Partners for Water and Sanitation

Note on project reports

The following report has been prepared by Partners for Water and Sanitation in response to a project Terms of Reference.

The content of the report is based on the opinion of the author(s) and does not necessarily represent the opinions of the wider PfWS partnership, or the project funders.

Any extracts from the report should only be used with prior permission of the report author(s).

anglianwater

Partners for Water and Sanitation (PfWS)
Wastewater Treatment Works Targeted Risk Reduction Assessments
Western Cape Province, South Africa

January 2010

Report prepared by Tom Wayling and Rob Smith of Anglian Water (UK), in collaboration
with Department of Water and Environmental Affairs (SA) and
Partners for Water and Sanitation.

Executive Summary

This report details outputs from an ongoing project intended to improve the quality of water and sanitation services available in South Africa. It forms part of a series of steps being taken to improve the health and well-being of the population, and to enhance the quality of water resources available to all, including areas such as agriculture.

The Department of Water Affairs (DWA) enlisted Partners for Water and Sanitation (PfWS) and Anglian Water (AW) in the UK to provide expert advice and assistance towards this aim.**

The involvement of PfWS and AW began in early 2009, with a visit to Gauteng Province in March of that year (reported separately). The second phase was AW hosting a two-week intensive placement in the UK for DWA staff. The third phase was a return visit to South Africa, this time to the Western Cape region. This report details the outputs of that third phase.

Over the course of 2009, the DWA developed a series of first order reports and Cumulative Risk Scoring (CRR) ratings for a number of treatment plants in the Western Cape. This process enabled comparisons to be made and a ranking of sites against a risk rating. The CRR score was based on the potential of the site to impact on the environment, and included design capacity, flow, sanitary compliance and technical skills. The intention then was to use these scores to develop a series of Risk Reduction Plans (RRAPs), targeted specifically at the problem areas.

The aims and objectives of this work included carrying out site inspections on treatment plants on the Berg River catchment, and to provide operational advice to local and provincial staff. The intention was to facilitate sustainable and realistic improvements in processes, compliance, investment and general operation. Furthermore, it was to assist the Municipalities in developing their own RRAPs.

In all, 13 sites were visited over the two-week period, covering a wide range of Municipalities. Several common themes were found. These included lack of site monitoring and process controls; lack of basic site test equipment; generally excessive mlss levels on aeration plants; critical equipment left out of action for long periods, poor record keeping and apparent poor detailed direction and supervision. On the more positive side, there were several examples of good practice (e.g. levels of analysis at Paarl, managerial approach at Porterville). In general, the levels of enthusiasm and desire to do the right thing were high (with a few notable exceptions).

It was felt that very few, if any, of the issues found could not be fixed. Many of these could be improved with relatively limited degrees of expenditure. A general lack of understanding of exactly what loadings the sites have to deal with exists. Also, a general lack of understanding of what the plants are capable of exists. These areas can be remedied by a series of intensive monitoring, analysis and calculation.

Once the site loadings are understood, then the sites themselves can be optimised to try and meet these loads. Following this, longer-term monitoring and subsequent process control

levels can be established to ensure compliance is maintained. Where this is then seen not to be possible, strategic decisions can be made as to expansion, modifications etc. This approach is highly likely to improve compliance, reduce wasted operational expenditure, enhance the levels of localised ownership of processes (i.e. improved involvement and pride), and either postpone or redirect some previously high levels of planned capital expenditure.

During the course of the visits it was decided that the best approach was to support the site advice by the generation of preliminary RRAPs. These were generated for most sites and then used to provide targeted feedback to each Municipality. The RRAP documents contain specific findings, calculations and recommendations for each site and are included as individual appendices in this document. The intention of these documents was to be targeted advice, but also to be used by the Municipalities as a basis for developing their own longer-term RRAPs. The presentation of these was generally well received.

There is also an important role and opportunity for the DWA to play in this process. They should actively engage in dialogue to facilitate areas such as environmental impact assessments where needed, but there are also areas where strong directive actions are necessary. It is recommended that they also strengthen their monitoring regime and share its outputs regularly via a locally based catchment management forum.

(** There has also been some involvement from other PfWS UK partner organisations, working in the eastern provinces of the country on sludge management and water supply. This work is reported separately by those involved.)

Acknowledgements

The authors extend their sincere thanks to the following people and organisations, all of whom played their part in organising and facilitating the inspection visits.

Partners for Water and Sanitation (PfWS)

Ms. Amina Ismail, Country Manager South Africa, PfWS
Ms. Olga Nemulenzi, Environmental Scientist, PfWS South Africa.
Ms. Rebecca Scott, PfWS Secretariat, Loughborough, United Kingdom
Ms. Claire Twelvetrees, PfWS Secretariat, Loughborough, United Kingdom

Department of Water Affairs (DWA)

Dr. Marlene van de Merwe-Botha (Water Group South Africa)
Mrs. Wilna Kloppers, Deputy Director, Western Cape Regional Office
Mrs. Ntombizanelle Mupariwa, Principal Water Pollution Control Officer, Western Cape
Mr. Kenneth Makhbele, Assistant Director, DWA National Office
Ms. B. N. Bele, Principal Water Pollution Control Officer, Western Cape
Mr. Larry Ferguson, Assistant Director, Water Sector Support, Western Cape

Municipalities of the Western Cape

All of the management and staff from the Municipalities of Stellenbosch, Drakenstein, Saldanha Bay, Berg River, Swartland, and Witzenburg.

Anglian Water

Mr. Paul Gibbs, Director of Wastewater Services, Mr, Graham Hackney, Ruthamford Catchment Manager, and Mr. Ian Bowmaker, Head of Process Science. All of whom allowed the authors the time to undertake the visits and prepare the report.

List of Contents

List of Figures

List of Appendices

Contains risk-reduction reports, and more specific and detailed advice for each of the sites visited. Grouped by Municipality.

1) Introduction

This report details the outputs from an ongoing project to improve water and sanitation in South Africa. Partners for Water and Sanitation (PfWS) have been working with the South African Department of Water Affairs (DWA) on this project for approximately 18 months, along with various UK based partner experts.

Two staff from Anglian Water (AW) first visited the country in March 2009, working in the Gauteng area. This was followed by AW hosting a two-week intensive placement for DWA staff, later in December 2009, in the UK. These phases of work then led to a return visit to South Africa, this time in the Western Cape area in January 2010.

Each of these phases has been reported on separately, and this document deals only with the Western Cape stage. This study looked at specifically at the West Berg River catchment area.

Utilising previous experiences and current legislation, a methodology for Targeted Risk Reduction Action Planning (RRAP) was developed during the latter part of 2009 by the DWA and advisors. This process created a Cumulative Risk Rating Score (CRR) for all of the regions works, based on a number of factors.

CRR = A* B + C + D where:

A= design capacity of plant
B = flow amount, exceeding/on/under capacity
C = no. Non-compliance trends
D = compliance against technical skills

This methodology was applied for all of the works in the catchment, and scores derived. These scores allowed comparison of all of the works in the catchment area, and subsequent ranking on a risk basis.

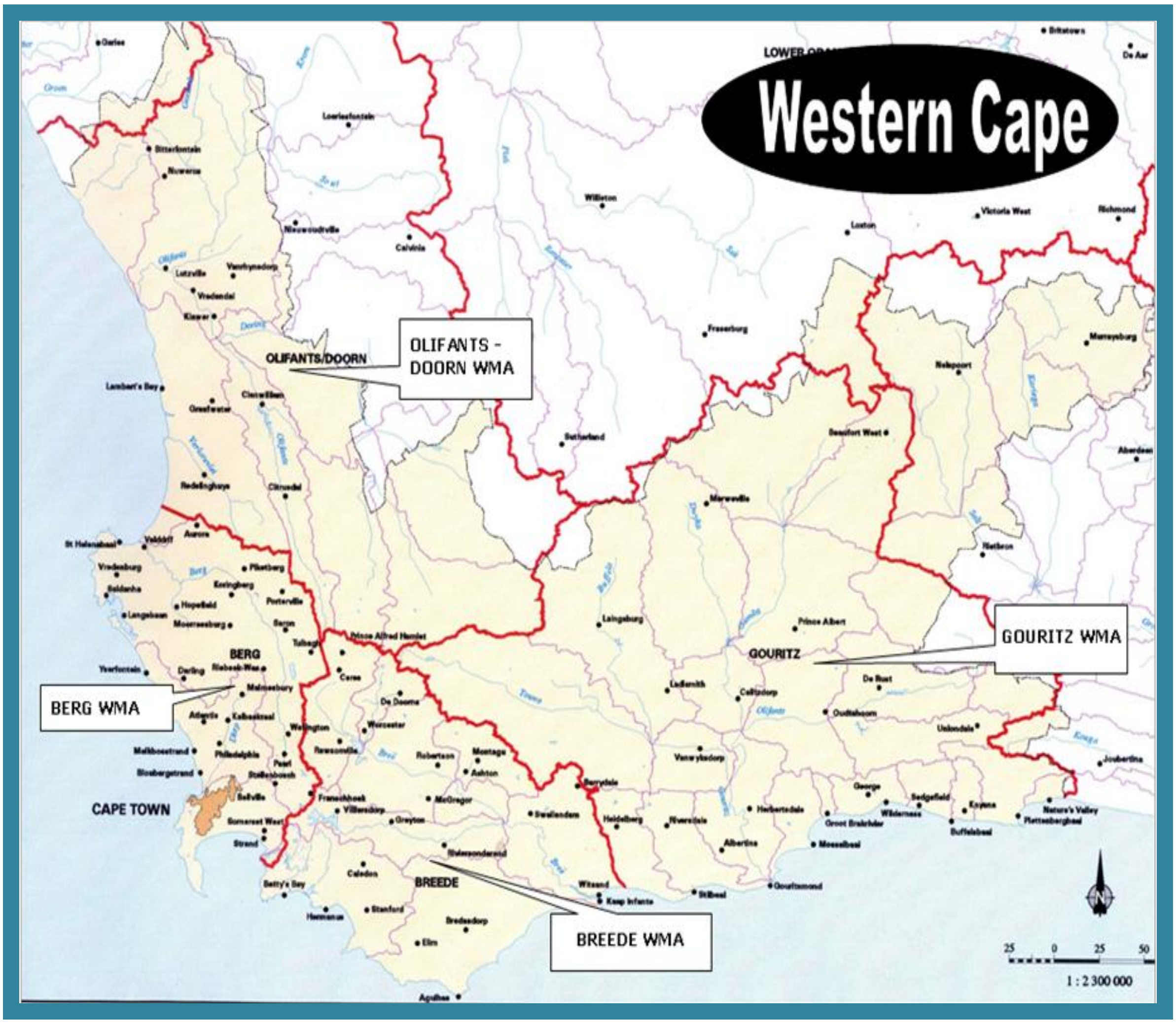
The aims of this project phase were:

