed liquor
30/11/17	3.66	mg N/L	Gisborne	Mixed liquor
15/12/17	2.39	mg N/L	Gisborne	Mixed liquor
21/12/17	3.62	mg N/L	Gisborne	Mixed liquor
22/12/17	3.62	mg N/L	Gisborne	Mixed liquor
28/12/17	2.55	mg N/L	Gisborne	Mixed liquor
29/12/17	4.01	mg N/L	Gisborne	Mixed liquor
2/01/18	3.654	mg N/L	Gisborne	Mixed liquor
4/01/18	6.25999999	mg N/L	Gisborne	Mixed liquor
5/01/18	3.6	mg N/L	Gisborne	Mixed liquor
9/01/18	3.65	mg N/L	Gisborne	Mixed liquor
10/01/18	3.5	mg N/L	Gisborne	Mixed liquor
11/01/18	2.2	mg N/L	Gisborne	Mixed liquor
12/01/18	2.91	mg N/L	Gisborne	Mixed liquor
15/01/18	2.11	mg N/L	Gisborne	Mixed liquor
16/01/18	2.45	mg N/L	Gisborne	Mixed liquor
17/01/18	3.53	mg N/L	Gisborne	Mixed liquor
18/01/18	2.25	mg N/L	Gisborne	Mixed liquor
19/01/18	2.23	mg N/L	Gisborne	Mixed liquor
22/01/18	1.21	mg N/L	Gisborne	Mixed liquor
23/01/18	1.41	mg N/L	Gisborne	Mixed liquor
24/01/18	0.521	mg N/L	Gisborne	Mixed liquor
25/01/18	2.04	mg N/L	Gisborne	Mixed liquor

29/01/18	0.56	mg N/L	Gisborne	Mixed liquor
30/01/18	5.03	mg N/L	Gisborne	Mixed liquor
31/01/18	2	mg N/L	Gisborne	Mixed liquor
1/02/18	2.83	mg N/L	Gisborne	Mixed liquor
6/02/18	1.83	mg N/L	Gisborne	Mixed liquor
7/02/18	3.16	mg N/L	Gisborne	Mixed liquor
8/02/18	4.07	mg N/L	Gisborne	Mixed liquor
14/02/18	1.03	mg N/L	Gisborne	Mixed liquor
16/02/18	2.32	mg N/L	Gisborne	Mixed liquor
19/02/18	4.18	mg N/L	Gisborne	Mixed liquor
21/02/18	1.03	mg N/L	Gisborne	Mixed liquor
26/02/18	0.486	mg N/L	Gisborne	Mixed liquor
28/02/18	0.01	mg N/L	Gisborne	Mixed liquor
1/03/18	3.6	mg N/L	Gisborne	Mixed liquor
2/03/18	3.1	mg N/L	Gisborne	Mixed liquor
6/03/18	4.21	mg N/L	Gisborne	Mixed liquor
7/03/18	3.3	mg N/L	Gisborne	Mixed liquor
9/03/18	1.8	mg N/L	Gisborne	Mixed liquor
14/03/18	6.58	mg N/L	Gisborne	Mixed liquor
15/03/18	6.72	mg N/L	Gisborne	Mixed liquor
16/03/18	8.61	mg N/L	Gisborne	Mixed liquor
19/03/18	7.77	mg N/L	Gisborne	Mixed liquor
21/03/18	1.89	mg N/L	Gisborne	Mixed liquor
22/03/18	5.59	mg N/L	Gisborne	Mixed liquor
23/03/18	3.51	mg N/L	Gisborne	Mixed liquor
27/03/18	4.65	mg N/L	Gisborne	Mixed liquor
28/03/18	6.5	mg N/L	Gisborne	Mixed liquor

29/03/18	2.11	mg N/L	Gisborne	Mixed liquor
12/04/18	5.72	mg N/L	Gisborne	Mixed liquor
13/04/18	0.812	mg N/L	Gisborne	Mixed liquor
18/04/18	6.75	mg N/L	Gisborne	Mixed liquor
23/04/18	4.22	mg N/L	Gisborne	Mixed liquor
27/04/18	3.21	mg N/L	Gisborne	Mixed liquor
1/05/18	4.2	mg N/L	Gisborne	Mixed liquor
4/05/18	4.01	mg N/L	Gisborne	Mixed liquor
7/05/18	4.01	mg N/L	Gisborne	Mixed liquor
8/05/18	1.1	mg N/L	Gisborne	Mixed liquor
10/05/18	2.93	mg N/L	Gisborne	Mixed liquor
22/05/18	1.02	mg N/L	Gisborne	Mixed liquor
23/05/18	4.22	mg N/L	Gisborne	Mixed liquor
29/05/18	3.86	mg N/L	Gisborne	Mixed liquor
27/06/17	3.16	mg N/L	Gisborne	Effluent
3/07/17	3.64	mg N/L	Gisborne	Effluent
24/07/17	2.76	mg N/L	Gisborne	Effluent
31/07/17	2.11	mg N/L	Gisborne	Effluent
8/08/17	1.8	mg N/L	Gisborne	Effluent
15/08/17	2.97	mg N/L	Gisborne	Effluent
29/08/17	5.16	mg N/L	Gisborne	Effluent
5/09/17	3.32	mg N/L	Gisborne	Effluent
12/09/17	2.5	mg N/L	Gisborne	Effluent
18/09/17	1.7	mg N/L	Gisborne	Effluent
26/09/17	1.55	mg N/L	Gisborne	Effluent
3/10/17	1.2	mg N/L	Gisborne	Effluent
10/10/17	0.58	mg N/L	Gisborne	Effluent
17/10/17	1.64	mg N/L	Gisborne	Effluent
24/10/17	1.23	mg N/L	Gisborne	Effluent
31/10/17	1.18	mg N/L	Gisborne	Effluent
13/11/17	0.992	mg N/L	Gisborne	Effluent
20/11/17	1.32	mg N/L	Gisborne	Effluent
28/11/17	6.12	mg N/L	Gisborne	Effluent
5/12/17	3.61	mg N/L	Gisborne	Effluent
14/12/17	0.662	mg N/L	Gisborne	Effluent
9/01/18	1.42	mg N/L	Gisborne	Effluent
11/01/18	0.845	mg N/L	Gisborne	Effluent

