

WATERWORKS



OFFICIAL JOURNAL OF THE WATER INDUSTRY OPERATORS ASSOCIATION

JUNE 2005





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Our Cover: Operation Manager Tony Davies checks the operation of the on line COD analyser at EarthTech's new Echuca Water Reclamation plant. The COD analyser is used to continuously monitor influent COD.

President's Message

A National Operators Association At Last!!

The 10th of February 2005 will be recorded in the history of the Australian water industry as a ground breaking day, the start of the development of a truly National operators association. At a meeting in Melbourne between representatives of WIOA, AWA and WSAA, agreement was finally reached on a structure that will allow WIOA to assume the role of dedicated service provider to operators throughout Australia.

As a result of this historic agreement, WIOA has appointed a full time Executive Officer, something the organisation has dreamed about for many years. The full time appointment will support the rapid development of the many initiatives that are being planned. We are pleased to report

- publish newsletters and journals with truly national content
- further develop and maintain our existing website
- continue to assist in the development of water industry training packages.

No doubt over time there will be opportunities to diversify into other fields as well and this will bring additional benefits to all Members and the water industry in general.

The formalisation of this agreement is the result of a lot of hard work over the past five years. To reach this point there have been many meetings, discussions and a mountain of correspondence. Our thanks for their patience, efforts and vision must be passed on to Rod Lehmann, Barry Norman, Chris Davis and Ian Jarman from AWA, Peter Donlon from both AWA and

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that WIOA's Secretary/Treasurer for the past 11 years and one of only four Life Members, Mr George Wall has accepted the important role as the foundation Executive Officer of WIOA. George commenced his duties on 5 April 2005.

From now on and with the full support of the other Associations, WIOA will be responsible for duplicating the quality services and events that we have enjoyed in Victoria for many years in all the other States.

Apart from maintaining the existing services, the key priorities for the Executive Officer in the short term will be to

- develop an operator support network in each State,
- develop operator focused events including conferences, trade exhibitions, seminars and workshops

WSAA, and our own Committee but in particular Ron Bergmeier and George Wall. Without their efforts this positive development for the WIOA and the water industry would not have been possible.

We look forward to working co-operatively in the future with the many individuals, companies and associations that have an interest in the delivery of services on a National basis to the "operators" in the Australian water industry.

*Cynthia Lim, WIOA President
June 2005*

"OPERATORS? - WHO CARES?"

George Wall

A wise person once wrote - "the only two certainties in life are death and taxes"? I'd like to add a third - CHANGE.

The passage of time and the advent of technology brings with it new and exciting challenges for us all. In our technology driven world we deal with change on a daily basis, probably without even noticing it. In our personal life we have a choice to take it or leave it, but in our work environment we are expected to embrace everything that has ever been dreamed up, particularly by those "evil IT people".

This introduction leads me into what this article is all about - "the operators" and what is expected of them. In the 1980's the role of the operator was to look after their plant, be available 24/7 and to keep it going through thick and thin and with little support. Specialist training was a luxury afforded to a select few. For any newcomers, their training consisted of a quick lesson by "Fred" because he had been the operator there for twenty years and knew everything about the place. Generally, the operators were told exactly

what to do and when, and there wasn't a lot of room for creativity. The engineering fraternity were the "professionals" and brains of the organisation and the operators mostly provided the brawn to get the job done.

In the 1990's, the role of the operator took on a massive transformation. Along came the personal computer, pocket sized mobile phones, electronics and such innovations as automatic control of treatment plants, CITECT, PLC's and SCADA to name a few. With all due respect to the previous generations, the operator "came of age" through this period and the skills required have continued to evolve at a great pace ever since. Although the quick history lesson from "Fred" is still important, the operator of today's systems needs to be much more highly trained and skilled to keep up with community and industry expectations.

"The operators of today and the future are provided training and opportunities that were not available just a few short years ago. They are highly paid, committed, motivated, often specialised and innovative people and have

effectively taken on the role of industry professionals as well. As a result they perform at a much higher levels and meet all the industry expects of them."

So does every operator in the water industry fit this last description? I'd suggest from my observations and discussions around the country that they definitely don't. "Why not?" you may well ask.

In my mind, there are a number of reasons. The first is that believe it or not, there are vast areas of the country where the operators are still treated as they were in the 80's but are expected to perform at a 21st century level. For example, many operators are rarely sent to do training because the budget is a bit tight or there's no-one to replace them while they are away. Some don't receive much in the way of personal support from their boss because there are too many reports to write or they are too busy in the office. Some bosses don't see any point sending out magazines or literature as the operators are too busy or won't read them anyway. The operators in these cases suffer

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from a severe case of isolation and effectively get left to their own devices. They miss out on chances to learn and grow in their industry role.

Many people do not recognise the need operators have for gaining knowledge and contacts or the benefits that this can bring. It still amazes me that some engineers/employers can go to an event such as a conference or seminar to learn, update skills and "network with their peers" but will not allow an operator to attend a similar function because it is a junket. It is true that the operators know how to have a good time but they are also receptive to ideas, love to talk about and solve their issues with other operators and are inquisitive about how technology can be updated or implemented. Adopting new ideas can save money and gain efficiency in the workplace into the bargain.

Another frustrating thing is that many operators have a low regard for the important role they personally play in the industry. I was talking to someone at an operator's event not long ago and asked what he did. "I work at the shitworks" was his reply. When I asked the same question in a different part of the country I got the response of "I am a wastewater treatment technologist". The technologist even got shirty that I dared to call him an operator!

Why did they answer the way they did even though they perform the same role?

Possibly, it is to do with the way the employer treats the employee and the value that each places on the person. Let's not just blame the poor old boss entirely in this case. Professional is as professional acts. We need to help change the mindset of the operator first and get across to him that if he looks at his role as a career rather than just a job both he and his employer will be better off. If we can provide ways to help him do that, he may then change the idea and the value his boss places on him into the bargain.

I could go on with examples like this all day but I trust you get the picture.

So, where do you as an operator or an employer fit into all these scenarios? If you are already committed or supportive, can you do more? If you are not, what can you do to change?

We'd like to think this is where WIOA can assist nationally. Although we have a list of set goals and objectives, I'd like to try to summarise the essence of what we are about in a few sentences. We are primarily about raising the profile and importance of the people we collectively call "operators". We aim to source, develop and share knowledge and resources with them and to

run informative events with an operator flavour. We want to give opportunities to operators to allow them to reach their true potential and we want to make sure that access to the best and most relevant training is readily available. Ultimately, we want to be a group that people are proud to be associated with.

There are already 500 or so people who have recognised the value of what WIOA has to offer and have joined up as members. We don't want our Association to be the nations best kept secret any more. Imagine how many other people work in the water industry right across the country. These people are all potential members if each of us promotes the association properly. We are excited about the future and want you to be as well.

If you would like more info on WIOA please contact me or visit our website at www.wioa.org.au

The Author

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WATER TREATMENT COAGULANTS

(OR HOW I LEARNED TO LOVE DOING JAR TESTS!)

Peter Gebbie

There are a growing number of coagulants now being promoted in the marketplace and many appear to have similar and confusing names. Some have peculiar terms used to specify their characteristics, such as " Al_2O_3 " and "basicity". And, importantly, when do you use one chemical instead of another?

This paper is intended to provide an introduction to using coagulants in water treatment by providing an A to Z guide.

A is for:

- **alkalinity:** for most surface and ground waters that we deal with, this is simply the concentration of bicarbonate (HCO_3^-) ion present in a water, expressed as mg/L calcium carbonate (CaCO_3). It is a very important parameter in water treatment. If raw water does not have sufficient alkalinity to start with, then you will most likely have to add some when you dose a coagulant. Why? Because most coagulants, such as alum, consume alkalinity. In the process, the pH of the water will decrease, sometimes to unsatisfactory levels as they actually behave like an acid when added to water. One of the benefits of using coagulants such as aluminium chlorohydrate or polyaluminium chloride is that they do not use up as much alkalinity in the coagulation process and so the pH will not be affected as much as if alum were used.

- **alum:** the workhorse coagulant! Its chemical name is aluminium sulphate and has the chemical formula $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$. When it is added to a raw water, alkalinity is used up and the pH of the dosed water will drop

- **aluminium chlorohydrate (ACH, $\text{Al}_2(\text{OH})_5\text{Cl}$):** commonly but incorrectly called polyaluminium chloride is a highly hydroxylated or prepolymerised aluminium-based coagulant. It has five OH molecules included in its structure and as a consequence has a very high basicity.

B is for:

- **basicity:** this gives a quantitative indication of how many hydroxyl ions are included in the structure of a hydroxylated or prepolymerised polyaluminium or polyferric coagulant. The higher the basicity of a coagulant, the lower the impact it will have on raw water pH. For example, aluminium chlorohydrate has the formula



$\text{Al}_2(\text{OH})_5\text{Cl}$. You can see that there are five OH ions in its structure. Typically ACH will have a basicity of 83-85%, indicating that it will have less impact on dosed water pH than polyaluminium chloride, which only has three OH ions in its structure and consequently has a typical basicity of 50-55%. Alum has no OH ions in its structure and hence has zero basicity.