1) To take the initial CRR scores and agree a list of sites to be visited.
2) To carry-out the site visits in conjunction with DWA and Municipality staff.
3) To advise on short, medium and longer term improvements for process and operation of the plants.

The objectives were:

1) To facilitate sustainable and realistic improvements in processes, investment and general operation of the plants in order to enhance compliance and performance.
2) To provide information and advice with targeted suggestions and recommendations that would lead to reduced risk and improved CRR scores.
3) To generate short risk reduction reports for each of the plants, which could then be handed-over as working documents to each of the Municipalities.

Figure 1 - Western Cape Province, Showing West Berg Area of Study



Taken from DWA Report, "*Municipal Wastewater Treatment - Base Information for Targeted Risk-Based Regulation, Western Cape Province, Status at June 2009.*"

2) Methodology

The methods utilised in this process were informal and simple. Once the site visit schedule was agreed, a programme of 2 or 3 sites visits per day was planned. Whilst it was considered important that we could meet the actual people running the sites, a request was made that at each Municipality provide at least one person in a "decision making" capacity on site. In practice this was likely to be the site manager, or perhaps supervisors. This was important to ensure that any suggestions made could be acted upon reasonably quickly.

Once on site, the format was to start at the inlet point and work down on foot through the plant following first the liquid flows, and then the sludge flows. Each stage of the process was examined and questions asked where relevant. In most cases it was possible to have a short discussion with site management before the tour. Requests were also made for copies of analysis reports, consultant reports, maintenance records and any other relevant information. Notes were taken throughout, and comparisons made to standards where known of, and from personal experiences. Opportunities to talk to actual site operating staff were also taken wherever possible. Attempts to read flow meters and displays were made across sites for "real-time" information.

As this project phase was focused on risk reduction planning, the emphasis was placed on the four scoring areas. However, the process flows were sketched-out to ensure a fuller understanding of how the process was being operated. This also enabled any issues with process control and maintenance to be highlighted. The information obtained from these visits was then collated and some basic calculations performed against expected norms for processes. For example, there are some normal assumptions for oxygen transfer and requirements on aeration plants, and these were compared to theoretical expectations.

E.g. General assumption is that 1KWhr of energy from an aerator will produce approximately 1Kg/hr of oxygen. Also, 1Kg of oxygen is required to oxidise 1Kg of COD/hr.

E.g. General assumption is that to oxidise nitrogen it takes approximately four times this amount of energy per capita.

These are general assumption, and it may be possible to improve on this depending on the efficiency of the mechanical equipment and ambient conditions. Both of these are widely referenced across many publications, but these are taken from:

Activated Sludge – Theory and Practice N.F.Gray, Oxford Science Publications 1990 ISBN 0-19-856341-8

Oxidation Ditch Technology Oxidation Ditches: The Up and Coming Solution for the UK? A.J. Rachwal The Institute of Public Health Engineers and The British Water and Effluent Treatment Association Central Conference Centre London 29th March 1984.

Worked examples of these calculations are to be found in the risk –reduction documents in this report.

Such calculation allowed comparisons to be made for each site and suggestions made as to operating philosophy. This would then, for example, result in advising running aeration equipment for a certain number of hours per day, dependent on the loading calculated to be in need of treatment.

3) Sites Visited and Relevant Municipalities

Figure 2 - Sites Visited with Current, Revised and Estimated Potential Future CRR Scores

		Cumulative Risk Score			
Site (WWTW)	Municipality	Original	Revised*	Future	Date of Visit
Wemmershoek	Stellenbosch	13		9	20/1/10
Franschhoek	Stellenbosch	13	17	10	20/1/10
Stellenbosch	Stellenbosch	18		13	20/1/10
Paarl	Drakenstein	16		8	21/1/10
Wellington	Drakenstein	12	14	10	21/1/10
Hopefield	Saldanha Bay	7		6	22/1/10
Veldriff	Berg River	12		10	22/1/10
Mooreesburg	Swartland	11		7	25/1/10
Picketburg	Berg River	7	11	8**	25/1/10
Porterville	Berg River	8		7	25/1/10
Tulbagh	Witzenburg	13		8	26/1/10
Riebeeck PPC	Swartland	16		10	26/1/10
Riebeeck West	Swartland	18		18***	26/1/10

* Following some of the visits it was felt appropriate to revise the current risk score. This was due to changes (largely for the worse) found. Subsequently, when determining an estimated potential CRR, the basis used was the revised score.

** Short term, post expansions, should be feasible to reduce to 4.

***No realistic likelihood of reducing the score without significant expenditure.

The following sections bring together observations, conclusions and comments from the project time as a whole. The actual risk reduction (RRAP) documents follow in the appendices, and are grouped by Municipality.

4) Significant Observations and Conclusions

The initial stakeholder workshop held in Paarl was very well attended, and contributed to a really positive start to this phase of the project. It was clear at this stage that all parties, whether regulatory (e.g. DWA), operator (e.g. Municipality), or even end-user (e.g. Agriculture Ministry) were very much committed to moving things forward and making improvements.

The project approach was to take the first order Cumulative Risk scores (CRR) and prioritise a programme of inspection. The outputs of this were on-site advice, some suggested adjustments, and the initial feedback reports provided on the close-up meeting in Cape Town.

The initial list sites constituted 15 sites, which was revised down to 11, but in the end a total of 13 sites were actually visited. This number of visits was made possible by a number of factors including:

1) The relatively small size of plants
2) Their reasonably close proximity
3) The high level of co-operation received.

The last of these was perhaps the most influential. We were welcomed at all sites, and did not feel obstructed in any significant way. Most sites were able to provide at least some information on analysis (e.g. A L Abbot reports), and some provided more extensive site information.

Perhaps the better examples of information came from Drakenstein Municipality, particularly at Paarl, where they were able to demonstrate regular monitoring over many parts of the plant. It was only regretful that they did not necessarily utilise this information as well as they might have done. In contrast to this, little or no analytical information was available at Veldriff and Riebeeck.

Some very common themes were observed, including:

1) Lack of sufficient site monitoring
2) Lack of on site process controls
3) Basic monitoring test equipment not available/used
4) Generally high mlss levels at aeration plants
5) Critical equipment out of action for long periods.
6) Poor record keeping
7) Apparent poor detailed direction of activities.
8) Lack of understanding of the impact of critical plant out of action
9) Lack of understanding of basic processes

4.1) Site Monitoring, Process Knowledge, Control and Equipment

In general, monitoring of some parameters was regular. However, some parameters were either only infrequently monitored, or not at all. Subsequently, the use of this information to actually control the site was very limited in most cases.

Popular parameters were total daily flow, pH, lime addition and settlement. Mlss, COD, ammonia, nitrates and phosphates seemed to be done only once a month. Drakenstein was a notable exception to this, with virtually weekly sampling on many parameters. Items such as amounts of sludge wasted, or returned to aeration reactors were rarely recorded as monitored.

Of the data seen, pH seemed reasonably neutral at most plants, so such regular monitoring perhaps wasn't really necessary. Little attention as to the loading on the plant was apparent, the preference being more towards flow. That is, most sites recorded total daily flow in, but influent strength information was limited. Without this, it is not possible to properly utilise treatment capabilities.