	12/01/18	1.13	mg N/L	Gisborne	Effluent
	15/01/18	1.16	mg N/L	Gisborne	Effluent
	15/01/18	1.33	mg N/L	Gisborne	Effluent
	16/01/18	1.11	mg N/L	Gisborne	Effluent
	17/01/18	1.1	mg N/L	Gisborne	Effluent
	18/01/18	1.16	mg N/L	Gisborne	Effluent
	19/01/18	1.08	mg N/L	Gisborne	Effluent
	23/01/18	1.12	mg N/L	Gisborne	Effluent
	29/01/18	1.06	mg N/L	Gisborne	Effluent
	31/01/18	1.13	mg N/L	Gisborne	Effluent
	6/02/18	0.929	mg N/L	Gisborne	Effluent
	6/02/18	1.2	mg N/L	Gisborne	Effluent
	7/02/18	0.92	mg N/L	Gisborne	Effluent
	8/02/18	1.03	mg N/L	Gisborne	Effluent
	13/02/18	1.11	mg N/L	Gisborne	Effluent
	19/02/18	1.27	mg N/L	Gisborne	Effluent
	28/02/18	0.694	mg N/L	Gisborne	Effluent
	6/03/18	1.34	mg N/L	Gisborne	Effluent
	20/03/18	2	mg N/L	Gisborne	Effluent
	27/03/18	0.7	mg N/L	Gisborne	Effluent
pH	27/03/18	1113	uS/cm	Gisborne	Influent
	4/04/17	7.96	units	Gisborne	Influent
	18/04/17	7.56	units	Gisborne	Influent
	24/04/17	7.56	units	Gisborne	Influent
	3/05/17	7.85	units	Gisborne	Influent
	9/05/17	8.23	units	Gisborne	Influent
	15/05/17	8.26	units	Gisborne	Influent
	23/05/17	7.53	units	Gisborne	Influent
	30/05/17	8.05	units	Gisborne	Influent
	6/06/17	7.9	units	Gisborne	Influent
	13/06/17	7.7	units	Gisborne	Influent
	19/06/17	8.22	units	Gisborne	Influent
	27/06/17	8.05	units	Gisborne	Influent
	3/07/17	8.04	units	Gisborne	Influent
	24/07/17	7.93	units	Gisborne	Influent
	31/07/17	7.96	units	Gisborne	Influent
	8/08/17	7.97	units	Gisborne	Influent
	15/08/17	7.86	units	Gisborne	Influent
	29/08/17	8.09	units	Gisborne	Influent
	5/09/17	7.93	units	Gisborne	Influent
	12/09/17	7.33	units	Gisborne	Influent
	18/09/17	7.82	units	Gisborne	Influent
	26/09/17	8.05	units	Gisborne	Influent
	3/10/17	7.81	units	Gisborne	Influent
	10/10/17	7.62	units	Gisborne	Influent
	17/10/17	8.3	units	Gisborne	Influent
	24/10/17	7.3	units	Gisborne	Influent
	31/10/17	7.28	units	Gisborne	Influent

13/11/17	7.76	units	Gisborne	Influent
20/11/17	7.66	units	Gisborne	Influent
5/12/17	7.16	units	Gisborne	Influent
12/12/17	7.34	units	Gisborne	Influent
9/01/18	7.57	units	Gisborne	Influent
15/01/18	7.66	units	Gisborne	Influent
23/01/18	7.45	units	Gisborne	Influent
29/01/18	7.59	units	Gisborne	Influent
6/02/18	7.72	units	Gisborne	Influent
13/02/18	8.04	units	Gisborne	Influent
19/02/18	8.23	units	Gisborne	Influent
28/02/18	7.74	units	Gisborne	Influent
6/03/18	7.89	units	Gisborne	Influent
20/03/18	7.69	units	Gisborne	Influent
3/04/17	6.98	units	Gisborne	Mixed liquor
5/04/17	6.95	units	Gisborne	Mixed liquor
6/04/17	6.92	units	Gisborne	Mixed liquor
15/05/17	7.12	units	Gisborne	Mixed liquor
17/05/17	6.97	units	Gisborne	Mixed liquor
18/05/17	6.95	units	Gisborne	Mixed liquor
24/05/17	7.15	units	Gisborne	Mixed liquor
8/06/17	6.87	units	Gisborne	Mixed liquor
9/06/17	6.85	units	Gisborne	Mixed liquor
13/06/17	7.12	units	Gisborne	Mixed liquor
14/06/17	7.14	units	Gisborne	Mixed liquor
15/06/17	7.06	units	Gisborne	Mixed liquor
19/06/17	9.05	units	Gisborne	Mixed liquor
10/07/17	6.9	units	Gisborne	Mixed liquor
11/07/17	7.1	units	Gisborne	Mixed liquor
13/07/17	7.14	units	Gisborne	Mixed liquor
14/07/17	7.1	units	Gisborne	Mixed liquor
17/07/17	7.12	units	Gisborne	Mixed liquor
19/07/17	7.15	units	Gisborne	Mixed liquor

20/07/17	7.1	units	Gisborne	Mixed liquor
26/07/17	6.98	units	Gisborne	Mixed liquor
27/07/17	7.22	units	Gisborne	Mixed liquor
28/07/17	7.2	units	Gisborne	Mixed liquor
31/07/17	7.02	units	Gisborne	Mixed liquor
3/08/17	7.19	units	Gisborne	Mixed liquor
8/08/17	7.24	units	Gisborne	Mixed liquor
28/08/17	7.1	units	Gisborne	Mixed liquor
29/08/17	7.29	units	Gisborne	Mixed liquor
14/09/17	7.26	units	Gisborne	Mixed liquor
21/09/17	7.14	units	Gisborne	Mixed liquor
25/09/17	7.11	units	Gisborne	Mixed liquor
27/09/17	7.12	units	Gisborne	Mixed liquor
4/10/17	7.34	units	Gisborne	Mixed liquor
10/10/17	7.25	units	Gisborne	Mixed liquor
19/10/17	7.16	units	Gisborne	Mixed liquor
3/11/17	7.12	units	Gisborne	Mixed liquor
6/11/17	7.65	units	Gisborne	Mixed liquor
8/11/17	7.00999999	units	Gisborne	Mixed liquor
13/11/17	7.15	units	Gisborne	Mixed liquor
16/11/17	7.21	units	Gisborne	Mixed liquor
17/11/17	7.09	units	Gisborne	Mixed liquor
21/11/17	7.29	units	Gisborne	Mixed liquor
21/11/17	7.29	units	Gisborne	Mixed liquor
28/11/17	7.28	units	Gisborne	Mixed liquor
29/11/17	7.12	units	Gisborne	Mixed liquor
30/11/17	7.27	units	Gisborne	Mixed liquor