C is for:

- **concentration:** often it is necessary to express the concentration of a coagulant (or other chemical, for that matter) in the units gram per litre or some other related unit. To do this you need to know the % w/w strength and specific gravity of the substance. The formula is: $\text{g/L} = 10 \times \% \text{ w/w} \times \text{SG}$. For example, consider ACH with a strength of 23.5% Al_2O_3 and SG 1.33. The actual concentration of ACH is 40.2 % w/w expressed as 100% ACH. Then the concentration in g/L will be: $10 \times 40.2 \times 1.33 = 535 \text{ g/L}$. Now, for alum with an Al_2O_3 content of 7.5% w/w and SG 1.29. This is equivalent to 49.0% w/w aluminium sulphate (as $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$). Using the same formula as before: $\text{mg/L} = 10 \times 49.0 \times 1.29 = 632 \text{ g/L}$.

D is for:

- **DBP's:** Disinfection By-products. These are compounds, many of which are suspected carcinogens that are formed as a result of the chemical reaction between a

disinfectant and organics present in the raw water. In the case of chlorine (or chloramine) DBP's include trihalomethanes and haloacetic acids. In the case where ozone is used for disinfection, DBP's of concern include bromates and formaldehyde. DBP's now require regular assessment under the new Victorian Safe Drinking Water Guidelines. Coagulation needs to be optimised to remove as much of the organic material in water as possible so as to minimise the formation of DBP's (see enhanced coagulation below).

- **DOC:** Dissolved Organic Carbon. This is used as a measure of the possible THM precursor components that may be present in raw water. DOC comes from Natural Organic Matter (NOM) that is dissolved into the water as rain percolates through decaying plant material. Generally if a raw water has a TOC > 10 mg/L, then care must be paid to its removal to ensure that disinfection by-products in the finished water (THM's and HAA's) are below the requirements set out in the Australian Drinking Water Guidelines (ADWG). Coagulation needs to be optimised to remove as much of the organic material in water as possible so as to minimise the formation of DBP's (see enhanced coagulation below).

E is for:

- **enhanced coagulation:** this refers to the practice of dosing a coagulant, typically alum at high concentrations and low pH to boost the removal of DBP precursors in the coagulation process. Whilst there is still debate about the exact nature of the mechanisms involved, it does appear that at low pH (4.5-5.0), direct neutralisation of negatively charged organic compounds and colloids by the aluminium, Al^{3+} ion takes place, thereby allowing the organic molecules to directly contribute to floc formation. The process is often more effective than conventional coagulation at a higher pH, say 5.8-6.5, when the predominant mechanism is adsorption of organics and colloidal matter onto metal hydroxide hydrolysis products that are formed. Obviously coagulating at such a low pH will require careful attention to avoid corrosion of construction materials including pipes in the distribution system and possible high aluminium residuals.



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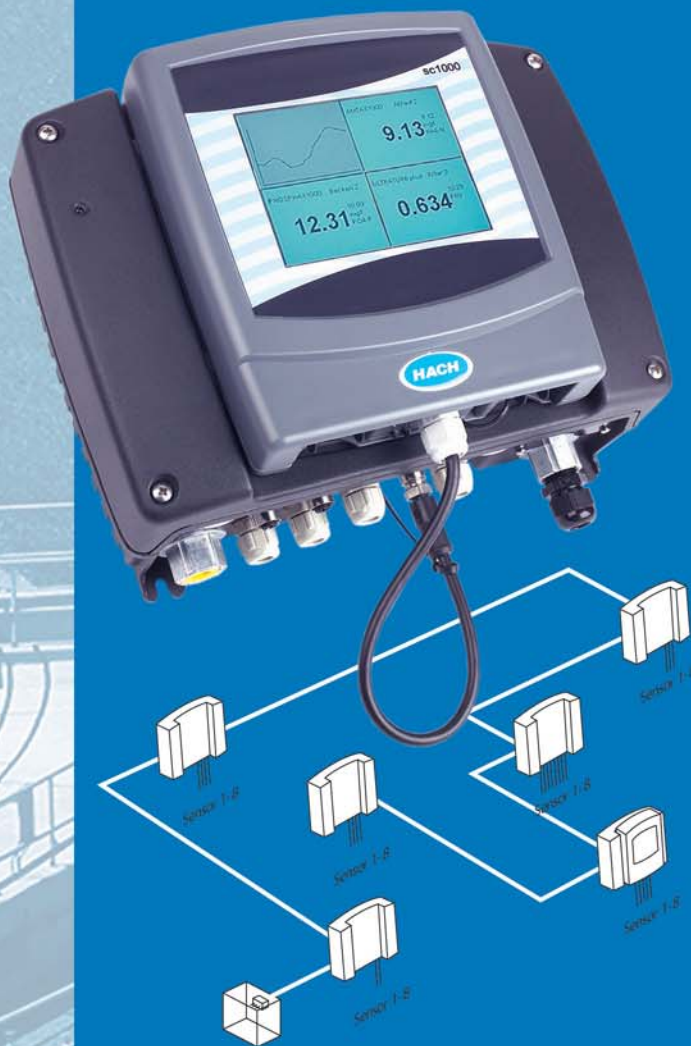
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H is for:

• **HAA's:** Haloacetic acids. This is a family of disinfection by-products formed by the chlorine/chloramine, the most common and important being trichloroacetic acid. This group of DBP's will now require closer scrutiny under the Victorian Safe Drinking Water Guidelines.

J is for:

• **jar test:** this really is one of the most important tools a WTP Operator has for evaluating and optimising different chemical dosing regimes, as well as checking on the performance of his/her plant on a regular basis. The American Water Works Association has updated its M37, which includes a very comprehensive chapter on the proper conduct of jar tests and I can highly recommend it for purchase by your Authority as an important reference¹.

P is for:

• **pH:** this gives an indication of how acid or alkaline a water is. It is a very important parameter in water treatment, especially for effective coagulation. Each coagulant has a narrow optimum operating pH range. For example, alum tends to work best at a dosed-water pH of 5.8-6.5. If the pH is lower or higher than this optimum, then problems of high residual colour, aluminium or DBP's may be apparent in the finished water. This can create problems when the raw water has a high alkalinity when very high alum doses will be required to achieve the right pH. The alternative is to dose acid to decrease the pH to a lower value *first* before dosing the coagulant. This is the opposite of the more common practice of dosing alkali (lime, soda ash or caustic soda) to raise the pH of low alkalinity waters.

• **percent weight/weight or w/w:** number of kilograms of active chemical per 100 kilograms of liquid chemical. For example, liquid alum is commonly delivered as 7.5% w/w Al_2O_3 , thus for every 100 kg of liquid chemical there are 7.5 kg of Al_2O_3 present

• **percent Al_2O_3 :** common method for quoting strength of aluminium-based coagulants on w/w basis. Another method of referring to concentration is to state the aluminium content, which is roughly half the Al_2O_3 content. For example, liquid alum is typically 7.5 w/w Al_2O_3 , which is the same as 4.0-w/w aluminium (Al).

• **polyaluminium chloride (PACl, $Al_2(OH)_3Cl_3$):** often incorrectly referred to as "PAC". This abbreviation is now more usually reserved for "Powdered Activated Carbon". Another hydroxylated aluminium-based coagulant with lower

Table 1. summary of important coagulant details.

COMMON COAGULANT NAME ¹	TYPICAL MANUFACTURERS	CHEMICAL NAME & FORMULA	TYPICAL ANALYSIS	NOTES	INDICATIVE COST, \$/tonne (as 100%) ²
Alum	Aluminates Omega Chemicals	Aluminium sulphate $Al_2(SO_4)_3 \cdot 18H_2O$	7.5-8% Al_2O_3 or 49-52% w/w $Al_2(SO_4)_3 \cdot 18H_2O$ SG 1.3	Most common coagulant used in water treatment. Relatively cheap.	450
PAC 23 MEGAPAC 23 ALCHLOR AC	Aluminates Omega Chemicals Hardman Chemicals	Aluminium chlorohydrate (ACH) $Al_2(OH)_3Cl$	23-24% Al_2O_3 or 40-41% w/w ACH SG 1.33 83-84% basicity 8.5% w/w Cl	Used in lieu of alum where raw water has low pH & alkalinity. Has little impact on pH.	2100
PROFLOC A23 PAC-10 LB MEGAPAC 10	Aluminates Omega Chemicals	Polyaluminium chloride (PACl) $Al_2(OH)_3Cl_3$	10-11% Al_2O_3 or 20-23% w/w PACl SG 1.18 50% basicity 10.5% w/w Cl	Used in lieu of alum where raw water has low pH & alkalinity. Has greater impact on pH than ACH.	2500
PAC-10 HB	Aluminates	Aluminium chlorohydrate (ACH)	Diluted ACH. 10% Al_2O_3 80% basicity	See ACH. Sometimes used in small WTP's.	2800
PACS	Aluminates	Polyaluminium chlorosulphate $Al_3(OH)_4.95Cl_{3.55}(SO_4)_{0.25}$	10% Al_2O_3 or 5.3% w/w Al SG 1.19 50% basicity 10% w/w Cl 2% w/w SO_4	Aluminium-based coagulant. Not commonly used; at some NSW WTP's.	2800
PASS®	Aluminates	Polyaluminium silicosulphate $Al_2(OH)_3.24Si_{0.1}(SO_4)_{1.58}$	10% Al_2O_3 or 5.3% w/w Al SG 1.34 54% basicity	Strange coagulant! Cannot be diluted with water: forms flocs. Gippsland Water has used with success.	2500
Sodium aluminate	Aluminates	$NaAl(OH)_4$	18% w/w Al_2O_3 or 41.7% w/w $NaAl(OH)_4$ SG 1.47 12% w/w free NaOH	Strong alkaline coagulant. Can work on highly coloured water with low alkalinity. Used at some Tasmanian WTP's.	2200
PFS®	Aluminates	Polyferric sulphate $Fe_2(OH)_0.5(SO_4)_{2.7}$	12.2% w/w Fe(III) or 43.7% w/w $Fe_2(SO_4)_3$ SG 1.54 10% basicity	Hydroxylated ferric sulphate. Used at several WTP's in NSW.	650
Ferric Sulphate MEGACLEAR 12	Hardman Omega Chemicals	Ferric sulphate $Fe_2(SO_4)_3$	12% w/w Fe(III) or 43% w/w $Fe_2(SO_4)_3$ SG 1.50	Similar to PFS®. Has greater impact on raw water pH.	550
PROFLOC F	Orica/ Spectrum	Ferric chloride $FeCl_3$	14-15% w/w Fe(III) or 41- 43% w/w $FeCl_3$ SG 1.45	Similar to other ferric coagulants. No SO_4 added to treated water. Very corrosive.	1400