On all plants there was a definite disconnect between analytical information and actual control of the plant. Wasting of sludge was often said to be done merely on a "so many minutes a week", or "on Tuesdays and Fridays" style rather than on mlss levels. Settlability was being carried out regularly in most places, but little obvious action following it. Use of aerators was also being done rather unscientifically. For example, some were put on timers to alternate. This was resulting in under or over aeration, with unstable and poorly settling sludge. It needs to be understood that treatment plants are living biological entities and need to be adjusted continuously to match changing environmental conditions.

There was no real evidence to suggest that these actions were being done maliciously, but there were definite gaps in demonstrated competence in site process controls.

Much of this monitoring and process control can be effected with some basic site equipment such as field test ammonia (e.g. Merck) kits, hand-held mlss monitors, turbidity tubes and portable dissolved oxygen meters. A few sites did have "cones" that were used to observe the final effluent, but this was purely a visual and un-calibrated test. Simple measuring cylinders (seen on one site) can be quickly adapted to use a very simple test, which acts a surrogate for solids levels in final effluent.

4.2) High Mlss levels

This was common across all of the aeration plants, and was most likely due to the lack of regular monitoring and wasting of sludge. Several examples were seen where wasting was only done following a monthly mlss sample, which was done some weeks before. High levels consume energy for biomass growth rather than actual treatment, and they lead to instability in FSTs and subsequent solids loss into effluent.

4.3) Critical Equipment Out of Use

Probably the worst examples were observed in Stellenbosch and Franschhoek. At Stellenbosch works several of the biofilters had suffered mechanical failure of rotating arms. This was leading to short circuiting, and could easily be fixed with simple metalwork repairs. Franschhoek was even worse, with critical pumps and tanks totally out of use for several months. In this case, the works had failed completely due to lack of attention to basic issues.

In many cases maturation ponds were next to useless due to heavy contamination with sludge. More than one example of final tanks out was seen. In one case, whilst the repair was of reasonable quality, it had taken several weeks for some concrete re-levelling to be done. This was heavily impacting on quality.

Other examples seen were where equipment was available, but not being used. Much of this was with aerators not being matched to site needs, but in some cases sabotage was implicit as they had merely been switched off (by unknown persons).

In all cases, there was a definite lack of understanding and appreciation of the impact in final effluent quality when major plant was not in use.

4.4) Record Keeping and Site Direction

There were significant extremes seen here. The analytical records at Paarl were very good, but process control notes limited. Porterville probably offered the best example of general site records, and was one of the few sites were we saw an actual site log. It was detailed and gave a good history of many of the site activities. The records at Mooreesburg gave the opportunity to record many items and there were several months worth seen on site. However, only a few of the columns were actually in use. Such records are crucial not only for management, but for the actual site operatives to follow what has happened and when.

Levels of supervisory and managerial influence also varied. Drakenstein need to be praised for the clear influence of the experienced site manager at Paarl, but they let themselves down at Wellington, where a simple pipe repair had taken 2 years. Such a repair could, and should have been completed within 48 hours. Stellenbosch appeared to be suffering from a drastic lack of managerial impact. It was not clear at what level this was lacking, but the site management certainly needs support from higher levels in the Municipality. Local management in Berg River came across as very much engaged and involved with their workforce. The regular involvement and teaching methods being used (particularly at Porterville) were very positive and encouraging ownership at site operative level.

Porterville also had routine tasks listed clearly on notice boards. These were split into daily, weekly, monthly etc. tasks. This is an example of good practice.

4.5) Capacity and Potential to Improve

Whilst these previous sections are largely critical, it is firmly believed that there is huge potential for improvement in all areas. Very few, if any of the issues found cannot be fixed.

Many of the areas can be rapidly improved by implementing relatively simple changes. Moreover, these changes do not need to carry large costs, and even where some do, these can soon be recouped by reduced expenditure through greater efficiency (e.g. optimising aeration processes usually cuts down on costs).

Once the general level of loadings on sites are established, sampling regimes can be optimised and costs reduced as expenditure is directed rather than wasted. Much of the field and site test equipment is simple to use and of relatively low cost.

For the majority of sites visited, the major part of the CRR score is compliance. In virtually all cases this can be improved by better controls on sites.

In many cases the improvements can be at a low level, but some will require the engagement and support from higher levels within Municipalities. The importance of good process control cannot be understated. This is a message that needs to reach all levels of municipal management, and support provided for more local levels.

There is opportunity for the DWA to act and assist the Municipalities to achieve their targets. One example of such assistance would be to actively facilitate and engage in dialogue over items such as environmental impact assessments (e.g. to promote the investment in an additional FST at Picketburg). At the other end of the scale it was felt necessary for them to issue strong directive action to persuade senior management levels to act and support remedial measures. A further example would be for the DWA to strengthen their monitoring regime and share the outputs regularly at local levels (e.g. localised catchment management liaison).

5) Recommendations

This section covers more general areas, as the individual RRAPs in this document detail more site-specific information and advice.

The main areas that would lead to quick and significant improvement in treatment works performance (and therefore reduced risk profile) are:

1) Establishment of standards for better basic site monitoring
2) Implementation of improved site process control and records
3) Provision of, and use of basic field testing equipment
4) Provision of support for local management and supervision
5) Engagement with all staff to enhance ownership

5.1) Establishment of Basic Site Monitoring

All sites and Municipalities need to examine what is actually going on at site level. There is a distinct lack of appropriate monitoring occurring. Critical parameters such as ammonia, turbidity, mlss and dissolved oxygen can all be measured on site easily. In general, this was not seen to be happening often enough. Parameters such as COD and suspended solids need laboratory involvement, but are not difficult tests. The frequency of these is also inadequate in most places.

Initially, there needs to be a series of composite sampling undertaken to establish what the loading patterns (COD, ammonia and flow) are actually being received. Once established, this monitoring can be cut back to monitor changes.

Generally recommended monitoring is as follows, although frequencies will vary with size of site.

Daily (field tests) - Ammonia and, turbidity (final effluent), dissolved oxygen (continuous in aeration basin), ammonia (influent).

Weekly (field tests) - Mlss and SVI

Others (laboratory) - COD, suspended solids (both influent and effluent weekly), nitrates (final effluent weekly), phosphates (influent and effluent).

Measurement of mlss and RAS concentrations, along with SVI values will allow more precise determination of wasting requirements. It is likely that wasting will need to occur very regularly, probably every day on significant aeration plants.

5.2) Implementation of Improved Site Process Control and Records

Once the basic information is obtained, it is then crucial to put this to good use. One of the main areas of concern was the lack of process control. First, it is essential to monitor the critical parameters such as mlss, SVI, COD, NH3 etc. These factors need to be recorded and then used to control the processes. Many examples of recording information and then not using it were observed.

Site records should monitor on a daily, weekly and monthly basis. Some of the recording sheets seen did provide for some of these, but they were woefully short of entries. Trend sheets/graphs for parameters should be kept on every site so the operators, supervisors and managers can follow the levels of any item. These should be printed graphs, which are then manually annotated each day as results are obtained. This is an easy way of quickly spotting adverse trends and then acting on them.

Maintenance and general observations on site activities should be recorded in some form of site log/diary. Any visitor to site should be encouraged to complete an entry in the log to explain their activity and reasons for being on site (e.g. pump repair/removal, or discharge of septic tank load).

All results need to be used to control the process. For example, a mlss level will give a ready indication if wasting of sludge is required. In many cases some form of wasting will be required every day, but it will take some time to establish and calibrate to the ideal volume of wasting to maintain a desired mlss level. Dissolved oxygen (DO2) will give an indication if aerators are being used properly. A typical expectation for a plug-flow aeration ditch would be around 1.5-2 mg/l dissolved oxygen. Anything greater probably means wasted energy, and lower means treatment is unlikely to be complete. Furthermore, rapid changes in DO2 may mean there has been a shock loading on the plant. (i.e. Rapid increase in demand for oxygen).

Understanding the incoming loads to the plant can then allow more precise calculation as to the amount of oxidation required. In practice, the general amount is likely to be reasonably constant, but it is essential to be able to respond to changes over time.

Spot checks on NH3 will give a quick indication that treatment is less effective, and should then lead to immediate on site investigation and possible actions.

5.3) Provision of, and Use of Basic Field-Testing Equipment

All sites should be equipped with some basic field test equipment and operatives trained to use it.

Typical examples of this would be NH3 test kits from Merck (or equivalent). This is a readily available test that can be used with almost no training. It utilises a colour change reaction, which allows “rough and ready”, but reliable means of assessing NH3 levels. This test takes approximately 5 minutes to perform.

A second example is a turbidity test. Whilst not wholly scientific, it allows a ready approximation of the suspended solids level to be obtain. Again, the test takes 5 minutes, and does not require any level of skill other than a pair of eyes. Simple measuring cylinders can be adapted and calibrated for this purpose. The key to this test is not necessarily the actual figure obtained, but how it changes and compares to expected levels. A significant rise in turbidity (e.g. if it goes particularly cloudy) can mean that settlement of sludge in the FSTs has worsened, or that there is incomplete treatment.