6/12/17	7.25999999	units	Gisborne	Mixed liquor
15/12/17	7.59	units	Gisborne	Mixed liquor
21/12/17	7.54	units	Gisborne	Mixed liquor
22/12/17	7.68	units	Gisborne	Mixed liquor
28/12/17	7.65	units	Gisborne	Mixed liquor
29/12/17	7.65	units	Gisborne	Mixed liquor
2/01/18	7.08	units	Gisborne	Mixed liquor
5/01/18	7.56	units	Gisborne	Mixed liquor
9/01/18	7.6	units	Gisborne	Mixed liquor
10/01/18	7.65	units	Gisborne	Mixed liquor
11/01/18	7.75	units	Gisborne	Mixed liquor
12/01/18	7.83	units	Gisborne	Mixed liquor
15/01/18	7.78	units	Gisborne	Mixed liquor
16/01/18	7.68	units	Gisborne	Mixed liquor
17/01/18	7.66	units	Gisborne	Mixed liquor
18/01/18	7.75	units	Gisborne	Mixed liquor
19/01/18	7.78	units	Gisborne	Mixed liquor
22/01/18	7.58	units	Gisborne	Mixed liquor
23/01/18	7.48	units	Gisborne	Mixed liquor
24/01/18	7.58	units	Gisborne	Mixed liquor
25/01/18	7.75	units	Gisborne	Mixed liquor
29/01/18	7.35	units	Gisborne	Mixed liquor
30/01/18	7.22	units	Gisborne	Mixed liquor
31/01/18	7.86	units	Gisborne	Mixed liquor
1/02/18	7.7	units	Gisborne	Mixed liquor
6/02/18	7.62	units	Gisborne	Mixed liquor
7/02/18	7.58	units	Gisborne	Mixed liquor

8/02/18	7.51	units	Gisborne	Mixed liquor
14/02/18	7.85	units	Gisborne	Mixed liquor
16/02/18	7.96	units	Gisborne	Mixed liquor
19/02/18	7.24	units	Gisborne	Mixed liquor
21/02/18	7.85	units	Gisborne	Mixed liquor
1/03/18	7.56	units	Gisborne	Mixed liquor
2/03/18	7.65	units	Gisborne	Mixed liquor
6/03/18	7.66	units	Gisborne	Mixed liquor
7/03/18	7.64	units	Gisborne	Mixed liquor
9/03/18	7.72	units	Gisborne	Mixed liquor
14/03/18	7.83	units	Gisborne	Mixed liquor
15/03/18	7.82	units	Gisborne	Mixed liquor
16/03/18	7.74	units	Gisborne	Mixed liquor
19/03/18	7.43	units	Gisborne	Mixed liquor
21/03/18	7.56	units	Gisborne	Mixed liquor
22/03/18	7.62	units	Gisborne	Mixed liquor
23/03/18	7.75	units	Gisborne	Mixed liquor
27/03/18	7.68	units	Gisborne	Mixed liquor
28/03/18	7.84	units	Gisborne	Mixed liquor
29/03/18	7.68	units	Gisborne	Mixed liquor
12/04/18	7.5	units	Gisborne	Mixed liquor
13/04/18	7.65	units	Gisborne	Mixed liquor
18/04/18	7.9	units	Gisborne	Mixed liquor
19/04/18	7.85	units	Gisborne	Mixed liquor
23/04/18	7.78	units	Gisborne	Mixed liquor
27/04/18	7.49	units	Gisborne	Mixed liquor
1/05/18	7.46	units	Gisborne	Mixed liquor

4/05/18	7.58	units	Gisborne	Mixed liquor
7/05/18	7.86	units	Gisborne	Mixed liquor
8/05/18	7.55	units	Gisborne	Mixed liquor
10/05/18	7.85	units	Gisborne	Mixed liquor
22/05/18	7.42	units	Gisborne	Mixed liquor
23/05/18	7.48	units	Gisborne	Mixed liquor
29/05/18	7.75	units	Gisborne	Mixed liquor
1/06/18	7.64	units	Gisborne	Mixed liquor
13/06/17	7.39	units	Gisborne	Effluent
19/06/17	7.3	units	Gisborne	Effluent
28/06/17	7.11	units	Gisborne	Effluent
3/07/17	7.19	units	Gisborne	Effluent
24/07/17	7.84	units	Gisborne	Effluent
31/07/17	7.51	units	Gisborne	Effluent
8/08/17	7.55	units	Gisborne	Effluent
15/08/17	7.6	units	Gisborne	Effluent
29/08/17	7.05	units	Gisborne	Effluent
5/09/17	7.46	units	Gisborne	Effluent
12/09/17	7.3	units	Gisborne	Effluent
18/09/17	7.33	units	Gisborne	Effluent
26/09/17	7.29	units	Gisborne	Effluent
3/10/17	8.65	units	Gisborne	Effluent
10/10/17	7.69	units	Gisborne	Effluent
17/10/17	7.35	units	Gisborne	Effluent
24/10/17	7.64	units	Gisborne	Effluent
1/11/17	7.32	units	Gisborne	Effluent
13/11/17	7.04	units	Gisborne	Effluent
20/11/17	7.37	units	Gisborne	Effluent
28/11/17	7.37	units	Gisborne	Effluent
5/12/17	7.37	units	Gisborne	Effluent
12/12/17	7.4	units	Gisborne	Effluent
4/01/18	8.01999999	units	Gisborne	Effluent
9/01/18	7.94	units	Gisborne	Effluent
15/01/18	7.92	units	Gisborne	Effluent
15/01/18	7.384	units	Gisborne	Effluent
16/01/18	7.91	units	Gisborne	Effluent
17/01/18	7.81	units	Gisborne	Effluent
18/01/18	7.85	units	Gisborne	Effluent
19/01/18	7.89	units	Gisborne	Effluent
23/01/18	8.25	units	Gisborne	Effluent
29/01/18	8.49	units	Gisborne	Effluent
6/02/18	8.1	units	Gisborne	Effluent