1. Brand names for coagulant products are shown in italics. In general, number refers to Al_2O_3 content in % w/w e.g. MEGAPAC 23 is ACH with nominally 23% w/w Al_2O_3 content.

2. Assumes 20 kL bulk delivery, ex works Melbourne.

basicity than ACH, and hence has more impact on raw water pH when used as a coagulant but less impact than alum.

• **polyDADMAC:** an abbreviation for a cationic (positively charged) polyelectrolyte (polymer) that is often used as a primary coagulant in direct filtration water treatment applications. It is sometimes used in combination with ACH and this mix is often sold as a proprietary blend, e.g. Ultrion series from Nalco/Ondeo and "1190" from Aluminates. PolyDADMAC does not give as high true colour removal and hence TOC/DOC removal as does metal-based coagulants.

S is for:

• **specific gravity (SG):** this is the unit weight of a liquid chemical relative to water at the same temperature. Strictly speaking,

SG has no units but you'll often find it or density stated on laboratory reports as "g/mL" or as "kg/L". For a given chemical, there is a direct relationship between its strength and its SG, and indeed chemical manufacturers use SG to measure the strength of a chemical during the manufacturing process. As an example, liquid alum (49% w/w) typically has a SG of 1.310, whilst liquid caustic soda (46% w/w) has a SG of 1.498 at 20°C.

T is for:

• **THM's:** Trihalomethane compounds. These are a class of disinfection by-products formed by chlorination and to a lesser extent chloramination. Under the new Victorian Safe Drinking Water Guidelines, THM's will require more frequent monitoring. The higher the raw water

1. AWWA, (2000), Operational Control of Coagulation and Filtration Processes, M37, 2nd Edition, *Manual of Water Supply Practices*, Denver, CO.

TOC/DOC, the higher will be the finished water THM levels. Coagulation needs to be optimised to remove as much of the organic material in water as possible so as to minimise the formation of THM's and other DBP's.

- **TOC:** Total Organic Carbon. This is also used as a measure of the possible DBP precursor components that may be present in raw water. Generally if a raw water has a TOC > 10 mg/L, then attention must be given to its removal to ensure that disinfection by-products in the finished water (THM's and HAA's) are below the levels set out in the ADWG.

Table 1 summarises important characteristics and supplier details for commonly used coagulants, as well as some notes on possible applications.

To finish off, a couple of tips about coagulant selection may be of help.

- Generally, alum is the first coagulant of choice because of its lower cost and availability throughout Australia. For coloured, low turbidity, low pH/alkalinity surface waters typical of South Eastern Australia, pre-treatment with lime, soda ash or caustic soda will be required to ensure that the optimum coagulation pH is achieved.

These types of water however, also make the use of ACH possible. It is often feasible to coagulate at a relatively high pH (7.5-8.0) and so avoid the need to dose alkali for pH correction, something that is often difficult at small WTP's. The need to add alkali can often be further reduced by replacing gas chlorine with hypo for disinfection. Recently ACH dosing was successfully implemented at the Mallacoota WTP. Finished water residual aluminium and THM levels have both been below ADWG limits since changing over from alum to ACH.

As a rule-of-thumb, ACH doses required for a surface water will be approximately 1/3rd of those required when using alum. The overall chemical cost increase when changing over to ACH from alum will be typically 15-20%. However, other benefits such as lower sludge production, avoidance of post-treatment alkali dosing and reduced materials handling may still make the use of ACH attractive.

So if you have a water with a low alkalinity and you are having difficulty treating it using alum, try one of the higher basicity coagulants e.g. ACH or PACl.

- Iron-based coagulants, such as ferric chloride, ferric sulphate and PFS®, are not

that popular in Australia and tend to be more expensive than alum on an equivalent kg per metal dosed basis. They also consume more alkalinity than alum, and hence tend to depress pH of the dosed water more dramatically. Opinions also differ as to whether they produce a fluffier floc, which is more difficult to settle. Several WTP's in NSW use PFS® in order to meet very stringent manganese limits in the finished water. Ferric-based coagulants are extremely corrosive and produce highly visible blood/rust-coloured stains when there are chemical spills and leaks.

Hopefully you have found this guide of some help. Please feel free to contact me if you have any particular concerns about coagulant choice, properties, pre- or post-treatment pH adjustment, choice of alkali, or other related matters!

I'll forward your queries and my replies to WaterWorks for future publication so that we can all participate in learning more about this challenging topic.

The Author

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IMPROVED FLOAT REMOVAL AT A DAFF

Karl Williams

The South Gippsland Region Water Authority constructed its first DAFF (Dissolved Air Floatation Filtration) treatment plant at Lance Creek in 1997-98. The Lance Creek treatment plant supplies water to the towns of Wonthaggi, Cape Paterson and Inverloch, representing approximately 50% of South Gippsland Water's customer base. The plant has a design capacity of 19ML/day

DAFF was selected due to its ability to remove algae without damaging the cells. This was a priority as Lance Creek Reservoir has been subject to frequent algal blooms due to the amount of nutrients from the predominantly agricultural catchment.

The Problem

Traditionally, removal of the float in the DAF process is achieved by mechanical scrapers which require on-going maintenance or flooding and overflowing the floatation tank, the method used at Lance Creek.

The problems with this method of float removal is that it uses large amounts of water; results in a heavy loading of wash water systems in summer and there is a risk of environmental contamination from a sludge spill.

The objectives in looking for improvements to the float removal system were to reduce the amount of water used for float removal and to reduce the amount of sludge produced.



The Lance Creek WTP.

Trials

The idea for the original trial was based on the fact that if you could blow the froth of a beer why couldn't the same process work for a DAFF cell? So a number of trials were set up.

1. Water sprays based on the cutting spray system with jets facing into the tank. These only proved effective within about a 1m of the sprays and made little difference to the overall float removal time.

2. High Pressure compressed air. This was based on a making up a manifold using the plants compressed air system. The results were similar to the water sprays

3. Low Pressure high volume air. Two smoke machine blowers were temporarily installed in a cell. They immediately proved effective, removing the sludge in a fraction of the time of the original system. The blowers are linked to the existing cell level control. When a float is activated, the rising level in the cell starts the blowers.



The Lance Creek Reservoir.



A DAFF Cell.

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The blower used in the initial trial.

The blower run time is controlled by a timer which is based on the total float time.

The float removal system uses low cost off the shelf units with low power cost and minimal maintenance requirements.

Outcomes

The blower units have proved successful in removing the float in a shorter time reducing water usage. Table 1 provides a comparison of float removal performance using the original system and the blower assisted system. The time lapse photographs below also show visually how the system has been improved.

The more efficient float removal system means that more potable water is produced for the same raw water volume. There is also a reduced loading on the sludge handling system and shorter run times leading to lower power consumption.

As a result of the trials two blower machines were installed on each of the three floatation tanks at the Lance Creek plant at a total cost of \$5000 and the new water treatment plant at Yarram has had blowers included at the design stage.

Acknowledgements

Kevin Mitchell and Peter Bentick assisted with installation of the equipment and

Ravi Raveendran and Bryan Chatalier provided technical assistance.

The Author

Karl Williams is a Water Treatment Plant operator with South Gippsland Water, Victoria, and can be contacted at kwilliams@sgwater.com.au. This paper was originally produced as a poster and won Best Operator Poster at the 2004 Victorian Conference.

TIME ELAPSED PHOTOGRAPHS

WITH BLOWER ASSISTANCE

WITHOUT BLOWER ASSISTANCE

0 secs



30 secs



60 secs



90 secs



Table 1. Performance Comparison Trials

With Blower Assistance	Parameter	Without Blower Assistance
432 kL/hr	Plant Raw Water Flow Rate	432 kL/hr
54 hours	Plant Run Time	65 hours
23138kL	Total treated water produced	27161kL
428.5kL/hour	Average treated water production	417.9kL/hour
190kL	Water lost during float	919kL
3.5kL/hr	Average float water lost	14.1kL/hour

Saving of water using air assisted withdrawal 10.6 kL/hour (24.7 kL/ML produced)

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CAIRNS WATER TREATMENT ALLIANCE

Brian Smyth and Chris Ormond

The Freshwater Creek Water Treatment Plant (WTP) was commissioned in 1980 to supply treated water to the City of Cairns. At that time Cairns had a population of around 75,000. Raw Water for the plant is taken from Freshwater Creek, a tributary of the Barron River. The catchment for Freshwater Creek consists of rainforest with generally low impact land. Storage is in Copperlode Dam, Lake Morris, where no recreational activities are allowed. Water quality in the lake is consistently good with the turbidity varying typically between 2 NTU and 4 NTU, colour between 7 and 15 Pt-Co and alkalinity between 9 mg/L and 12 mg/L. There are no iron, manganese or algal problems, however raw water turbidity can peak at over 900 NTU during Cyclone events!!