Elevated nitrates in final effluent often mean that the dentrification stages of an aeration plant are less than ideal. This may be due to lack of recirculation of mlss or RAS, or possibly a failure of anoxic zone mixing. Elevated phosphates should point towards problems in the anaerobic zones, but may also be down to a lack of treatment in the aerobic zones. Either way, quick investigation is required.

5.4) Provision of Support for Local Management and Supervision

It was apparent in some areas that the focus on wastewater treatment by senior levels within Municipalities is not necessarily strong enough. Whilst it is accepted that treating wastewater is not a fashionable subject in any country, its efficacy is crucial to the health and well being of many. The DWA should engage with the Municipalities to ensure that sufficient support is given to those managers responsible for operating treatment plants. Furthermore, those managers need to ensure that their supervisors rigorously enforce process control actions on sites. Allowing situations such as those found at Wellington and Franschhoek to exist for so long is totally unacceptable.

It is likely that further training will be necessary at all levels within the industry, but this should include ensuring that people such as General Managers etc. physically see what occurs on sites. Joint stakeholder visits to sites are recommended.

5.5) Engagement with All Staff to Enhance Ownership

Following on from the above sections, the degree of ownership within the local teams needs to be improved. There were some good examples of this where local managers were regularly spending time with site operators and going through the various tasks in a practical manor. Instructions need to be made clear, and targets set. Efforts should be made to train local staff so they can carry out tasks for themselves (in whatever discipline) and see the results and benefits. For example, provide the local site operative with an ammonia test kit, train them in its use, and encourage them to keep records. They can then see the benefit of carrying out those tasks and follow-up of any required remedial actions.

There are a variety of training aids previously published by organisations such as the DWA, which utilise various methods. Some of these include pictographic instructions, which are useful if literacy is an issue. Locally developed methods can also be just as valuable.

6) Technical Advisory Centre (TAC)

Whilst not directly part of this project phase, the opportunity to engage with the TAC was taken during the time in-country. The TAC is a small group, which is beginning to get established, with a view to providing a resource available to all. The TAC is a joint initiative of the WRC, DWA, WISA, DBSA and SALGA. It was formally launched at the WISA 2008 Biennial Conference in Sun City in May 2008. Representatives from the TAC attended both the initial scoping workshop, and the final feedback meeting.

Initially the purpose of the TAC was to be a centre that could be contacted by any of the people responsible for operating treatment sites, or even others in related organisations. Their position was one of largely reactive assistance in response to problems being raised. However, they are attempting to modify their approach and become more proactive. At the final feedback meeting they gave a second presentation that detailed their plans to more actively seek to visit problem areas and carry out a similar programme of inspection and assistance.

This new approach is considered to be highly appropriate and should be supported by both regulators and operators. Many problem areas have been highlighted, so there is plenty of opportunity for the TAC team to begin providing targeted assistance.

7) Appendices

This section contains the RRAP documents for each individual site, grouped by Municipality. The initial draft documents were distributed to stakeholders at the Cape Town feedback meeting.

Appendix 1 - Stellenbosch Municipality

Sites visited included Wemmershoek, Franschhoek and Stellenbosch WWTWs.

1.1) Wemmershoek WWTW

Visit date: 20th January 2010
Risk Score= A* B+C+D
Risk Score= 1*2+9+2 = 13

Compliance C therefore perceived as the major issue. From 2008-09 compliance charts: Very limited information was submitted to this study for compliance, therefore it was not possible to score anything other than a 9. What little information was available did not help this score.

Sample data from 2009 was made available at the time of visit. However, this is only monthly, and therefore not adequate to correctly assess and evaluate actual compliance.

Furthermore, this site receives several septic tank discharges every day, which form a significant portion of the flow when tankers are on site. This will substantially impact on any influent samples taken at the time (as was the case observed in November 2009).

COD

Largely non compliant, but this is influenced by the amount of available aeration capacity, and the elevated levels of mlss. Current higher levels of mlss will be reducing oxidation efficiency, as it will be consumed by biomass growth.

Suspended Solids

Largely non compliant, but this could be affected by the relatively poor settleability of the mlss in the FST. Also being impacted by the growth of algae in the maturation pond.

Ammonia

Some evidence of ammonia treatment being achieved, but this is suffering from a lack of oxidation (i.e. normally excessive COD load will hinder nitrification). Also, the relative lack of measurement and control of recycle, RAS rates and dissolved oxygen will be contributing towards the lack of effective nitrification and subsequent denitrification in the anoxic zone.

Oxidation Capacity

The capacity of the plant to deal with oxidation of COD and NH3 is made up from the AS plant.

AS plant has 2 * 4.5KW surface aerators	=	9KW capacity
	=	9kg/hr oxygen supplied
	=	216kg oxygen capacity per day
	=	216kg COD per day capacity

COD Removal (oxidation)

Estimated COD load on site	=	143m3/day * av. COD of 1200mg/l
	=	172kg COD / day

Average COD calculated from only available 3 values, but one of these excessively high (i.e. c3000mg/l), which implies that it was taken at the time of a septic tank discharge. Values were

Oct 2009	915mg/l
Nov 2009	3171mg/l
Dec 2009	367mg/l

Adjusted average = 800mg/l

Ammonia Removal (oxidation)

Estimated NH3 loading on site	=	143m3/day * av. NH3 46.5mg/l
	=	6.65Kg NH3 /day
	=	6.65*4
	=	26.6kg oxygen / day

(Assumptions from literature for NH3 removal across processes: NH3 removal requires 4kg of oxygen per kg of NH3)

Summary of Oxidation Needs

COD load on plant	=	172kg/day
NH3 load on plant	=	26.6kg/day

Total oxygen required	=	199kg/day

Oxidation Capacity versus Needs

9KW motor power	=	9kg/hr oxygen
	=	216kg/day

This implies that there is sufficient oxidation capacity. However, this would be wholly dependent on the actual proportion and strength of septic tank flows. Initial site estimates suggest approximately 50m3/day of septic import. If this is correct, then the average influent COD is likely to be much higher.

Comments and Recommendations

Generally well kept aesthetically, with no major tidiness or cleanliness issues. This did suggest a certain degree of pride in the site operators.

Inlet – clean and operational. Receives flows from nearby septic tank discharge point. Some discharges were witnessed and these significantly increased the flow for a short period of time. Screening is minimal, but this did not appear to be drastically affecting the process.

Both aerators on the AS plant were running, and appeared to be in reasonable order. These were small, but were receiving basic maintenance. No measurement of dissolved oxygen was in place. Mlss did appear dark, indicating high levels. Anoxic tank operating and all mixers working. No major floating debris observed.

Final settlement – reasonable clarification occurring, with some small of fine solids carry-over. No major accumulation of algae on surface.

Maturation pond – heavily algified and very turbid and green. Unlikely that there is any significant UV pathogen kill being achieved due to the high turbidity. The growth was indicative of high nutrient levels – i.e. it suggested that insufficient dentrification was occurring.

RAS/mlss return – system not measured or done on any mathematical or scientific way. Considered that although nitrification was occurring in the oxidation basin, the relatively low levels of return to the anoxic zone would have been allowing more nitrates to pass into the maturation pond.

Comments

1) Insufficient on site process control sampling is taking place.
2) Current compliance is poor analytically, albeit the FST did look visibly okay.
3) Retention time and excess nitrates are allowing algal growth in maturation pond.
4) SVI levels are measured every day, but these are not then really being used for control.
5) Mlss levels are generally too high
6) Septic tank discharges may well be much more of an influence than currently known.
7) Sludge age records are very poor – i.e. only one out 3 months is viable.

Recommendations

1) Implement a series of composite (24hr) samples on the influent to more accurately determine the actual loading on the plant. These should be done weekly for approximately two months, on different days, including weekends. During this time flows should be monitored very closely.
2) From the above data, determine more realistic and accurate loading patterns to compare with on site treatment capacity.
3) Implement on site process control sampling as follows:

Daily (field tests)
Ammonia and turbidity (final effluent), dissolved oxygen (continuous in aeration basin).

Weekly (field tests)
Mlss and SVI

Others (laboratory)
COD, suspended solids (both influent and effluent weekly), nitrates (final effluent weekly), phosphates are not measurable, as this plant is not designed to treat them.

4) Measurement of mlss and RAS concentrations, along with SVI values will allow more precise determination of wasting requirements. It is likely that wasting will need to occur very regularly, probably every day.
5) Waste from mlss / RAS in order to bring the mlss down to a level of approximately 3000-3500mg/l. This will enable the supplied oxygen to more effectively transfer into the actual treatment rather than being consumed by biomass growth.
6) Closely monitor valve gate levels – as adjusted on site visit day – to increase rate of return to the anoxic zone. When levels of ammonia and nitrate reach acceptable levels, then this should be used as a calibration point on the valve stems.
7) Continue to run the existing aerators full time as it is suspected that capacity is close to or being breached. This may be resolvable in the short to medium term by increasing the size of the aerators.
8) Currently the maturation pond is actually the effluent worse. Consideration should be given to bypassing this. Discussion should take place with the DWA regarding this and the risk of pollution without the use of the pond (i.e. from failures of the FST).
9) Consider the installation of barley straw (or possible alternative) into the maturation pond. This should be done at the rate of 5g/m2 of pond surface area. It needs to be packed loosely in some form of netting to allow water to pass through. These nets will float, and should be placed across the inlet of the pond. As the pond is already full of algae, it would be necessary to stop the flows, empty the pond and then refill after the straw is fitted in.
10) Look to more closely monitor and potentially control septic imports. Perhaps consider some form of regulation or charging regime, which may encourage tighter compliance with quality of imported materials. Suggest taking some random samples directly from the tankers before permitting discharge to evaluate actual strengths.