	13/02/18	7.86	units	Gisborne	Effluent
	19/02/18	7.87	units	Gisborne	Effluent
	28/02/18	7.91	units	Gisborne	Effluent
	6/03/18	7.99	units	Gisborne	Effluent
	20/03/18	8.45	units	Gisborne	Effluent
	27/03/18	8.23	units	Gisborne	Effluent
Phosphorus, Reactive as P	19/06/17	2.71	mg/L	Gisborne	Effluent
	24/07/17	2.3	mg/L	Gisborne	Effluent
	31/07/17	0.65	mg/L	Gisborne	Effluent
	8/08/17	2.5	mg/L	Gisborne	Effluent
	15/08/17	1.6	mg/L	Gisborne	Effluent
	29/08/17	1.2	mg/L	Gisborne	Effluent
	12/09/17	1.6	mg/L	Gisborne	Effluent
	18/09/17	2.2	mg/L	Gisborne	Effluent
	26/09/17	2	mg/L	Gisborne	Effluent
	3/10/17	0.7	mg/L	Gisborne	Effluent
	10/10/17	2.4	mg/L	Gisborne	Effluent
	24/10/17	2.7	mg/L	Gisborne	Effluent
	31/10/17	1.1	mg/L	Gisborne	Effluent
	13/11/17	1.3	mg/L	Gisborne	Effluent
	20/11/17	0.325	mg/L	Gisborne	Effluent
	28/11/17	3.2	mg/L	Gisborne	Effluent
	5/12/17	2.5	mg/L	Gisborne	Effluent
	12/12/17	1.32	mg/L	Gisborne	Effluent
	9/01/18	1.2	mg/L	Gisborne	Effluent
	15/01/18	0.5	mg/L	Gisborne	Effluent
	18/01/18	0.51	mg/L	Gisborne	Effluent
	23/01/18	1.8	mg/L	Gisborne	Effluent
	29/01/18	1.8	mg/L	Gisborne	Effluent
	31/01/18	0.681	mg/L	Gisborne	Effluent
	6/02/18	0.761	mg/L	Gisborne	Effluent
	6/02/18	1	mg/L	Gisborne	Effluent
	8/02/18	0.5	mg/L	Gisborne	Effluent
	13/02/18	1.5	mg/L	Gisborne	Effluent
	19/02/18	1.6	mg/L	Gisborne	Effluent
	27/02/18	2.9	mg/L	Gisborne	Effluent
	6/03/18	2.5	mg/L	Gisborne	Effluent
	20/03/18	3.9	mg/L	Gisborne	Effluent
	27/03/18	2.4	mg/L	Gisborne	Effluent
	27/03/18	8.02	units	Gisborne	Influent
	4/04/17	11.6	mg/L	Gisborne	Influent
	18/04/17	11.5	mg/L	Gisborne	Influent
	24/04/17	10.2	mg/L	Gisborne	Influent
	3/05/17	8.31	mg/L	Gisborne	Influent
	9/05/17	10.9	mg/L	Gisborne	Influent
	15/05/17	13.1	mg/L	Gisborne	Influent
	23/05/17	7.46	mg/L	Gisborne	Influent
	30/05/17	10.4	mg/L	Gisborne	Influent

6/06/17	7.53	mg/L	Gisborne	Influent
13/06/17	6.19	mg/L	Gisborne	Influent
19/06/17	10.5	mg/L	Gisborne	Influent
27/06/17	9.89	mg/L	Gisborne	Influent
3/07/17	6.48	mg/L	Gisborne	Influent
24/07/17	8.04	mg/L	Gisborne	Influent
31/07/17	7.97	mg/L	Gisborne	Influent
8/08/17	5.4	mg/L	Gisborne	Influent
15/08/17	14.1	mg/L	Gisborne	Influent
29/08/17	9.2	mg/L	Gisborne	Influent
5/09/17	9	mg/L	Gisborne	Influent
12/09/17	8.39	mg/L	Gisborne	Influent
18/09/17	9.67	mg/L	Gisborne	Influent
26/09/17	10.6	mg/L	Gisborne	Influent
3/10/17	10.7	mg/L	Gisborne	Influent
10/10/17	7.65	mg/L	Gisborne	Influent
17/10/17	12.2	mg/L	Gisborne	Influent
24/10/17	0.94	mg/L	Gisborne	Influent
31/10/17	9.1	mg/L	Gisborne	Influent
13/11/17	10.8	mg/L	Gisborne	Influent
20/11/17	6.58	mg/L	Gisborne	Influent
5/12/17	11.6	mg/L	Gisborne	Influent
12/12/17	8	mg/L	Gisborne	Influent
9/01/18	7.8	mg/L	Gisborne	Influent
15/01/18	7.7	mg/L	Gisborne	Influent
23/01/18	8.9	mg/L	Gisborne	Influent
29/01/18	10.7	mg/L	Gisborne	Influent
6/02/18	10.5	mg/L	Gisborne	Influent
13/02/18	11.3	mg/L	Gisborne	Influent
19/02/18	12	mg/L	Gisborne	Influent
27/02/18	9.75	mg/L	Gisborne	Influent
6/03/18	10.9	mg/L	Gisborne	Influent
20/03/18	10.4	mg/L	Gisborne	Influent
13/06/17	0.4	mg/L	Gisborne	Effluent
19/06/17	0.5	mg/L	Gisborne	Effluent
27/06/17	0.4	mg/L	Gisborne	Effluent
3/07/17	0.4	mg/L	Gisborne	Effluent
24/07/17	0.7	mg/L	Gisborne	Effluent
31/07/17	0.21	mg/L	Gisborne	Effluent
8/08/17	0.8	mg/L	Gisborne	Effluent
15/08/17	0.5	mg/L	Gisborne	Effluent
29/08/17	0.4	mg/L	Gisborne	Effluent
5/09/17	0	mg/L	Gisborne	Effluent
12/09/17	0.5	mg/L	Gisborne	Effluent
18/09/17	0.34	mg/L	Gisborne	Effluent
26/09/17	0.3	mg/L	Gisborne	Effluent
3/10/17	0.231	mg/L	Gisborne	Effluent
10/10/17	0.21	mg/L	Gisborne	Effluent