The original plant consisted of four up-flow clarifiers and four multi media filters with a maximum capacity of 55 ML per day. The clarifiers proved difficult to run with such clean raw water so they were deactivated and straight gravity flows went to the filters. The plant was expanded with an additional two filters in 1988 to a design capacity of 120 ML per day. Cairns population through the 80's and 90's outgrew projected increases. Population serviced today is 130,000 residents and an average of 25,000 tourists on any given day. A new 150 ML treatment plant is currently in the design stage for construction beginning in 2006.

The plant now operates as a direct filtration plant with multi media filters and upstream alum and polyelectrolyte dosing. Soda ash is applied post filtration for pH control. The water is disinfected with gaseous chlorine. The plant runs on demand, and averages 18 to 22 hours per day with flows as required. The average flow is approximately 800 L/sec. Nine staff who are in attendance at the plant for 8 hours per day operate the plant. Staff are responsible for all operations and maintenance of the plant. They also operate and maintain Copperlode Dam, a second treatment plant (Behana) which supplies the southern side of Cairns with a 44ML a day capacity and 2 in stream intakes. They also service and maintain all high-pressure trunk mains, (75 kms total of 406mm - 1080mm, at 1200kpa).



Figure 1. Copperlode Falls Dam - source water for Freshwater Creek.

The Water Treatment Alliance Project

Cairns Water became aware of the Water Treatment Alliance at a workshop in Sydney in August 2000 conducted by Bill Lauer from the American Water Works Association.

The Water Treatment Alliance is a continuous improvement program for Water Treatment Plants based on a

thorough self-assessment of the plant including design, operation and administration. The Alliance is jointly supported and administered in Australia by the Water Services Association of Australia (WSAA), the Australian Water Association (AWA) and the Cooperative Research Center for Water Quality and Treatment (CRCWQT).



Figure 2. Freshwater Creek Intake - supplies raw water to the Plant.

At the initial stage Cairns Water was interested in the concept but no official works were commenced. However the basic ideas were discussed and several improvements to the plant were identified and work commenced on the improvements.

Cairns Water was approached in May 2002 to formally participate in the Alliance. Cairns Water agreed to participate and in September 2002 the Self Assessment Handbook and early version of the data collection software was delivered.

Project Team

One of the first steps in the Alliance program is the establishment of a project team. At Cairns Water the team consisted of the Water Supply Team Leader and three Treatment Plant Operators. This team formed the basis of the Alliance project for 12 months. Base line turbidity data was collected for 12 months on filter operations. Monthly Alliance meetings were included into the plants normal Safety/Staff/Team Brief/Operations/Tool Box, meetings. By combining the WTA activities with the other normal plant activities, the concept of the Alliance approach was integrated with the normal operation of the plant and minimised the number of separate meetings and time off the job.

Team Projects

As the Freshwater Creek WTP was over 20 years old, many upgrade ideas were in train for capital works and minor works for staff. The plant process hadn't been reviewed for over 15 years. New ideas were thought about and several were implemented or trialled.



Figure 3. Freshwater Creek Water Treatment Plant.

These included:

- PLC replacement
- Electrical wiring upgrades and Rat proofing of the control cabinets. (We have a major issue with an Australian Marsupial called a "White Tailed Rat". They are ferocious eaters of electrical cables).
- Sludge removal process upgrade. A Dehydum was decommissioned and sludge pumped to sewer
- SCADA system upgrade. *Macroview* to be replaced by *Citect*.
- Flow meter replacement program
- Pre soda trial for low alkalinity water
- Calibration and servicing upgrade for test equipment.

- Polyelectrolyte requirement trial
- Filter ripening trials over the plants flow range. Min 400 L/sec to 1200 L/sec.
- Trialling a Streaming Current Detector (SCD) for process control
- Total replacement of the water hydraulic valve system with Rotork electric actuators.
- Review of filter husbandry procedures.
- Review of plant standard operating procedures.

Water Quality: Summary of Results

The WTA relies heavily on the collection of turbidity data for both the raw and treated water. Turbidity is an excellent surrogate measure for the overall water quality but in particular the risk of *Cryptosporidium* and

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Giardia in the finished treated water. The WTA strongly recommends individual on line turbidity meters for each filter, however at the time of participation, the Freshwater Creek WTP had a single on line turbidity meter monitoring the combined filtered water quality. One of the projects for the future is to install individual turbidity meters.

Table 1 shows the raw water quality for the period 2002 to 2004.

The raw water generally has a low turbidity however higher turbidities do occur during heavy rainfall. The standard operating procedure is for the plant to shut down at 30 NTU. Experience has shown that the water is untreatable above this figure. Dirty water events are generally of short duration and there is sufficient water stored in the treated water storages to supply water during that period. Approximately 72 hours supply is held in storage, but with community awareness and severe restrictions this could be extended further.

The filtered water turbidity data is collected daily and entered to the WTA software. At the end of 12 months the data is analysed and produces a graph and also a turbidity spike count. Turbidity spike counts are the number of times that the turbidity exceeds a certain value. This is a useful way to view the overall performance of the filters and the spike count data for 2002 to 2004 is shown in Table 2.

The table shows very similar treated water quality for the 2 years.

One of the other key objectives specified in the WTA is that filter ripening periods be <0.3 NTU and no longer than 15 minutes. Filter ripening times at the Freshwater Creek WTP remained the same for both years. Filtered water turbidity returned to below 0.1 NTU within 12 minutes at all plant flows between 400L/sec and 1000 L/sec.

Benefits from the Alliance Project.

While there has been no real improvement in the treated water quality (Water from the Freshwater Creek WTP was already very high quality) a number of other significant benefits have been realised. These are listed below.

- Polyelectrolyte system shut down for 9 months of the year (Clean raw water times). Cost saving of \$2,500.00. No loss of finished water quality, no breakthrough from filters, extended filter runs by approximately 12%. The extended filter run times resulted in reduced backwash water

Table 1. Raw water turbidity for the 12-month periods 2002/2003 and 2003/2004.

	2002/2003	2003/2004
Minimum Turbidity (NTU)	1.9	1.1
Maximum Turbidity (NTU)	33.7	43.7
Average	2.8	3.0

demands by 2ML per week allowing that water to go to the distribution network. During December to April, polyelectrolyte is still required to assist with coagulation.

- The pre soda ash trial proved successful. This facility is now a permanent fixture, which can be switched on as required. The problem was at certain times of the year we couldn't maintain a good floc because the alkalinity dropped below 8mg/L.
- Occasional double backwashes. It was found that doubling up backwashes once a month greatly improved the filter run times. More than that it was noticed the filter ripening times started to creep up to 15 minutes prior to the double backwashes. Also spelling a filter and drying it out prevented mud balling and algae growth on the sidewalls. Filter walls are now hosed during backwashing at least once per week and twice a year the walls are pressure water blasted. Filters are spelled for a period of 14 days, on rotation at a time when demands allow.
- Sieve samples were taken from all filters to ascertain media size and serviceability. Filters 1- 4 (older units) were all still within the 95% of original specifications and filter 5&6 were 97%.
- Maintenance costs on the plants valve actuators has been reduced by \$15,000 per annum.
- The Streaming Current Monitor test was successful during the clean water period of the year but was not able to cope with wet season variables. More tests on this unit will be done during the current wet season, before a decision is made for the long term.
- Review of the calibration and testing of flow meters and online instrumentation showed up the requirement for an upgrade. Staff training and review of procedures now

Table 2. Turbidity spike counts for finished water at the Freshwater Creek WTP for the 12-month periods 2002/2003 and 2003/2004.

Turbidity Spike	2002/2003	2003/2004
0 - 0.1 NTU	305	319
0.1 - 0.2 NTU	44	41
0.2 - 0.3 NTU	9	5
0.3 - 0.4 NTU	8	1
0.4 - 0.5 NTU	0	0

gives a greater confidence in collected data.

- With the implementation of the new Citect program, operators have been able to view additional information the previous program was unable to provide. Based on this additional information, over a dozen changes have been made to the PLC

program to optimise the treatment process. These include:

- Time between backwashes reduced by 15 minutes by adjusting levels in the service water reservoir and pump start/stop levels.
- An additional 20kL of water being treated at the beginning of each backwash cycle instead of draining through the sludge cycle.
- Less floc carry over in supernatant water returning to Freshwater Creek by a combination of installation of an online turbidity meter in the settling tanks and adjustments to paddle stirrer times.
- Quicker filter refilling times after a backwash by using raw water instead of the original backwash water, after installing baffles to dissipate flow volumes over a greater surface area. PVC air scour lines are situated directly under the raw water inlet valve. These pipes need to be covered by water before the heavy flows from the inlet valve cascade over them. Several had cracked before this modification was installed.