Comments on Risk Reduction

Visual signs and available data suggest that hydraulics are not an issue on this site.

Previous risk score for compliance is 9, due to lack of information. This can be improved rapidly by instigating the suggested sampling regimes. This will not necessarily in itself make the site fully compliant with standards, but it will improve the situation.

Provision of information has the potential to improve this element of the score from 9 to 7. Actions on site management and process control could well see this drop to maybe 6, or even 5. It is unlikely that the site will become fully compliant as the oxidation process is apparently heavily loaded. However, this should be reviewed over a period of months before deciding on any extra construction on site.

CRR therefore estimated	=	1 * 2 + 7 + 2
	=	11
or possibly	=	1 * 2 + 5 + 2
	=	9

1.2) Franschhoek WWTW

Visit date: 20th January 2010
Risk Score= A* B+C+D
Risk Score= 1* 3 + 8 + 2 = 13

Compliance C therefore perceived as the major issue. From the 2008-09 compliance charts:

First order study gives a compliance score of 8. However, looking at the compliance charts for 2008, this should really be a 9. The near compliance of pH only was not considered to be relevant or significant to actual site performance. However, the actual number of samples was only 6, which is not sufficient to be representative. This was made even worse with only 1 value for E coli.

Sample data from 2009 was made available at the time of visit. However, this was only monthly, (3 months of AL Abbot reports), and is therefore not adequate to correctly assess and evaluate actual compliance.

COD

At the time of visit the site was wholly non compliant and not performing any degree of treatment. See below comments.

Suspended Solids

At the time of visit the site was wholly non compliant and not performing any degree of treatment. See below comments.

Ammonia

At the time of visit the site was wholly non compliant and not performing any degree of treatment. See below comments.

General Overall Comments and Observations on Compliance

At the time of visit, none of the processes on site were achieving any treatment at all. The site was functioning in respect that flows were being passed through most of the plant, and the aerators were actually turning. However, due to a variety of issues, no actual treatment was being done.

It did appear that this had been the case for some time. Looking at the results from AL Abbot analysis, no treatment was apparent from at least October 2009. Also, evidence from Google Earth pictures implies that this was the case from some months before this.

The analysis also showed values for mlss, SVI and sludge age that should have been ringing loud alarm bells. None of these could be taken as credible, as they did not relate to any treatment functions. Mlss values of less than 500mg/l mean there is no viable biomass in the reactor. Sludge ages were not determinable as there was no sludge biomass. No RAS concentrations were available as no RAS return was occurring.

The flow meter head had been moved downstream to include both incoming flows. This was a correct action, but the chamber it was then placed in did not appear to have any measuring flume. It was also heavily surcharged, so no reliance could be placed on the flow meter readings. High surcharge levels would lead to flow data higher than reality. These would then give higher than real COD and NH3 loading values.

Oxidation Capacity

The capacity of the plant to deal with oxidation of COD and NH3 is made up from the AS plant.

AS plant has 2 * 15KW surface aerators = 30KW capacity
= 30kg/hr oxygen supplied
= 720kg oxygen capacity per day
= 720kg COD per day capacity

COD Removal (oxidation)

Estimated COD load on site = 1488m3/day * av. COD of 1026mg/l
= 1529kg COD / day

Average COD calculated from only available 3 values. These are all high, but reasonably consistent. Flow values very suspect, and in reality, probably lower.

Ammonia Removal (oxidation)

Estimated NH3 loading on site = 1488m3/day * av. NH3 55.6mg/l
= 82.7Kg NH3 /day

= 82.7*4
= 331kg oxygen / day

(Assumptions from literature for NH3 removal across processes: NH3 removal requires 4kg of oxygen per kg of NH3)

Summary of Oxidation Needs

COD load on plant = 1529kg/day
NH3 load on plant = 331kg/day

Total oxygen required = 1860kg/day

Oxidation Capacity versus Needs

30KW motor power	=	30kg/hr oxygen
	=	720kg/day

This implies that the site is wholly overloaded biologically. However, this is being calculated on the basis of very unreliable flow information. It is possible that the flow meter is reading several % over reality.

Comments and Recommendations

The initial aesthetics were the only aspect of this site that was deemed satisfactory. It was immediately clear that the contents in the aeration basin were very thin and devoid of any viable biomass.

Inlet works – the mechanical screen had been removed, without any known reason.

Anaerobic pond – has potential for use as an overflow storage area, and visibly already had been. It contained thick sludge and many rags. This pond would need constant cleaning to ensure its capacity was always available.

Aeration basin – all mixers and aerators present and running, but not contributing to treatment. RAS recycle operating, but quality of material very poor. Mlss recycle not functioning. Mobile belt press adjacent, but not operable.

Final settlement – both tanks in very poor condition, with blackened and thick deposits on the surface. One tank said to have RAS outlet blocked. Site information varied, some saying this had been the case since December 2009. However, the AL Abbot report for October 2009 stated that it was blocked then. The net result was that no sludge was being removed, although the tank was still receiving flows.

Furthermore, the other FST was being hugely overloaded due to the lack of flow through the other. We were told that some attempts had been made to jet the outlet blockage, but no real detail was available. These efforts had clearly been ineffective. The feed valve from the aeration basin to this tank was also said not to be working. This may have been blocked with grit and rag, or perhaps mechanically unsound. The facts were not clear.

No clarification was being achieved in the FSTs, but this would be expected in these circumstances.

Maturation pond – this was heavily contaminated with sludges and other debris. The quality of the water was very poor. The chlorination area was surcharged and overwhelmed with water. This area was also overflowing, via a dug channel, directly into the watercourse (using a nearby concrete channel). This represented a gross pollution of the watercourse!!

RAS/mlss return – there was a pump duck-foot problem reported with these pumps. However, it was not possible to view this due to the surcharged conditions. Effectively no mlss would have been returned, as this was not being created in the first place!

Final effluent pumps and pond – the pumps in the ps building area were running, but clearly not pumping and flows to the fe pond. No reason was known for this. It may have been that the flooded conditions were blocking the pump suctions, or perhaps a non-return valve failure, or even worn pump internals.
The final effluent pond (also used as an irrigation source) was heavily contaminated with solids and debris, with a significant growth of reeds. The irrigation pumps were not running, which is just as well, because water quality was very low.

Recommendations

Inlet Works

Refit mechanical rake and return to service as soon as possible
Clean out flow meter chamber channel – unlikely to get a reliable reading if flooded as is now (is there a measuring flume under it?)
Clean out overflow basin, dry sludge to be removed to Wemmershoek drying beds, pump wet sludge into site beds for dewatering. (If the mobile belt press could be fixed then it may be possible to utilise this on the wet sludge).

Aeration Reactor

Has no viable mixed liquor in the tanks.
Fix outlet valve asap to enable isolation and clean out of FSTs.
Re-seed tank with 2 loads of RAS from Wemmershoek

Final Settlement

Isolate right hand side tank, drain, use jetter to unblock sludge draw-off. (The bottom scrapers may need replacing if broken/missing)
Repeat with other FST
Replace drive wheels on bridge – they will fail very soon.

RAS Return PS

Install temporary overpump to return mlss and RAS to aeration tank.
Investigate and fix main pumps.

Chlorine Dosing/Final Effluent Lift Pumps

Strip and fix lift pumps to enable effective lifting of water to fe pond (near inlet)

Maturation Pond and FE Pond

Raise levels of walls by use of sandbags
Clean out maturation ponds.
Clean out FE pond, removing all sludge and weed growth.

Suggested Order of Importance:

1) Clean out overflow basin to provide space for temporary fe pond.
2) Fix valve at end of aeration lane to enable isolation cleaning of FST (may be able to liquidise contents of chamber and work the valve to close, otherwise use sandbags to temporarily block it off).
3) Drain and completely clean the FST, including jetting to unblock the sludge draw-off line. Then return to service.
4) Install temp. overpump to enable return of mlss to anoxic zone.
5) Re-seed the basin from Wemmershoek (use RAS, its thicker) – 2 loads.
6) Fix the fe lift pumps or install temp. overpump to pump fe up the hill to the pond for discharge/irrigation use.
7) Divert fe flows into the newly cleaned-out small pond.
8) Clean out existing fe pond, using sludge drying beds as storage. When clean, restore to normal use.
9) Closely examine the competence of all persons on site. It would appear that there are some significant gaps in both knowledge and willingness to work. Management action will be necessary,

Further Recommendations

Once these immediate issues have been addressed and a more normal site function assumed, then a number of factors need to be catered for. These include properly establishing exactly what the site is receiving, both hydraulically and biologically, before matching against its capacity.