	17/10/17	0.1	mg/L	Gisborne	Effluent
	24/10/17	0.12	mg/L	Gisborne	Effluent
	31/10/17	0.092	mg/L	Gisborne	Effluent
	13/11/17	0.22	mg/L	Gisborne	Effluent
	20/11/17	0.325	mg/L	Gisborne	Effluent
	28/11/17	0.48	mg/L	Gisborne	Effluent
	5/12/17	0.54	mg/L	Gisborne	Effluent
	14/12/17	0.43	mg/L	Gisborne	Effluent
	9/01/18	0.4	mg/L	Gisborne	Effluent
	15/01/18	0.5	mg/L	Gisborne	Effluent
	23/01/18	0.74	mg/L	Gisborne	Effluent
	29/01/18	0.867	mg/L	Gisborne	Effluent
	6/02/18	0.55	mg/L	Gisborne	Effluent
	13/02/18	0.75	mg/L	Gisborne	Effluent
	19/02/18	0.56	mg/L	Gisborne	Effluent
	27/02/18	0.8	mg/L	Gisborne	Effluent
	6/03/18	0.7	mg/L	Gisborne	Effluent
	20/03/18	0.65	mg/L	Gisborne	Effluent
	27/03/18	0.4	mg/L	Gisborne	Effluent
Settled Solids	17/05/17	850	unitless	Gisborne	Mixed liquor
	18/05/17	880	unitless	Gisborne	Mixed liquor
	8/06/17	690	unitless	Gisborne	Mixed liquor
	9/06/17	790	unitless	Gisborne	Mixed liquor
	15/06/17	690	unitless	Gisborne	Mixed liquor
	19/06/17	900	unitless	Gisborne	Mixed liquor
	11/07/17	900	unitless	Gisborne	Mixed liquor
	14/07/17	920	unitless	Gisborne	Mixed liquor
	20/07/17	940	unitless	Gisborne	Mixed liquor
	28/07/17	955	unitless	Gisborne	Mixed liquor
	31/07/17	940	unitless	Gisborne	Mixed liquor
	3/08/17	920	unitless	Gisborne	Mixed liquor
	8/08/17	720	unitless	Gisborne	Mixed liquor
	28/08/17	620	unitless	Gisborne	Mixed liquor
	29/08/17	640	unitless	Gisborne	Mixed liquor
	21/09/17	850	unitless	Gisborne	Mixed liquor

25/09/17	880	unitless	Gisborne	Mixed liquor
4/10/17	880	unitless	Gisborne	Mixed liquor
3/11/17	990	unitless	Gisborne	Mixed liquor
6/11/17	980	unitless	Gisborne	Mixed liquor
13/11/17	970	unitless	Gisborne	Mixed liquor
21/11/17	850	unitless	Gisborne	Mixed liquor
28/11/17	960	unitless	Gisborne	Mixed liquor
29/11/17	920	unitless	Gisborne	Mixed liquor
30/11/17	840	unitless	Gisborne	Mixed liquor
15/12/17	860	unitless	Gisborne	Mixed liquor
22/12/17	670	unitless	Gisborne	Mixed liquor
28/12/17	0	unitless	Gisborne	Mixed liquor
2/01/18	720	unitless	Gisborne	Mixed liquor
4/01/18	600	unitless	Gisborne	Mixed liquor
5/01/18	880	unitless	Gisborne	Mixed liquor
10/01/18	780	unitless	Gisborne	Mixed liquor
11/01/18	600	unitless	Gisborne	Mixed liquor
16/01/18	870	unitless	Gisborne	Mixed liquor
17/01/18	590	unitless	Gisborne	Mixed liquor
18/01/18	850	unitless	Gisborne	Mixed liquor
19/01/18	860	unitless	Gisborne	Mixed liquor
22/01/18	720	unitless	Gisborne	Mixed liquor
23/01/18	880	unitless	Gisborne	Mixed liquor
24/01/18	900	unitless	Gisborne	Mixed liquor
29/01/18	830	unitless	Gisborne	Mixed liquor
30/01/18	850	unitless	Gisborne	Mixed liquor
31/01/18	780	unitless	Gisborne	Mixed liquor

	1/02/18	820	unitless	Gisborne	Mixed liquor
	6/02/18	620	unitless	Gisborne	Mixed liquor
	7/02/18	520	unitless	Gisborne	Mixed liquor
	8/02/18	620	unitless	Gisborne	Mixed liquor
	14/02/18	920	unitless	Gisborne	Mixed liquor
	16/02/18	920	unitless	Gisborne	Mixed liquor
	19/02/18	620	unitless	Gisborne	Mixed liquor
	21/02/18	920	unitless	Gisborne	Mixed liquor
	1/03/18	820	unitless	Gisborne	Mixed liquor
	6/03/18	690	unitless	Gisborne	Mixed liquor
	9/03/18	620	unitless	Gisborne	Mixed liquor
	14/03/18	890	unitless	Gisborne	Mixed liquor
	19/03/18	920	unitless	Gisborne	Mixed liquor
	22/03/18	925	unitless	Gisborne	Mixed liquor
	23/03/18	920	unitless	Gisborne	Mixed liquor
	12/04/18	820	unitless	Gisborne	Mixed liquor
	8/05/18	8603	unitless	Gisborne	Mixed liquor
SUS SOLIDS	27/03/18	10.1	mg/L	Gisborne	Influent
	4/04/17	414	mg/L	Gisborne	Influent
	18/04/17	868	mg/L	Gisborne	Influent
	26/04/17	162	mg/L	Gisborne	Influent
	2/05/17	264	mg/L	Gisborne	Influent
	9/05/17	182	mg/L	Gisborne	Influent
	15/05/17	242	mg/L	Gisborne	Influent
	23/05/17	866	mg/L	Gisborne	Influent
	30/05/17	267	mg/L	Gisborne	Influent
	6/06/17	268	mg/L	Gisborne	Influent
	14/06/17	144	mg/L	Gisborne	Influent
	19/06/17	392	mg/L	Gisborne	Influent
	27/06/17	278	mg/L	Gisborne	Influent
	3/07/17	108	mg/L	Gisborne	Influent
	24/07/17	226	mg/L	Gisborne	Influent
	31/07/17	104	mg/L	Gisborne	Influent
	8/08/17	230	mg/L	Gisborne	Influent
	15/08/17	678	mg/L	Gisborne	Influent