Conclusions

The Freshwater Creek WTP has always produced very high quality water. Whilst there hasn't been any measurable improvement in treated water quality over the past 2 years, the approach recommended by the WTA and the self-assessment of the plant has allowed Cairns Water to greatly improve operational reliability and achieve considerable cost savings. Ongoing projects to continue the improvement process include, installation of additional turbidity meters for the individual filters, a Particle Counter on outlet water, bulk handling equipment for chemicals and changing the plant from liquid chlorine gas to sodium hypochlorite.

The Authors

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TRADE WASTE MANAGEMENT PLANS - COOPERATIVE COMPLIANCE

Jason McGregor

*Paper presented at the Annual Victorian
Water Industry Engineers and Operators Conference 2004*

Introduction

The Victorian *Water Act 1989* requires a Water Authority to "provide, manage and operate systems for the conveyance, treatment and disposal of sewage and, if it so decides, of trade waste". This provides the incentive for an authority to develop and maintain an effective trade waste management system.

A typical trade waste management system may include:

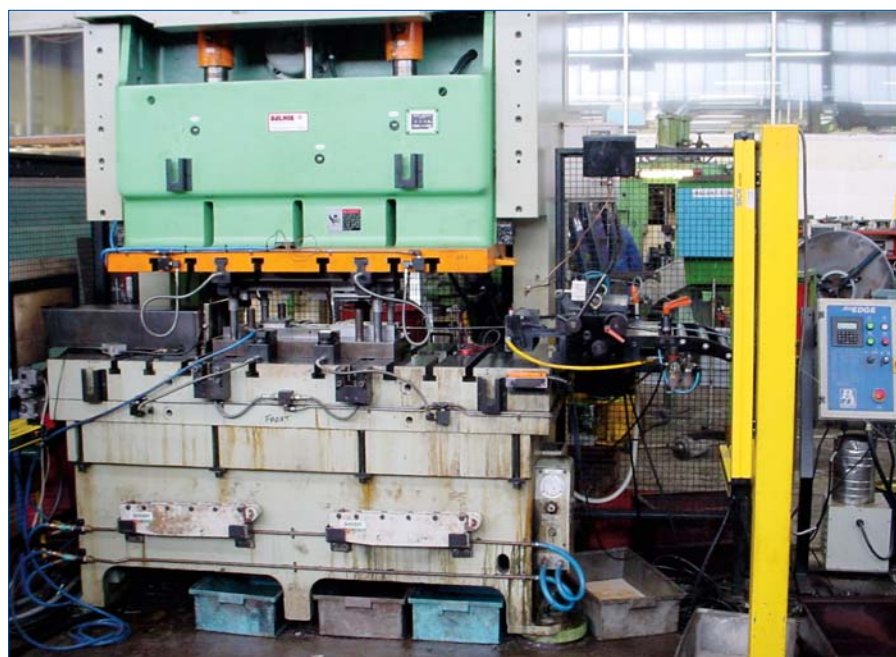
- a trade waste by-law developed in accordance with the *Water Act*,
- a trade waste policy set by the authority,
- a trade waste agreement or consent which is issued to customers that discharge trade waste into the authority's sewers and
- a set of criteria that prescribes limits for individual contaminants based on safety considerations, system integrity, treatment capacities and increasingly, re-use potential.

Many trade waste customers are unable to comply with stringent quality limits without significant change, often leading to either reluctance to sign a trade waste agreement or non-compliance with an existing agreement. Likewise, water authorities are limited in their ability to relax quality limits without compromising safety and/or system efficiency.

In addition, the basic business objectives of the trade waste customer and that of the water authority differ. The authority's goal is to safeguard against risk, while invariably, the trade waste customer wishes to maximise profitability. Historically this is where legislative methodology has failed to bridge the gap.

A Trade Waste Management Plan (TWMP) is an effective tool that has proven successful in linking both the water authority and the trade waste customer to an agreed action plan in support of a trade waste agreement.

The Victorian Water Industry Association in partnership with the Victorian EPA has published and released a set of guidelines titled *Trade Waste Management Plans - A Guide And Industry Template For Improving Trade Waste*



Part of CMI Operations' metal pressing and finishing plant.

Discharges. As the name suggests, this guideline provides the framework for developing a TWMP with a view to reducing trade waste related contamination. The guideline also provides some valuable tools such as a process flow diagram template and root cause analysis template, for use in identifying the process steps and root cause associated with the priority parameters.

A good TWMP will contain a minimum of three key ingredients:

- a description of the customer's trade waste circumstances and compliance deficiencies;
- an agreed action plan with objectives and timeframes designed to address compliance deficiencies; and
- a set of contingency plans for use in an emergency.

The TWMP should provide a pathway for continuous improvement as a condition of the agreement. At every stage in the process, the TWMP must remain dynamic enough to cater for changing circumstances.

Mutual Awareness

TWMPs provide a flexible joint in the customer/authority relationship, linking the customer's trade waste obligations with achievable milestones. It is therefore imperative that at the outset, both the customer and authority agree to a partnership approach. The interests of both customer and authority are best served through cooperation and understanding. The term "partnership" implies a willingness to understand the other's position and to accommodate the other's needs where possible.

The water authority should take the opportunity to educate the customer of the issues and difficulties surrounding its discharge of trade waste. Only through developing the customer's awareness can the water authority hope to approach underlying issues with the support of those responsible. An informed customer is more likely to take ownership of the issues surrounding their company's trade waste discharge, particularly where the customer can see a benefit to themselves also.

The viability of the partnership needs to be maintained by meeting regularly and



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WASTE MANAGEMENT



Figure 1. Reduced Monthly Trade Waste Discharge Volumes.



Figure 2. Increased Chemical Oxygen Demand at CMI Operations Due to Recycling.

sharing information and discussing problems.

Collection of Information and Identification of Priorities

Collection of information and setting of priorities will help determine the scope of the TWMP. Efforts towards trade waste improvements must be properly focused in order to maximise any likely benefits.

In all cases the volume discharged should be targeted so that water conservation and potable substitution receive due attention. The contaminants chosen for inclusion in the plan should be chosen for their relative importance with regard to the risk of non-compliance with the customer's trade waste agreement, risk to health and safety and risk to the sustainability of re-use projects. A risk assessment conducted on the characteristics of the customer's trade waste is a valuable aid.

To achieve reductions in the volume or strength of the selected parameters, an understanding of the source of these parameters is necessary. However, sharing information with the water authority can be daunting for the customer, therefore the water authority must exude an enthusiasm to work cooperatively. It is rewarding to the relationship to reinforce the aim of the exercise regularly. The aim is to implement cleaner production in partnership with the customer to the benefit of all concerned.

Goal Setting

Goal setting should be based on expected benefits, the financial impact on the customer, available technology and the consequences of doing nothing. It is important that in setting these goals, both parties agree that the goals are achievable.

Keeping goals to a minimum ensures that the focus is maintained on the priority parameters.

Identification of Options and Plan Development

Based on the identified goals, the customer and water authority should brainstorm all possible options to achieve the goals. It is important to think beyond treatment technology and consider process changes, or product substitution to achieve cleaner production. Recycling is often an easy means of waste minimisation, yet without simultaneous reductions in priority parameters, critical loads may not be improved.

Since the customer will have an intimate knowledge of the processes and limitations of its operations, the water authority will most often rely on the customer to suggest process change. However the water authority will usually possess a greater awareness of treatment options. This combination serves to provide a comprehensive list of options from which to choose. The next key step is to assess these options based on benefit, cost and consequences. Section 6 of the Trade Waste Management Plan guidelines offers a systematic approach towards developing and assessing options. This is particularly useful in providing structure when assessing options.

Once both parties have agreed to the plan, it can be appended to the trade waste agreement.

Implementation and Review

The regular review of the customer's trade waste agreement and TWMP offers insight into the customer's compliance with the agreed action plan, while periodic



Part of CMI Operations' metal pressing and finishing plant.



Finished components.

consultation with the customer helps to maintain both parties' understanding of changing circumstances.

A Case Study - CMI Operations

CMI Operations is an international company manufacturing pressed metal components for the automotive industry. As an ISO 14001 accredited company, CMI Operations is committed to improving its overall environmental performance.

Metal finishing is an integral part of daily operations, with components subjected to heat treatment, surface preparation and coating with various rust inhibitors and metal based surface veneers. These processes have historically resulted in high concentrations of zinc, chromium and oil in the trade waste discharged to Central Highlands Water's sewers.

CMI, in partnership with Central Highlands Water, embarked on a trade waste management plan focused on

reducing heavy metal loads and total trade waste flows to the sewer. Focusing attention on these parameters allowed CMI staff to identify a number of problem areas within the factory. A simple site visit helped identify the key processes and equipment generating a large percentage of the trade waste.

Working with Central Highlands Water, CMI Operations developed a range of options including recycling of cooling water and minimising heavy metal residue to

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sewer. To minimise the total volume of trade waste discharged, a closed circuit recovery and cooling system was installed to recycle gas furnace cooling water.

The approach taken by CMI to reduce heavy metal loads was surprisingly simple. Staff began by questioning the processes up-stream of the point of discharge to sewer and made some simple observations.