1) Implement series of composite (24hr) samples of the influent to accurately determine the actual site loading. This should be done weekly for approximately 2 months, on different days, including weekends. During this time, flows should be monitored closely.
2) From the above data, determine more realistic and accurate loading patterns to compare with on site treatment capacity.
3) Implement on site process control sampling as follows:

<u>Daily (field tests)</u>
Ammonia and turbidity (final effluent), dissolved oxygen (continuous in aeration basin).

<u>Weekly (field tests)</u>
Mlss and SVI

<u>Others (laboratory)</u>
COD, suspended solids (both influent and effluent weekly), nitrates (final effluent weekly), phosphates are not measurable, as this plant is not designed to treat them.

4) Measurement of mlss and RAS concentrations, along with SVI values will allow more precise determination of wasting requirements. It is likely that wasting will need to occur very regularly, probably every day.

5) Waste from mlss / RAS in order to bring the mlss down to a level of approximately 3000-3500mg/l. This will enable the supplied oxygen to more effectively transfer into the actual treatment rather than being consumed by biomass growth.
6) Closely monitor mlss and RAS pump return levels – to increase rate of return to the anoxic zone. When levels of ammonia and nitrate reach acceptable levels, then this should be used as a calibration points.
7) Continue to run the existing aerators full time as it is suspected that capacity is close to or being breached. This may be resolvable in the short to medium term by increasing the size of the aerators.
8) Ensure that the maturation pond levels are kept below critical levels. This will require effective use of the permanent pumps. In order to do this it may require a planned operation to remove the ps from service to access the pumps and restore their full automatic use.
9) Consider the installation of barley straw (or possible alternative) into the maturation pond. This should be done at the rate of 5g/m2 of pond surface area. It needs to be packed loosely in some form of netting to allow water to pass through. These nets will float, and should be placed across the inlet of the pond.
10) Examine the current flow meter location. It would appear that there is no actual flow device at this point. It may be necessary to either construct a flume, or fit an in/on pipe device (e.g. Magflow) to provide reliable data. Once done, then actual loadings can be determined.

Comments on Risk Reduction

Due to the very poor state of this site, and the clear issues with personnel, the opinion is actually to increase the risk score as follows:

CRR current = 1 * 3 + 8 + 2 = 13

CRR revised = 1 * 4 + 9 + 3 = 17

This is largely due to the inability to accurately measure flows, and the apparent inability of the site operators/poor supervisory effectiveness. To have allowed this situation to exist for so long is totally unacceptable.

However, the attitude of management was observed to be very positive, and there was a clear desire to do the right things. Also, much of the technical aspects on site are resolvable with the right amount of effort and support from higher levels within the Municipality.

If the correct actions are taken and the support given from all the necessary levels, this site can be turned around in a relatively short time period. The physical works could largely be completed inside 3-4 weeks, and a reasonably stable platform established. From this, the true ability of the site could then be accurately measured over a 6 – 12 month period.
It may well transpire that the site is not capable of reaching all of its compliance targets, but it is not possible to establish this at this time. Furthermore, it is possible to at least postpone the planned expenditure by closing the works and transferring flows to Wemmershoek – which would in itself, need significant expenditure to be made on upgrades. CRR can be modified as follows:

After 1 month (dependent on actions)

CRR therefore estimated = 1 * 4 + 7 + 3 = 14

After 3 months (dependent on actions)

CRR therefore estimated = 1 * 3 + 6 + 3 =13

After 1 month (dependent on actions)

CRR therefore estimated = 1 * 4 + 5 + 3 = 10

Further reductions are reachable, but will be dependent on the levels of support provided and actions taken on the ground. Much of the initial work required is of a non-complex nature, being more physical than technical. Technical work to follow will bear greater costs, but there is an opportunity to offset some of these by a lesser need to expend large capital sums with the planned move to Wemmershoek.

1.3) Stellenbosch WWTW

Visit date: 20th January 2010
Risk Score= A* B+C+D
Risk Score= 3* 3 + 7 + 2 = 18

A larger plant, justifying an A score of 3, compliance C therefore perceived as the major issue. From the 2008-09 compliance charts: Several factors apparent, with no actual passing parameters, especially when compared against the Special limits.

COD

From available data, the site was just failing this parameter.

Suspended Solids

A total of 5 failures from 7 samples.

Ammonia

A total of 5 failures from 7 samples.

Other Parameters

TON showing only 1 failure, but there was no real evidence of full nitrification. The single result for faecal coliforms was grossly non compliant at >24000 (limit = 0), indicating failure of any disinfection. Phosphates did not meet any limits, nor did conductivity. Some minor issues with pH compliance.

Average daily flows implied that the site was operating at around 86% of its hydraulic capacity. Septic flows were also being received, but would have been forming only a relatively minor proportion of flows.

Oxidation Capacity

The capacity of the plant to deal with oxidation of COD and NH3 is made up from a series of 6 biofilters, followed by 2 aeration lanes..

Comments and Recommendations

Although there were no immediately obvious major issues, several were found upon closer examination.

Inlet works – Three incoming sewers (2 @300mm, 1 @ 450mm), also the discharge point for septic tanks. Two automated vertical rake screens, with a bypass and small compactor unit. Bypass has coarse screening downstream. Flows split into two channels, one with 2 rotary grit classifiers, another with a single unit. There was some doubt about the efficacy of these units, as they did not appear to be fully functional. Also, site management did state that only one of these channels should have been in use. This requires investigation.

Primary Settlement – 4 PSTs, all of which looked generally okay, with the exception that one of the bridges was turned off for no apparent reason. This was reset by site management at the time, but needs investigation.

Biofilters – first stage of secondary treatment is done using 6 filters, 2 large and 4 smaller units. These units were suffering from any cracks and damage to their outer walls. Some efforts had been made to place metal banding around them, but with limited success.

A significant amount of media had been removed from the perimeter to lessen the loading on the walls. However, the distributor sparge holes over this area were still open, leading to flows passing through very thin media. These need to be blocked off, as this would be short-circuiting and reducing quality of the overall filter effluent. The other large filter was rotating, but only intermittently.

Of the smaller filters, 2 were not rotating but still receiving flows. This would have been causing short-circuiting and a poor quality effluent. Some of this was due to damage and sagging of the distribution arms. Statements were made that this was the uneven nature of the stones, but observation showed it to be sagging arms in need of welding and repair to straighten them.

All filter effluent was then passed on and distributed to one of 2 aeration ditches, each with surface aerators.

Aeration Ditch 1 - Only 1 of 3 aerators running. One was out of service, but one had merely been switched off. Unit turned back on by site supervisor. This needs investigation. Floating scum did imply that this had been off for some hours.

Aeration Ditch 2 – Had 4 aerators present, but a temporary unit was substituting one of the permanent units.

Final settlement – One ditch discharges to 2 large FSTs, the other to 4 smaller units. These appeared in reasonable order, albeit the effluent rather poor.

Maturation ponds – the site has 2 reasonably large units, but one was completely out of action due to a very large amount of sludge having been deposited in it. This clearly had occurred over a long time. The costs of cleaning this out and bringing it back into use would be high.
The smaller pond in use did appear to be functioning, and little or no signs of algal growth. It may have been that the nutrients were being removed by effective nitrification and denitrification, but the poor ammonia results do not support this.

Chlorination – this is done by a flow proportional dose at the inlet to the maturation pond. Only 1 result was available, and this grossly failed, so the effectiveness of this process was doubtful. Some of the mixing baffles were missing, and should be replaced to assist effective mixing.

Sludge – this area has suffered significant neglect, but some of the outputs were reasonable.

The site has digesters, but these were being used merely as thickening tanks for primary sludges. Waste activated sludge was being thickened for just a day before being blended (approx. 75% WAS to 25% primary). Blended sludges then mixed in an external polymer-mixing tank and dewatered in a single centrifuge. Eight batches are processed in an 8-hour shift. This certainly appeared to be a bottleneck in the overall sludge handling process.

Improvements could be made by increasing the number of mixing tanks, or even running longer shifts. A second centrifuge would also help, but would entail a new building and conveyor system. It is likely that running additional shifts would be more cost effective. However, this needs to be balanced against the very long downtime for servicing (said to be months).

Sludge cake is then passed to the adjacent composting plant, which did seem to be yielding a good product.

Recommendations

Short term

1) Controls to all critical plant should be locked off to prevent undue errors or sabotage.
2) Block off filter sparge holes under areas where media removed.
3) Repair and restore all filter arms to restore full use.
4) Restore and utilise function of all aeration equipment. If this is not possible, use floating temporary units.
5) Replace missing chlorination baffles.

Medium term

1) Implement longer (possibly 24hr) shifts in the sludge treatment area to deal with the current backlogs.
2) Construct additional polymer mixing tanks to more continuously feed the centrifuge plant (would need to be sited outside main building).

Longer term

1) When sludge backlogs dealt with, consider clean out of larger maturation pond.
2) Do cost-benefit analysis for purchase of second centrifuge line.