29/08/17	400	mg/L	Gisborne	Influent
6/09/17	240	mg/L	Gisborne	Influent
12/09/17	164	mg/L	Gisborne	Influent
18/09/17	224	mg/L	Gisborne	Influent
26/09/17	224	mg/L	Gisborne	Influent
3/10/17	166	mg/L	Gisborne	Influent
10/10/17	144	mg/L	Gisborne	Influent
17/10/17	236	mg/L	Gisborne	Influent
24/10/17	60	mg/L	Gisborne	Influent
31/10/17	362	mg/L	Gisborne	Influent
13/11/17	206	mg/L	Gisborne	Influent
20/11/17	232	mg/L	Gisborne	Influent
5/12/17	756	mg/L	Gisborne	Influent
14/12/17	310	mg/L	Gisborne	Influent
11/01/18	382	mg/L	Gisborne	Influent
16/01/18	246	mg/L	Gisborne	Influent
23/01/18	318	mg/L	Gisborne	Influent
29/01/18	308	mg/L	Gisborne	Influent
6/02/18	192	mg/L	Gisborne	Influent
13/02/18	336	mg/L	Gisborne	Influent
19/02/18	196	mg/L	Gisborne	Influent
27/02/18	192	mg/L	Gisborne	Influent
7/03/18	386	mg/L	Gisborne	Influent
20/03/18	268	mg/L	Gisborne	Influent
5/04/17	5560	mg/L	Gisborne	Mixed liquor
15/05/17	4090	mg/L	Gisborne	Mixed liquor
17/05/17	7500	mg/L	Gisborne	Mixed liquor
18/05/17	4100	mg/L	Gisborne	Mixed liquor
24/05/17	3440	mg/L	Gisborne	Mixed liquor
8/06/17	4840	mg/L	Gisborne	Mixed liquor
9/06/17	4910	mg/L	Gisborne	Mixed liquor
15/06/17	6320	mg/L	Gisborne	Mixed liquor
19/06/17	7090	mg/L	Gisborne	Mixed liquor
10/07/17	5000	mg/L	Gisborne	Mixed liquor
11/07/17	5460	mg/L	Gisborne	Mixed liquor
13/07/17	6200	mg/L	Gisborne	Mixed liquor
14/07/17	5650	mg/L	Gisborne	Mixed liquor

17/07/17	5600	mg/L	Gisborne	Mixed liquor
20/07/17	5470	mg/L	Gisborne	Mixed liquor
28/07/17	5340	mg/L	Gisborne	Mixed liquor
31/07/17	6870	mg/L	Gisborne	Mixed liquor
3/08/17	5920	mg/L	Gisborne	Mixed liquor
8/08/17	5830	mg/L	Gisborne	Mixed liquor
28/08/17	3590	mg/L	Gisborne	Mixed liquor
29/08/17	3500	mg/L	Gisborne	Mixed liquor
14/09/17	4630	mg/L	Gisborne	Mixed liquor
21/09/17	6250	mg/L	Gisborne	Mixed liquor
25/09/17	5820	mg/L	Gisborne	Mixed liquor
27/09/17	6210	mg/L	Gisborne	Mixed liquor
4/10/17	3500	mg/L	Gisborne	Mixed liquor
3/11/17	4960	mg/L	Gisborne	Mixed liquor
6/11/17	5500	mg/L	Gisborne	Mixed liquor
14/11/17	4930	mg/L	Gisborne	Mixed liquor
20/11/17	5425	mg/L	Gisborne	Mixed liquor
28/11/17	5460	mg/L	Gisborne	Mixed liquor
29/11/17	4960	mg/L	Gisborne	Mixed liquor
30/11/17	4780	mg/L	Gisborne	Mixed liquor
15/12/17	4020	mg/L	Gisborne	Mixed liquor
21/12/17	4100	mg/L	Gisborne	Mixed liquor
22/12/17	4280	mg/L	Gisborne	Mixed liquor
28/12/17	4240	mg/L	Gisborne	Mixed liquor
2/01/18	4380	mg/L	Gisborne	Mixed liquor
5/01/18	4210	mg/L	Gisborne	Mixed liquor
5/01/18	4210	mg/L	Gisborne	Mixed liquor

15/01/18	4470	mg/L	Gisborne	Mixed liquor
16/01/18	4360	mg/L	Gisborne	Mixed liquor
17/01/18	4440	mg/L	Gisborne	Mixed liquor
18/01/18	4380	mg/L	Gisborne	Mixed liquor
19/01/18	4420	mg/L	Gisborne	Mixed liquor
23/01/18	4380	mg/L	Gisborne	Mixed liquor
24/01/18	5120	mg/L	Gisborne	Mixed liquor
29/01/18	4780	mg/L	Gisborne	Mixed liquor
30/01/18	4620	mg/L	Gisborne	Mixed liquor
31/01/18	5880	mg/L	Gisborne	Mixed liquor
1/02/18	4510	mg/L	Gisborne	Mixed liquor
6/02/18	6480	mg/L	Gisborne	Mixed liquor
7/02/18	4960	mg/L	Gisborne	Mixed liquor
14/02/18	5180	mg/L	Gisborne	Mixed liquor
16/02/18	4480	mg/L	Gisborne	Mixed liquor
19/02/18	5030	mg/L	Gisborne	Mixed liquor
21/02/18	5200	mg/L	Gisborne	Mixed liquor
2/03/18	4580	mg/L	Gisborne	Mixed liquor
6/03/18	4570	mg/L	Gisborne	Mixed liquor
7/03/18	4500	mg/L	Gisborne	Mixed liquor
9/03/18	4620	mg/L	Gisborne	Mixed liquor
14/03/18	4710	mg/L	Gisborne	Mixed liquor
15/03/18	4650	mg/L	Gisborne	Mixed liquor
16/03/18	4710	mg/L	Gisborne	Mixed liquor
19/03/18	4920	mg/L	Gisborne	Mixed liquor
22/03/18	5210	mg/L	Gisborne	Mixed liquor
23/03/18	4950	mg/L	Gisborne	Mixed liquor