CMI staff discovered that hundreds of litres of heavy metal laden wastewater were regularly discharged from a large caustic bath. As a result the caustic bath is no longer used to clean equipment, instead a small water efficient pressure cleaner is used inside a purpose built spray booth. The reduction of the volume discharged to sewers is shown in Figure 1. The associated increase in COD is shown in Figure 2. This increased COD concentration has not presented any difficulties to Central Highlands Water treatment operations.

The much lower volume of concentrated wastewater generated is now transported off site to an appropriate treatment facility. Work is also being done to reduce the metals at the source.

The recycling of cooling water reduced potable water consumption and trade waste volumes by 57,000 litres per day. This more than halved their total daily volume. This initiative provides an annual saving of

approximately \$8,400 for potable water alone and more than \$2,000 in trade waste charges.

By changing its cleaning processes, CMI completely eliminated its heavy metal discharge to sewer. This resulted in a further \$1700 saving in trade waste charges. It also managed to reduce its use of caustic saving a further \$600 per annum and reducing the discharge of sodium, a limiting factor in wastewater reuse. Compared to the cost of implementation at around \$12,000, the collective savings provide a payback period of little more than 12 months.

This partnership built a strong working relationship between CMI and Central Highlands Water which was an integral part in the development of CMI Operations' trade waste management plan and in overcoming troublesome non-compliances with CMI's trade waste agreement.

For Central Highlands Water the key achievement from this partnership was the elimination of heavy metals being discharged to sewer. The reductions achieved by CMI will assist in improving biosolids quality and decreasing the risk to various re-use projects.

It should also be noted that an awareness of the consequences of any actions is

necessary in order to plan for changing circumstances. It is important to stay alert to the potential for increasing concentrations when recycling, or for deferring the problem rather than minimising or eliminating it altogether.

Don't over engineer a solution to a problem that can be avoided or minimised. Remember the waste hierarchy; cleaner production provides a better solution than disposal.

Conclusions

Integrating a trade waste agreement with a TWMP provides an avenue for flexible trade waste minimisation. The constraints associated with prescriptive trade waste agreements are softened and in doing so, the ability of the customer to improve its performance becomes measurable.

Regardless of the extent of trade waste contamination or degree of compliance deficiency, the TWMP offers a systematic approach to implementing cleaner production and waste minimisation and encourages improvement from every customer within the customer's means.

A significant demand on resources can be expected when utilising a TWMP in support of a trade waste agreement. The negotiation and monitoring of TWMPs across a number of customers requires significant effort. However the benefits can be quantified to establish a rate of return.

Acknowledgements


The efforts of Central Highlands Water's trade waste customers in working with the Authority towards waste minimisation and cleaner production through the development and use of trade waste management plans is acknowledged with thanks.

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COMPOSTING BIOSOLIDS

Darren Key and Peter Mosse

Biosolids are one of the products of wastewater treatment. Left in a stockpile after dewatering they tend to slump and thus require a relatively large area for storage. The piles tend to develop unpleasant odours and are very difficult to apply to land using conventional agricultural equipment. Composting is one way to convert this relatively undesirable product into a friable, pleasant smelling earthy product in as little as 8 to 12 weeks. The final product is easy to handle for both domestic and agricultural applications.

Gippsland Water operates five activated sludge Sewage Treatment Plants (STP). At the Warragul STP, waste activated sludge is thickened and dewatered using a conventional belt press. A cationic polymer is mixed with the Waste Activated Sludge and then passes through a drum thickener and on to a belt press. The resultant product is around 16% to 18% solids. Approximately 35m³ of product is produced each week. This product has been transported approximately 130km to an agricultural site and stockpiled for a period prior to application to the land. The application to the land has always been a relatively smelly and sticky job.

Consistent with the changing emphasis toward beneficial reuse of biosolids, a decision was taken to compost the biosolids with green waste to produce a more acceptable product for reuse.

Construction of a Composting Pad

A thick gravel pad consisting of a compacted road base material, approximately 30m by 120m was established for the composting operations. This pad was constructed so that any leachate would be collected in an adjacent drain and disposed of to a nearby wastewater lagoon.

After the first composting trials, the pad area was found to be too small to be able to compost all of the biosolids being produced. The pad was therefore extended by a further 120m by 45m.

A water supply main was installed around the pad with multiple outlets to allow easy application of water to the windrows when necessary to achieve optimal moisture content.

Composting

The starting point for the composting trial was a basic mix of 2 parts of shredded green



Figure 1

waste to 1 part biosolids (2:1 v/v). This gave a carbon:nitrogen ratio of about 17:1. Our target ratio was 20:1. The basic mix was therefore changed to 2.5:1 to achieve the required carbon to nitrogen ratio.

Shredded green waste has been obtained from a number of local suppliers. The green waste is delivered to site using B double trucks (Figure 1). One of our main problems has been with the amount of contamination in the green waste. This has included plastic of all types, metal, concrete, dolls heads, tennis balls, cans, shade cloth and other general garbage and litter. You name it we've had it. There have also been problems with the size of the wood chips with some large branches and lumps of wood getting through. These larger contaminants have damaged the windrow turner on a regular basis.

The windrows were constructed by first laying out a long bed of green waste wide enough for a truck to drive along. Biosolids



Figure 2



Figure 3

were then deposited directly from the trucks along the green waste bed (Figure 2). The sides of the bed were then folded over using a backhoe bucket, any extra green waste added to make up the correct ratios and then formed into a windrow small enough for the windrow turner to fit over (Figure 3).

During the initial trials, the windrow turner was passed through the piles many



Figure 4

times. It was soon realised that too much mixing produced a biosolids and green waste "paste" that then tended to form big clumps which were hard to break up. The "paste" and clumps didn't allow air to flow into the windrow meaning these clumps became anaerobic and odorous. When the pile was mixed initially with only three passes of the turner, then left to dry for a few days, then mixed again, a well homogenised mixture was achieved which was still fairly porous, allowing better air flow through the pile. The mixture became easier to mix as the materials began to compost. For this reason our procedure has now been standardised for 3 passes with the windrow turner (Figure 4).

The composting process, while simple, needs to be monitored carefully. The piles are monitored for temperature, moisture level and initially, oxygen levels. Because of the tackiness of the biosolids, oxygen sampling probes continually became blocked and so were found to be impractical for this application. Enough data was collected though, to indicate that, as the oxygen level in the pile depleted, the microbial activity slowed and the temperature began to fall. This meant that the piles could be managed and turned based on temperature (Figure 5). We aim to keep the temperature between 55°C to 65°C.

Moisture tests are also carried out periodically (usually about once per week depending on weather conditions) on the compost and, if needed, water added to maintain optimum moisture levels in the piles. Our target is to keep the pile between 50% to 60% moisture. Moisture levels are determined by weighing out a sample of compost then putting it in a microwave oven for approximately one minute. The sample is again weighed and the process continued until there is no weight change. The difference in weight can be used to determine the moisture as a percentage. This information can then be applied to the volume of the windrow to calculate how much water needs to be added.

Open windrow composting requires the compost to be turned 5 times during the composting stage of the process, with the piles at a temperature of > 55°C for a total of 15 days. This is to make sure that all parts of the pile have been above 55°C for 3 consecutive days. Figure 6 and Figure 7 show temperature and oxygen profiles for two windrows.

In our experience it takes around a day for the piles to return to temperature after being turned. This means that it actually takes longer than 15 days to complete the active composting stage. The effect of turning can be clearly seen in Figures 6 and 7.

Maturation

Once the active composting is finished, the windrows are pushed into bigger windrows for maturation. Temperatures are still monitored and the piles are turned regularly if the temperature exceeds 65°C to prevent charring of the materials. This is continued until the temperature decreases indicating that the full composting process is complete. Without the maturation phase, the compost may be toxic to plants. Turning of the large windrows is carried out using a loader with a four metre bucket

Screening

Once the piles have matured the product is screened. This has been done using a shaker screen (Figure 8) with the wires set at 10mm. The screen was hired from a nearby gravel pit. During the screening process some of the contaminants are removed by the screens themselves. If the screening is done on a windy day most of



Figure 5

the plastic is blown out. This makes a bit of mess on the site and the adjacent paddocks. Some sort of fence would be useful to catch the plastic.

Large wood chips that have been screened out are used to seed new windrows since they already have white rot fungi developed on them. This seems to activate a new windrow in as little as one day where as without the seeding chips it can take up to three or four days before temperatures in the pile begin to rise as the microbes develop.

Depending on how well the green waste has been shredded, the proportion of useable product to reject materials varies quite a lot.

Testing

Apart from the testing of the windrows during the composting process, another important test for the final product is to check that it isn't toxic to plants. Plant phytotoxicity testing was done using radish seeds. Four groups of trays were prepared. One group contained a brand name seed raising mix purchased from the local hardware store, one a sandy soil from the site, one compost and one a 1:1 mixture of compost and sand (Figure 9).