Further Recommendations

Once these immediate issues have been addressed and a more normal site function assumed, then a number of factors need to be catered for. These include properly establishing exactly what the site is receiving, both hydraulically and biologically, before matching against its capacity.

1) Implement series of composite (24hr) samples of the influent to accurately determine the actual site loading. This should be done weekly for approximately 2 months, on different days, including weekends. During this time, flows should be monitored closely.
2) From the above data, determine more realistic and accurate loading patterns to compare with on site treatment capacity.
3) Implement on site process control sampling as follows:

<u>Daily (field tests)</u>
Ammonia and turbidity (final effluent), dissolved oxygen (continuous in aeration basin).

<u>Weekly (field tests)</u>
Mlss and SVI

<u>Others (laboratory)</u>
COD, suspended solids (both influent and effluent weekly), nitrates (final effluent weekly), phosphates.

Measurement of mlss and RAS concentrations, along with SVI values will allow more precise determination of wasting requirements. It is likely that wasting will need to occur very regularly, probably every day.

Waste from mlss / RAS in order to bring the mlss down to a level of approximately 3000-3500mg/l. This will enable the supplied oxygen to more effectively transfer into the actual treatment rather than being consumed by biomass growth.

Closely monitor mlss and RAS pump return levels – to increase rate of return to the anoxic zone. When levels of ammonia and nitrate reach acceptable levels, then this should be used as a calibration points.

Comments on Risk Reduction

Restoration of available biological treatment should reduce compliance issues almost immediately. This could reduce this element of the score down to 2 in the short term, or even lower.

CRR current	=	3 * 3 + 7 + 2 = 18
CRR estimated	=	3 * 3 + 2 + 2 = 13

There were several points of concern such as the “switched-off” equipment, which need to be investigated, and some issues with operator competency/training.

However, the attitude of management was observed to be very positive, and there was a clear desire to the right things. Also, much of the technical aspects on site are resolvable with the right amount of effort and support from higher levels within the Municipality.

If the correct actions are taken and the support given from all the necessary levels, this site can be turned around in a relatively short time period.

Appendix 2 - Drakenstein Municipality

Sites visited included Paarl and Wellington WWTWs.

2.1) Paarl WWTW

Visit date: 21st January 2010
Risk Score= A* B+C+D
Risk Score= 3 * 3+5+2 = 16

Compliance C therefore perceived as major issue. From 08-09 compliance charts:

COD trend generally upwards, but only 1 actual failure.
SS trend on or above limits, but not excessively so.
NH3 high and very much rising.

However, a different story becomes apparent when the internal results from 44 samples taken weekly between Jan – Nov 2009:

COD

COD trend definitely down across the year, 11 actual fails from total of 44 samples. This represents 75% compliance rate. If looked at for the second half of the year, this improves to 2 fails from 21 samples, i.e. 90% compliance.

Suspended Solids

Trend definitely down, albeit a little up towards the end of the year. There was one exceptional outlier, which looks like it was some inert material from the maturation ponds. It is not considered to have been a treatment failure. There were 3 fails from 44 samples, which is 93% compliance. Once again, the early part of the year was the worst (Jan – Feb).

Ammonia

The 2008 trend was definitely up, and getting worse. Jan – Jun 09 was not good, with many high levels. In later June a step change occurred which took it much closer to compliance levels (with one exceptional outlier). For Jan – Jun average approx. 25mg/l, Jul – Nov average approx. 12mg/l.

Oxidation Capacity

The capacity of the plant to deal with oxidation of COD and NH3 is made up from the biofilters and the AS plant.

AS plant has 10 * 55KW surface aerators	=	550KW capacity
	=	550 kg/hr oxygen supplied
	=	13200 kg oxygen capacity per day
	=	13200 kg COD per day capacity

COD Removal (oxidation)

Estimated COD load on site = 22MLD * av. COD of 980mg/l
= 21500 kg COD / day

Assumptions from literature for COD removal across processes:

Removal across PSTs approx. 50%
Therefore, loading on biofilters = 21500 / 2 = 10250 kg COD/day

Removal across Biofilters approx. 50%
Therefore, loading on AS plant = 10250 / 2 = 5000 kg COD/day

Ammonia Removal (oxidation)

Estimated NH3 loading on site = 22MLD * av. NH3 50mg/l
= 1100 kg NH3 /day

Assumptions from literature for NH3 removal across processes:

Removal across PSTs negligible, and Biofilters only "roughing" of 10%

Therefore, loading on AS plant = 1100 - 10%
= 1000 kg NH3/day approx.

(Assumptions from literature for NH3 removal across processes: NH3 removal requires 4kg of oxygen per kg of NH3)

Therefore, need = 1000 *4
= 4000 kg oxygen / day

Summary of Oxidation Needs

COD load on plant = 5000 kg/day
NH3 load on plant = 4000 kg/day

Total oxygen required = 9000 kg/day

Oxidation Capacity versus Needs

55 KW motors = 55 kg/hr oxygen

55kg /motor / hour * 24 = 1320 kg/day/motor

= 9000 /1320
= 7 aerators required to run all day.

Comments and Recommendations

Generally well kept aesthetically, with no major tidiness or cleanliness issues (except the extension works area). This did suggest a certain degree of pride in the site operators. Site management also very committed to their work.

Inlet – clean and operational, with some spare capacity being built.

PSTs – appeared to be running okay, albeit raised level prevented close inspection.

Biofilters – all in use and in reasonable order, albeit only being used in a "roughing" capacity due to flow levels. Appearance of murky effluent and sewage fungus – indicating overloading. This is less significant as the AS plant follows.

Humus tanks – murky and brown, this being indicative of the biofilter overloading.

AS plant – only 5 of the possible 10 aerators running (one out for repair). Manual control, not really adequate or sufficiently scientific. No obvious dissolved oxygen or NH3 measurement. Calculations indicate that more aeration is required – need to use more of the units to achieve the COD and NH3 treatment. Appearance and odour all seemed okay.

FSTs – 2 in use, 1 being built. Some extent of rising sludge, possibly due to sludge retention being too long, resulting in pin-floccing. Water quality not great, but blankets stable. Algal growths present and in need of attention.

Maturation ponds – one in process of being dried-out, other in use. No obvious algal problems.

Chlorine contact tank – some civil works to be completed, but generally okay. Some solids build-up at outlet scum board/weir, but generally being retained. Cleaning valve leaking and not readily accessible.

Sludge Management – digesters looked in good condition and were being used. Evidence of gas production, 2 gas holders reasonably full. Gas being used to power boiler, which was then providing heat for the digesters and rag incineration. Dewatering belts in use and producing good quality cake (approx. 28% ds).

Polymer usage was estimated at 25 kg per 8 hours, producing 40 m3 of 28% ds cake. This equates to approx. throughput of 11,200 kg ds. Equates to approx. 350 – 4500m3 of wet sludge processed in 8 hours (at 3%ds feed).

Although good quality cake was being produced from the belts, there were several tonnes of it being deposited on open ground near the chlorine contact tank. It was not clear if any testing for metals or pathogens was being done.

Standby power – generator in place and test run on load every week. However, not clear if this was either big enough or connected to, all of the critical plant.

Management were experienced and passionate about their roles. Furthermore, there were some significant plants to ensure that the contractors building the new plant would provide training for it before being fully paid. Most persons observed on site were actively engaged in useful work.

Recommendations

1) At flows of approx. 22 MLD, need to utilise 7 aerators all day
2) Ensure PSTs are desludged regularly
3) Monitor NH3 of AS plant outlet every day.
4) Ensure mlss and SVI tested every day. Look to maintain mlss approx. 3500mg/l and SVI of less than 100 (absolute max 120)
5) Commission new extensions as soon as possible.

The amount of site sampling and monitoring was very good. However, this needs to be extended to ensure that site loadings and performance are fully understood at all times of the year. This should include a series of periodic composite sampling (24hr) of influent and effluent, with close monitoring of flows to derive actual plant loading data. This data should also then be used to control the processes (e.g. by altering the amount of aeration being used). Other tests should include:

Daily (field tests)
Ammonia and turbidity (final effluent), dissolved oxygen (continuous in aeration basin).

Weekly (field tests)
Mlss and SVI

Others (laboratory)
COD, suspended solids (both influent and effluent weekly), nitrates (final effluent weekly), phosphates (influent and effluent).

Measurement of mlss and RAS concentrations, along with SVI values will allow more precise determination of wasting requirements. It is likely that wasting will need to occur very regularly, probably every day.

Waste from mlss / RAS in order to bring the mlss down to a level of approximately 3000-3500mg/l. This will enable the supplied oxygen to more effectively transfer into the actual treatment rather than being consumed by biomass growth.

Comments on Risk Reduction

Hydraulic aspect – extensions will assist this, but the PSTs and biofilter stages may prove limiting, with no obvious storm management capacity.

Compliance – increases in available aeration should be able to reduce compliance issues in the short term. Following this, commissioning of the extensions should assist further. Estimated score reduction could be down from 5 to 1.
Hydraulic capacity being increased, but overall score estimated to go from 3 to 2, based on the potential limiting PSTs/biofilters.