	12/04/18	5730	mg/L	Gisborne	Mixed liquor
	13/04/18	5760	mg/L	Gisborne	Mixed liquor
	8/05/18	4340	mg/L	Gisborne	Mixed liquor
	10/05/18	4680	mg/L	Gisborne	Mixed liquor
	29/05/18	6080	mg/L	Gisborne	Mixed liquor
	14/06/17	5	mg/L	Gisborne	Effluent
	19/06/17	15	mg/L	Gisborne	Effluent
	27/06/17	10	mg/L	Gisborne	Effluent
	3/07/17	5	mg/L	Gisborne	Effluent
	24/07/17	10	mg/L	Gisborne	Effluent
	31/07/17	13	mg/L	Gisborne	Effluent
	8/08/17	20	mg/L	Gisborne	Effluent
	15/08/17	10	mg/L	Gisborne	Effluent
	29/08/17	16	mg/L	Gisborne	Effluent
	6/09/17	14	mg/L	Gisborne	Effluent
	12/09/17	16	mg/L	Gisborne	Effluent
	18/09/17	10	mg/L	Gisborne	Effluent
	26/09/17	6	mg/L	Gisborne	Effluent
	3/10/17	22	mg/L	Gisborne	Effluent
	10/10/17	5	mg/L	Gisborne	Effluent
	17/10/17	25	mg/L	Gisborne	Effluent
	24/10/17	20	mg/L	Gisborne	Effluent
	31/10/17	6	mg/L	Gisborne	Effluent
	13/11/17	25	mg/L	Gisborne	Effluent
	20/11/17	5	mg/L	Gisborne	Effluent
	28/11/17	15	mg/L	Gisborne	Effluent
	5/12/17	5	mg/L	Gisborne	Effluent
	14/12/17	18	mg/L	Gisborne	Effluent
	11/01/18	23	mg/L	Gisborne	Effluent
	16/01/18	3	mg/L	Gisborne	Effluent
	23/01/18	13	mg/L	Gisborne	Effluent
	29/01/18	30	mg/L	Gisborne	Effluent
	6/02/18	13	mg/L	Gisborne	Effluent
	13/02/18	70	mg/L	Gisborne	Effluent
	19/02/18	15	mg/L	Gisborne	Effluent
	27/02/18	13	mg/L	Gisborne	Effluent
	7/03/18	13	mg/L	Gisborne	Effluent
	20/03/18	8	mg/L	Gisborne	Effluent
	27/03/18	8	mg/L	Gisborne	Effluent
SVI	17/05/17	113	unitless	Gisborne	Mixed liquor
	18/05/17	214	unitless	Gisborne	Mixed liquor
	8/06/17	135	unitless	Gisborne	Mixed liquor

	15/06/17	142	unitless	Gisborne	Mixed liquor
	19/06/17	127	unitless	Gisborne	Mixed liquor
	11/07/17	165	unitless	Gisborne	Mixed liquor
	28/07/17	178	unitless	Gisborne	Mixed liquor
	3/08/17	155	unitless	Gisborne	Mixed liquor
	8/08/17	120	unitless	Gisborne	Mixed liquor
	29/08/17	182	unitless	Gisborne	Mixed liquor
	21/09/17	76	unitless	Gisborne	Mixed liquor
	25/09/17	110	unitless	Gisborne	Mixed liquor
	15/12/17	214	unitless	Gisborne	Mixed liquor
	16/01/18	199	unitless	Gisborne	Mixed liquor
	17/01/18	132	unitless	Gisborne	Mixed liquor
	18/01/18	194	unitless	Gisborne	Mixed liquor
	23/01/18	200	unitless	Gisborne	Mixed liquor
	24/01/18	176	unitless	Gisborne	Mixed liquor
	30/01/18	185	unitless	Gisborne	Mixed liquor
	31/01/18	132	unitless	Gisborne	Mixed liquor
	1/02/18	181	unitless	Gisborne	Mixed liquor
	6/02/18	95	unitless	Gisborne	Mixed liquor
	14/02/18	177	unitless	Gisborne	Mixed liquor
	19/03/18	187	unitless	Gisborne	Mixed liquor
	22/03/18	178	unitless	Gisborne	Mixed liquor
	23/03/18	176	unitless	Gisborne	Mixed liquor
TKN	27/03/18	166	mg/L	Gisborne	Influent
	4/04/17	94.2	mg/L	Gisborne	Influent
	18/04/17	81.3	mg/L	Gisborne	Influent
	24/04/17	78.6	mg/L	Gisborne	Influent
	2/05/17	60.3	mg/L	Gisborne	Influent
	9/05/17	91.1	mg/L	Gisborne	Influent
	15/05/17	94.7	mg/L	Gisborne	Influent

	23/05/17	57.5	mg/L	Gisborne	Influent
	30/05/17	80.7	mg/L	Gisborne	Influent
	6/06/17	58	mg/L	Gisborne	Influent
	13/06/17	98.9	mg/L	Gisborne	Influent
	19/06/17	94	mg/L	Gisborne	Influent
	27/06/17	71.9	mg/L	Gisborne	Influent
	3/07/17	46.4	mg/L	Gisborne	Influent
	24/07/17	60.3	mg/L	Gisborne	Influent
	31/07/17	60.3	mg/L	Gisborne	Influent
	8/08/17	47.3	mg/L	Gisborne	Influent
	15/08/17	99.1	mg/L	Gisborne	Influent
	29/08/17	72.4	mg/L	Gisborne	Influent
	5/09/17	70.2	mg/L	Gisborne	Influent
	12/09/17	64.2	mg/L	Gisborne	Influent
	18/09/17	60	mg/L	Gisborne	Influent
	26/09/17	76	mg/L	Gisborne	Influent
	3/10/17	68	mg/L	Gisborne	Influent
	10/10/17	49.6	mg/L	Gisborne	Influent
	17/10/17	93.7	mg/L	Gisborne	Influent
	24/10/17	31.2	mg/L	Gisborne	Influent
	31/10/17	45.9	mg/L	Gisborne	Influent
	13/11/17	78	mg/L	Gisborne	Influent
	20/11/17	69.5	mg/L	Gisborne	Influent
	5/12/17	52.6	mg/L	Gisborne	Influent
	12/12/17	48.9	mg/L	Gisborne	Influent
	9/01/18	91.6	mg/L	Gisborne	Influent
	15/01/18	62.3	mg/L	Gisborne	Influent
	23/01/18	58	mg/L	Gisborne	Influent
	29/01/18	81	mg/L	Gisborne	Influent
	6/02/18	80.1	mg/L	Gisborne	Influent
	13/02/18	91.4	mg/L	Gisborne	Influent
	19/02/18	95.1	mg/L	Gisborne	Influent
	27/02/18	73.4	mg/L	Gisborne	Influent
	6/03/18	76.1	mg/L	Gisborne	Influent
	20/03/18	69.2	mg/L	Gisborne	Influent
Total Nitrogen	27/06/17	3.22	mg/L	Gisborne	Effluent
	3/07/17	3.96	mg/L	Gisborne	Effluent
	24/07/17	3.94	mg/L	Gisborne	Effluent
	31/07/17	3.4	mg/L	Gisborne	Effluent
	8/08/17	3.42	mg/L	Gisborne	Effluent
	15/08/17	4	mg/L	Gisborne	Effluent
	29/08/17	8.92	mg/L	Gisborne	Effluent
	5/09/17	5.8	mg/L	Gisborne	Effluent
	12/09/17	4.4	mg/L	Gisborne	Effluent
	18/09/17	3.7	mg/L	Gisborne	Effluent
	26/09/17	3.78	mg/L	Gisborne	Effluent
	3/10/17	4.11	mg/L	Gisborne	Effluent
	10/10/17	3.8	mg/L	Gisborne	Effluent