A single seed was sown in each compartment of the tray making a total of 12 seeds for each tray. The trays were kept moist and the

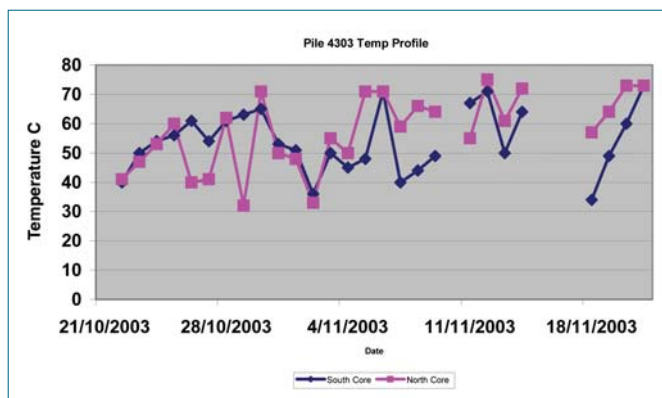


Figure 6. Compost temperatures taken at two sites along a windrow showing the temperature time relations to produce compost. There were three turnings of the windrow in the period shown.

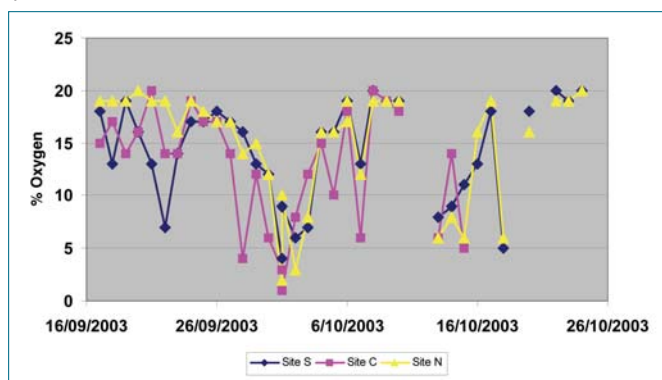


Figure 7. Compost oxygen levels measured at three sites along a windrow. Note the periods of low oxygen levels. This was associated with some odour development and also decreased temperatures. The rise in oxygen levels after each low point shows the effect of turning the pile. The recommended oxygen level for composting is >15%.



Figure 8



Figure 9



Figure 10

seeds allowed to germinate and grow until the first true leaves had formed. This took approximately three weeks. The seedlings were then removed from the trays and the soils carefully cleaned from the root systems. The plants were then placed on graph paper so that they could be photographed and measurements taken to determine plant and root growth (Figure 10).

The most successful growth medium was found to be the compost and sand mixture, producing 100% strike rate and the best plant growth and root development. The compost and the brand name seed raising mixture also produced reasonable results. The trays with the sandy soil from the site produced poor results. The compost alone tended to shed the water and it took a long time for water to soak into it. This was possibly due to the flat shape of the small woody particles in the compost. In the trays with the compost/sand mixture, the sand would have made the compost more porous allowing good moisture penetration with the compost helping to retain this moisture.

The important result from the phytotoxicity testing was that the compost did not hinder growth in any way and in fact promoted growth when mixed with the sand.

The final product has also been tested for metal and pesticide contaminants using the same tests as those required for biosolids. This was done at a NATA accredited laboratory. While the biosolids Zinc and Copper levels were a bit high, the final compost product complied with all levels required for unrestricted reuse.

Product Use

At this stage the intention is for the product to be used in the agricultural operations at the site. The goal of the operation is to produce a marketable product. To do this, particular attention will need to be applied to all steps in the process.

We have also conducted some informal trials with Gippsland Water staff using the product for gardens, lawns and as a potting mix, with good results.

Things We Have Learned

- The compacted road base material has proved to be unsuitable because some of the stones in the road base material end up contaminating the piles due to the stones being picked up by the loader bucket and being added to the piles.
- The green waste needs to be clean and of an even size with no logs or branches. While not all plastic can be removed, the less the better. If the green waste contained too much larger, woody material, the piles stayed active for a lot longer as this larger material took a lot longer to break down.
- Over mixing of the pile in the initial stages causes the biosolids and the green waste to mash into clumps and forms a sort of "paste" that tends to become anaerobic and is difficult to break up. If these clumps were not broken up the centre did not compost and when broken apart, contained raw biosolids.
- Application of water can be difficult. Water had to be applied slowly or it would just run off the surface of the pile with little penetration. The wind at the site also caused problems when adding water.
- Wind also caused problems by blowing small stones and pebbles onto the surface of the windrows. To overcome this, compost was allowed to build up on the gravel to form a new work surface and to stop the stones getting into the compost, however after heavy rains this tends to become sloppy.
- Odour hasn't been much of a problem. The biosolids themselves are very odorous when delivered to the site but once mixed in with the green waste the odour disappeared fairly quickly, developing into just an earthy smell in the first few days after mixing.
- Open windrow composting can be affected by weather conditions that can

cause difficulties in trying to control the process. High rainfall events caused high moisture which can cause anaerobic conditions to develop in the windrows. High wind was also a problem, blowing unwanted debris and stones onto the piles and drying the piles out in summer months. Time of year and daily temperatures had little effect on the compost, with the piles reaching composting temperatures no matter what the air temperature was.

- The final product is of a good quality and has produced good results in trial applications. Most of the compost produced so far meets the composting standards for reuse. Contamination of the green waste is the main problem. It would be far better to remove the contaminants before the green waste is shredded and composted rather than doing the separation at the end when the shredding and compost turning has broken each piece of rubbish into lots of smaller ones.

Conclusions

Composting represents a way of value adding to biosolids and can convert a relatively unpleasant, difficult to handle product, to a friable, pleasant smelling, easy to handle product that can be used beneficially and is environmentally friendly. Composting also represents a way of turning other waste streams into a reusable and possibly marketable product.

The Authors

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WHAKAPAPA ALPINE SEWERAGE SCHEME

Warren Furner

Mt Ruapehu and Mt Tongiriro, situated on New Zealand's north island, are sacred to the Maori, especially the tribes of Tuwharetoa and Ngati Rangī. In 1887 the chief of the Tuwharetoa, gifted the summits of Tongariro and Ruapehu to the people of New Zealand so that their *tapu* or "intrinsic worth" may be protected for all time.

Over the hundred years since this gift, Tongariro National Park has grown and has developed as New Zealand's best known and most used national park for skiing and tramping. The Tongariro National Park is considered to be an outstanding pristine environment which has significant cultural and spiritual values for Maori. These attributes have been recognised internationally with the Park holding dual World Heritage Status as a natural site and cultural landscape of outstanding universal value.

The most challenging task facing the managers of Tongariro National Park lies in establishing a level of use at which public access can be facilitated and commercial operations permitted within the park without compromising the *tapu* of this precious landscape.

Waste Water Management

Whakapapa and Iwikau villages are the two main sites of development and occupation within the Park, and as such they pose the greatest challenge for sewage disposal. Ski facilities and huts were first constructed on the mountain in the early 1900s. Post-war development in the 1950s and 1960s saw the construction of many more huts, something which the Park Board of the day encouraged with a view to assisting development and interest in the ski field and promoting recreational use of the Park.

The Department of Conservation has allowed the ski fields and club lodges to remain within the Park, recognising that they have had an historical and legal association in the history and development of the Park and are instrumental in providing for public enjoyment. The impact and effects of such development however, must not compromise the natural and cultural values and resources that have given the Park its high national and international status.



The Whakapapa Village sewage treatment plant (STP) is located north of the Chateau Golf Course. Built in the 1940's, this plant has been upgraded over time to handle increasing numbers of people but in recent times has not met contemporary environmental or cultural requirements.

At Whakapapa ski field and Iwikau village the sewage from the 48 ski club lodges and lower ski field facilities has been treated in approximately 50 separate or combined septic tanks with deep disposal soakage pits. The septic tanks are all within the upper catchment of the Whakapapanui stream. Ongoing problems with the

operation of these systems have been documented over time, together with the difficulties of sludge removal from an alpine environment. This is often carried out by helicopter which has potential for accidental spillage. There have also been problems with backflow of effluent leading to surface discharge and odour problems at the start of high-use periods.

To date the methods for treating and disposing of sewage within the Whakapapa/Iwikau Area have been considered to be creating a greater negative impact than is acceptable. Furthermore the issue of disposal of human sewage on a sacred mountain or into the pristine



waterways that flow from the mountain is one of considerable cultural sensitivity which, in the past, has not been adequately dealt with. The Department of Conservation has been working with the local community to address this since 1990.

A feasibility study confirmed that it was possible to collect the sewage from the mountain, upgrade the treatment at the Whakapapa STP and irrigate the final effluent by subsoil infiltration in an area adjacent to the Chateau Golf Course. The estimated price for the scheme was \$3.75 million. Importantly the study concluded that the scheme could be developed while preserving the tapu of the area.

In June 2001 all parties including Maori agreed and committed to the proposed scheme and resource consents were applied for and obtained mid 2002.

Project Challenges

One of the major challenges in the construction of the collection system was the vertical fall from the head of reticulation at 2100 m to the treatment plant situated at 1150 m, a fall of 950m. This required work to be carried out on some quite steep slopes.

In addition, due to the seasonal snow cover, there was a limited time frame in which to construct the upper half of the reticulation.

Of particular importance was the need to ensure that the construction processes minimised the impact on the environment and to thereby protect the tapu of the heritage area. In the detailed design stages, attention was given to building a system that would also minimise the impact of any maintenance activities at a later date.



How It Was Done

To complete the construction within the limited timeframe, three concurrent contracts were tendered:

1. Installing the buffer tank and reticulation system at Iwikau, using conventional diggers and helicopter support. This was carried out from November 2003 - June 2004.
2. Laying of the reticulation pipe using conventional methods along the Bruce Road corridor. This was conducted from November 2003-May 2004.
3. Upgrading the Whakapapa Treatment Plant and installing the irrigation field using conventional civil construction methods on site of existing disturbance. This was carried out from December 2003 - May 2004.