17/10/17	5.28	mg/L	Gisborne	Effluent
24/10/17	5.7	mg/L	Gisborne	Effluent
31/10/17	4.45	mg/L	Gisborne	Effluent
13/11/17	3.9	mg/L	Gisborne	Effluent
20/11/17	5.58	mg/L	Gisborne	Effluent
28/11/17	6.12	mg/L	Gisborne	Effluent
5/12/17	6.36	mg/L	Gisborne	Effluent
11/12/17	4.23	mg/L	Gisborne	Effluent
9/01/18	3.38	mg/L	Gisborne	Effluent
15/01/18	2.95	mg/L	Gisborne	Effluent
23/01/18	3.9	mg/L	Gisborne	Effluent
29/01/18	4.6	mg/L	Gisborne	Effluent
6/02/18	7.41	mg/L	Gisborne	Effluent
13/02/18	4.17	mg/L	Gisborne	Effluent
19/02/18	2.88	mg/L	Gisborne	Effluent
27/02/18	4.1	mg/L	Gisborne	Effluent
6/03/18	3.95	mg/L	Gisborne	Effluent
20/03/18	4.1	mg/L	Gisborne	Effluent
27/03/18	3.2	mg/L	Gisborne	Effluent
27/03/18	87.8	mg/L	Gisborne	Influent

APPENDIX 3 – SCRIPTS USED FOR AMPLICON ANALYSIS

```
-------------------------------QIIME 2 ANALYSIS PROCEDURE-----------------

Required Files:

1)sequence data (fastq) - a single file for single ended, two files for
paired end (DOWLOAD FROM THE EUROPEAN NUCLEOTIDE ARCHIVE (ncbi doesn't
supply seperate forward and reverse reads)

2)manifest file (txt, tsv) - Create this yourself (see attached example)
3)metadata file (txt, tsv) - Create this yourself (see attached example)

4)MiDAS sequence file (.fasta) & MiDAS taxonomy file (.tax) - These are
modifed versions of the publically available MiDAS files (I'll sent them to
you).


IMPORTING

-------------------------------SINGLE ENDED MANIFEST IMPORT------------

qiime tools import --type 'SampleData[SequencesWithQuality]' --input-path
manifest.tsv --output-path sample_single_demux.qza --source-format
SingleEndFastqManifestPhred33



--------------------PAIRED END MANIFEST IMPORT-------------------------

qiime tools import --type 'SampleData[PairedEndSequencesWithQuality]' --
input-path manifest.tsv --output-path sample-paired-demux.qza --source-
format PairedEndFastqManifestPhred33



---------------THEN RUN THIS TO LOOK AT SUMMARY------------------------

qiime demux summarize --i-data sample-single-demux.qza --o-visualization
visualise-single-end.qzv

qiime demux summarize --i-data sample-paired-demux.qza --o-visualization
visualise-paired-end.qzv

qiime tools view demux-single-end.qzv


QUALITY CONTROL


-------------------------------------DENOISE SINGLE END SEQS--------------
```

```
qiime dada2 denoise-single --p-max-ee 8 --i-demultiplexed-seqs
sample_single_demux.qza --o-representative-sequences single_rep_seqs.qza --
o-table single_table.qza --p-trim-left 37 --p-trunc-len 270 --verbose
```

------------------------------------DENOISE PAIRED END SEQS---------------

```
qiime dada2 denoise-paired --p-max-ee 8  --i-demultiplexed-seqs demux-
paired-end.qza --o-table sample_table --o-representative-sequences
sample_rep_seqs.qza --p-trim-left-f 25 --p-trim-left-r 30 --p-trunc-len-f
265 --p-trunc-len-r 265 --verbose
```

IMPORTING MIDAS SEQUENCES AND TAXONOMY

-----------------------------------MiDAS IMPORT and TRAINING-----------

```
tar xzvf midas_s123_213tar.gz

qiime tools import --type 'FeatureData[Sequence]' --input-path
MiDAS_S123_2.1.3.fasta --output-path MiDAS_S123_2.1.3ALT.qza

qiime tools import --type 'FeatureData[Taxonomy]' --source-format
HeaderlessTSVTaxonomyFormat --input-path MiDAS_S123_2.1.3.tax --output-path
MiDAS_S123_2.1.3_ref_taxonomy.qza

qiime feature-classifier extract-reads --i-sequences
MiDAS_S123_2.1.3ALT.qza --p-f-primer AGAGTTTGATCCTGGCTCAG --p-r-primer
ATTACCGCGGCTGCTGG --o-reads MiDAS_S123_2.1.3extract.qza

qiime feature-classifier fit-classifier-naive-bayes --i-reference-reads
MiDAS_S123_2.1.3extract.qza --i-reference-taxonomy
MiDAS_S123_2.1.3_ref_taxonomy.qza --o-classifier MiDASclassifier.qza
```

ASSIGNING TAXONOMY

----------------------------------TAXONOMIC ANALYSIS and PRESENTATION-----

```
qiime feature-classifier classify-sklearn --i-classifier
MiDASclassifier.qza --i-reads single_rep_seqs.qza --o-classification
MiDAS_S123_2.1.3taxonomy.qza

qiime taxa barplot --i-table single_table.qza --i-taxonomy
MiDAS_S123_2.1.3taxonomy.qza --m-metadata-file metadata.tsv --o-
visualization sample_taxa_bar_plots.qzv
```