In order to avoid freezing and mechanical damage during the winter months the conveyance pipe had to be

protected. This was done by burying it to a depth of 600-900mm.

Where the pipe was exposed such as at the Whakapapanui Bridge, it was inserted into another lined pipe for extra insulation.

All wastewater is collected at the point of generation at each facility in both villages. All kitchen discharges pass through grease traps before entering the reticulation system.

HDPE pipe sizes were selected to be in excess of estimated peak flows to allow for future growth of day visitation to Whakapapa Ski Area and to take account of larger flow volumes immediately following system maintenance.

Potential blockage was minimised by restricting the pipe size at each connection to 80mm. This acts as a choke and if blockage is to occur it will be at the source where the potential spill is minimal and can be detected early.

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The new sewers at Iwikau Village were buried to avoid freezing damage and located to maximise ease of installation in hard volcanic rock. The installation of the pipelines from some facilities required blasting to break up the hard volcanic bedrock. Inspection points were located at appropriate intervals and geocloth was used to avoid the scour of bedding materials in the trench.

The skeletal nature of the mountain soils and the very hard basaltic rock cover made digging and excavation difficult in the Iwikau village area. This was exacerbated in some parts along the pipeline route by the steep cliffs and rocky outcrops.

To minimise disturbance of the natural environment, the pipeline between the ski fields and Iwikau village was laid where the natural environment had been previously disturbed to establish ski runs. Where possible the opportunity was taken to co-locate snow-making pipes and power and telecommunication cables in the same trench. This meant that the need for further disturbance was minimised and the sewerage pipe trench provided for long-term benefits beyond the sewerage scheme. As a result some of the pipe routes traversed slopes up to 28 degree in slope.

From Iwikau to the Whakapapa STP, the pipe was located and buried within the road and shoulder of the Bruce Road and utilised existing structures to cross the Whakapapanui Stream. The road also provides a reasonably consistent downhill gradient for the pipe. This design feature and location assisted matters such as pressure variation, air-locking, water hammer surges and the deposition of solids over time.

The contract team worked to a specification which limited the disturbed

area to a 3.5 m wide access track. This limited trench methodology to a "once in" to clear access and working platforms, blasting rock to excavate a trench with careful placement of excavated material on the way out, importing and laying bedding sand by helicopter followed by hand laid pipe installation and bedding retention, then digger access again for final reinstatement.

The final effluent is passed through an ultraviolet disinfection system before being percolated through specially designed subsurface irrigation tubes and trenches laid within a 7.0 hectare soakage field. The soakage field is located in a site formerly used as an airstrip and pig farm, in the tundra area beside the Chateau Golf Course.

The filtering/absorption qualities of the soils, in particular the pumice in the soakage field further reduces Coliform bacteria counts and phosphorus. The irrigation journey ensures that a suitable loading of nitrogen per hectare of land is achieved.

In April 2004 the scheme was commissioned with trials continuing within the irrigation field.

Conclusion

Contractors worked to achieve approximately 15000 m of reticulation over a vertical elevation of 950m. Critical to the success were contractors with a can-do approach and willingness to work outside specifications to solve problems. Snow, ice, volcanic hazard and severe sun made up the environmental hazards along with strict supervision from environmental officers and the general public who regard this landscape as their own.

Acknowledgements

I would like to take this opportunity to thank all those involved in the project and the WIOA for their interest in taking this story to the Australian industry.

The Author

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BRAIN TEASER - Disinfection

1. Which disinfection process uses the combination of Chlorine and Ammonia?
 - a. Chlorination
 - b. Chlorine dioxide
 - c. Chloramination
 - d. Chloralkali
2. Which of the following diseases can be caused by pathogens?
 - a. Typhoid
 - b. Salmonella
 - c. Cryptosporidiosis
 - d. Diptheria
 - e. All of the above
3. Chlorine in the form of solid tablets is?
 - a. Sodium hypochlorite
 - b. Calcium hypochlorite
 - c. Elemental chlorine
 - d. Chlorine dioxide
4. When Chlorine gas is added to water it reacts with the water to produce?
 - a. Hypochlorous Acid & Hydrochloric Acid
 - b. Hypochlorous Acid & Calcium Hydroxide
 - c. Hypochlorous Acid & Sodium Hydroxide
5. The sum of Free and Combined Residual is called?
 - a. Desired residual
 - b. Total residual
 - c. Best residual
6. Calculate the new Chlorine feed rate in kg/day using the following information.
Current feed rate = 3.2 kg/24hr
Flow rate = 42.3 m³/hr
7. When Chlorine gas is added to water the pH,
 - a. Increases
 - b. Stays as it is
 - c. Decreases
8. What is the recommended ratio of Chlorine to Ammonia for Chloramination?
 - a. 2:1
 - b. 3:1
 - c. 4:1
9. A weak solution of what can be used to detect small gaseous chlorine leaks?
 - a. Ammonia
 - b. Fluoride
 - c. Sodium hypochlorite
10. When Sodium Hypochlorite is added to water the pH,
 - a. Increases
 - b. Stays as it is
 - c. Decreases
11. Name one advantage and one disadvantage of using full strength Sodium Hypochlorite (Hypo 12.5%) for disinfection.
12. What safety equipment should be used when changing over Chlorine cylinders?

Current free residual = 0.9 mg/L
Desired free residual = 0.3 mg/L

The Man From Boggy Creek

Max Thomas 1981

I'm heading up the Tanjil, Pete,
where the country's a delight.
I thought you'd like to come along,
And he replied alright.

Now, Pete's a pretty cautious chap
As Bacto's mostly are,
But he didn't catch my crafty grin
As we loaded up the car.

The talk was mostly straight, you know,
Cause Lyn was in the back,
But I'll swear she caught what Donlon thought
As we crashed down Orton's track.

Hullo trouble, what brings you 'ere?
As if I need to ask.
This is P'Peter, I said
He's here to supervise the t'task

Well, the man from Boggy Creek, it seems,
Was one for keeping score.
I'd get the Boys to run yers up.
He'd seen the likes of us before.

Only the Boys...aint 'ere,
And the Fergy's runnin' hot
Look, go on, get up on the dray,
I'd like to see this sampling spot.

I'll walk if you don't mind, I said,
In a half suspicious tone.
Go on, get on up, he said,
Perched high on Fergy's throne.

Well, there we sat like tourists,
With muck and straw all round,
He let the Fergy have her head,
And she knew the roughest ground.

I don't know if you go for pork,
Or if you like it rare,
But the question's really who'll eat who,
The way pigs look at you up there.

Lyn clutched the sample bottles,
Porkers followed on the trot.
When one tried to mount the dray
She nearly lost the plot.

A nice fat goose that is, Pete said,
Are you going to pluck it?
Pipe down you! If I want a pig,
I'll rattle on the bucket.

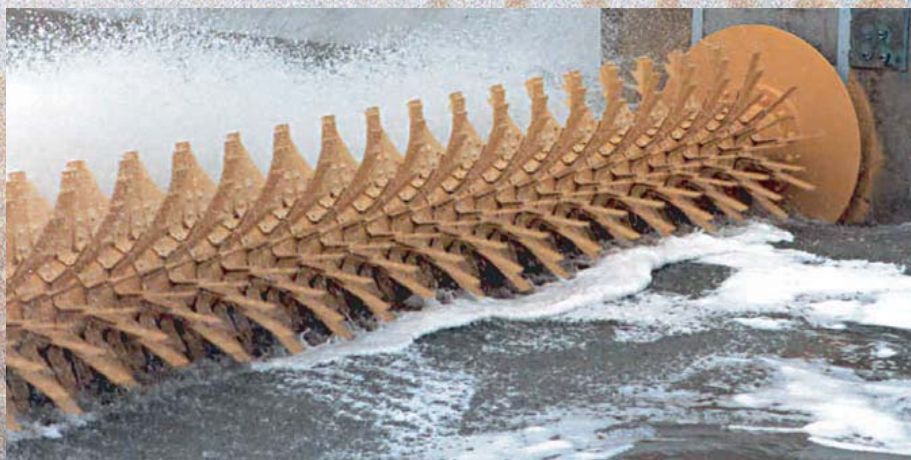
So now the ordeals over,
And the brew-room sceptics doubt,
But 'til you've sampled on the Boggy,
You don't know what sampling's about.

At last, up by the Tanjil,
In the land of sudden storms,
They've made the place a sanctuary,
For faecal Coliforms.

Editors Note: The poem describes a water sampling trip in the forests of Gippsland in the distant past. Names in the poem have not been changed to protect the innocent !! The "innocent" may well recall their past!!

Answers to Disinfection Brain Teaser

1. C
2. E
3. B
4. A
5. B
6. 2.6 kg/day
7. C
8. C (the actual ratio depends on the conditions but 4:1 by Disadvantages
9. A
10. A
11. Advantages
- paying same delivery costs
- for more "active ingredient" (There may be others?)
- Self contained breathing apparatus
- Safety boots
- Loss of active ingredient
- Dangerous Good
- (There may be others?)
12. Safety equipment should include
- Safety boots
- Gloves
- Safety boots



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