CRR current	=	3 * 3 + 5 + 2 = 16
CRR estimated	=	3 * 2 + 1 + 1 = 8

2.2) Wellington WWTW

Visit date: 21st January 2010
Risk Score= A* B+C+D
Risk Score= 2 * 3+4+2 = 12

Compliance C therefore perceived as the major issue. From 2008-09 compliance charts:

COD

Trend generally improving – becoming compliant after August 09, however, 9 fails from 16 samples Jan- Aug 09.

Suspended solids

SS trend similar to COD, with 7 fails from 22 samples, only 1 fail after Aug 09.

Ammonia

NH_3 wholly non compliant – i.e. all 21 samples failed in 2009. TON – plan often not nitrifying but 7 fails from 24 samples in 2009.

Other Parameters

Faecal coliforms 9 fails from 13 between Jan – Aug 09, compliant Sep – Dec 09.
Phosphates – 8 fails from 12 Jan – Jun 09, all compliant Jul – Dec 09.
Compliant for conductivity and pH throughout 2009.

Plant Capacity – currently up to 8MLD, but planned extensions, including BNR plant up to 18MLD (10MLD diverting from Paarl WWTW). Stated average organic load of approx. 10,100 kg COD/day.

Oxidation Capacity

The capacity of the plant to deal with oxidation of COD and NH_3 is made up from the biofilters and the AS plant.

Comments and Recommendations

Inlet – elevated inlet with 2 vertically raked screens and 2 grit channels. These appeared generally clean and operational.

PSTs – 2 units, but only one is use. Second unit full of sewage, but no inflow/ outflow due to downstream issues. Floating sludge. Said to be desludged regularly, but appearances did not support this.

Biofilters – total of 5 biofilters, 2 large and 3 smaller. Only the larger filters were in use. The 3 smaller units were dry and clearly disused. This was found to be due to collapse in the underground feed pipe from the PST. To our amazement, it would seem that this had been the case for some 2 years! Very recent action by new management had repaired it, and it was due to be put on line within the week.

Humus tanks – 2 in use, discharging directly into the aeration plant. Quality of effluent very poor, quite likely as a result of the lack of upstream treatment.

AS plant – single reactor, anoxic zone with 2 mixers, aerobic zone with 4 dissolved oxygen controlled mechanical surface aerators. One of these aerators was not running, and there was no evidence to suggest that the DO monitors were indeed controlling the aeration. Mlss said to be 3400mg/l. Wasting said to be on mlss levels over 24hrs, but this was not being measured?

FSTs – 2 present, only one in use due to bearing failure on bridge driver motor. This had been out for 2 weeks, causing significant overloading in the other tank, and consequently very poor effluent.

Maturation ponds – not in use due to heavy sludge contamination. Chlorine dosing point immediately before discharge to this area.

Sludge Management – primary and secondary sludges combined in digester tank. No mixing, ad hoc intermittent fill and draw, with no actual attempts at actual digestion. Said to have been filled twice a week for approx. 90 minutes. Sludge pumped out to lagoons for drying prior to landfill.

Recommendations

Short term

1) Restore function of all filters immediately. If necessary, flows can be over pumped whilst feed pipe being repaired.
2) FST scraper drive to be repaired ASAP. to alleviate hydraulic overloading of other tank.
3) DO probe to be serviced and checked for efficacy.
4) Mlss levels and Settlability should be established and checked weekly.

The rate and frequency of sampling performed during 2009 is adequate, but other factors such as mlss, SVI, dissolved oxygen, nitrates and phosphates need to be regularly monitored.

Daily (field tests)
Ammonia and turbidity (final effluent), dissolved oxygen (continuous in aeration basin).

Weekly (field tests)
Mlss and SVI

Others (laboratory)
COD, suspended solids (both influent and effluent weekly), nitrates (final effluent weekly), phosphates (influent and effluent).

Measurement of mlss and RAS concentrations, along with SVI values will allow more precise determination of wasting requirements. It is likely that wasting will need to occur very regularly, probably every day.

Waste from mlss / RAS in order to bring the mlss down to a level of approximately 3000-3500mg/l. This will enable the supplied oxygen to more effectively transfer into the actual treatment rather than being consumed by biomass growth.

Comments on Risk Reduction

Compliance – increases in utilisation of existing biological and FST capacity should reduce issues almost immediately. Reviewing the 2009 data indicates that the CRR score for compliance of 4 is too low, and should be perhaps 6.

CRR current = 2 * 3 + 4 + 2 = 12

CRR revised = 2 * 3 + 6 + 2 = 14

After changes made,

CRR estimated = 2 * 3 + 2 + 2 = 10

Appendix 3 - Saldanha Bay Municipality

Only a single site visited here, that being Hopefield WWTW.

3.1) Hopefield WWTW

Visit date: 22nd January 2010
Risk Score= A* B+C+D
Risk Score= 1 * 2+4+1 = 7

Compliance C therefore perceived as the major issue. From 2008-09 compliance charts:

Only limited actual compliance information has been seen, but the risk score is relatively low. Site observations went some way to support this. A single AL Abbot report from December 09 was made available.

COD

The site has relatively low flows, but the influent does appear to be quite strong, albeit the aeration capacity should be able to match this need. Without actual COD (mg/l) data it is difficult to be precise. Some COD concentrations were derived from estimated COD loadings, but contrast with the spot sample taken on 9th December 09, which was somewhat weaker at 604mg/l.

Suspended Solids

Visual appearance of the FST effluent was good. The limited available final effluent results were not compliant, but this was thought to be down to the algal growth rather than true treatment-related solids. FST blanket was stable and clarification good.

Ammonia

As with COD, the site did appear to be treating ammonia. The larger aeration capacity was a factor here.

Nitrification would have been affected by the lack of anoxic zone mixing. The mixer had been away for some time before the visit, but was in place merely awaiting an electrical connection. There would have been significant solids build-up in this zone and reduced denitrification. RAS was returned from the FST, but the mlss return was not occurring. This was due to a failure of the pumps, which had been out for several days.

Oxidation Capacity

The capacity of the plant to deal with COD and NH3 is made up from the AS plant.

AS plant has 2 * 22KW surface aerators	=	44KW capacity
	=	44 kg/hr oxygen supplied
	=	1056 kg oxygen capacity per day
	=	1056 kg COD per day capacity

COD Removal (oxidation)

Estimated COD load on site	=	34m3/day * av. COD of 604mg/l
	=	208 kg COD / day

The flow and COD values were taken from the sample of the 9th December 09, but other data may suggest that the COD averages could be higher.

Ammonia Removal (oxidation)

Estimated NH3 loading on site	=	334m3/day * av. NH3 88mg/l
	=	30.3 kg NH3 /day

Assumptions from literature for NH3 removal across processes: NH3 removal requires 4kg of oxygen per kg of NH3.

Therefore, need	=	30.3 *4
	=	121 kg oxygen / day

Summary of Oxidation Needs

COD load on plant	=	208 kg/day
NH3 load on plant	=	121 kg/day
Total oxygen required	=	329 kg/day

Oxidation Capacity versus Needs

1*22KW motor gives 22kg/hr oxygen, or 528kg/day (2 aerators then give 1056kg oxygen/day). As the derived demand is only 329kg/day, this suggests:

Available oxygen	= 1056kg/day
Required oxygen	= 329kg/day

Hours required to run aerators	= 3.2hrs/day

This implies that there is more than ample aeration capacity. However, caution needs to be taken in respect of the very estimated nature of the flows and COD loadings. Also, although the calculations suggest only a few hours requirement, this would not be practicable. A better option might be to downsize the aerators.

Comments and Recommendations

Generally well kept aesthetically, with no major tidiness or cleanliness issues. This did suggest a certain degree of pride in the site operators.

Inlet – clean and operational. New inlet under construction. All flows are pumped into the site. Screening is minimal, but did not appear to be drastically affecting the process.

Anoxic mixer out of action. Apparently this had been out for some time before the visit, but was now only awaiting electrical connection. This would have been hindering the dentrification process, and allowing some settlement of solids materials in that zone.

Both aerators working at time of visit. General impression was that there is perhaps too much aeration being done. The motors are 22KW, which is large for the estimated COD loading received. Some mousse foam flotation tended to support this. The AL Abbot report also mentioned this.

The mlss return pumps were not functioning. One had only been out for a short time, but the other for some weeks. This would have been hindering the general denitrification process. No dissolved oxygen measurement in place. Mlss levels appeared high and dark in appearance.

Final settlement – reasonable clarification occurring, with some small or fine solids carry-over. No major accumulation of algae on surface. Some floating mousse.

Four large maturation ponds – estimated travel time across these ponds was 5-7 days. The water was heavily algified. This would have been resulting from the higher than normal nitrate loading (due to inadequate dentrification) and the long residence time. Algal growth can be expected to start after a residence of approx. 50 hours, especially in hot climates.

No chlorination was being done on site, this occurring close to the point of use at the irrigation of the sports field.

RAS/mlss return - system not measured or done on any mathematical or scientific basis.

Comments

1) Insufficient on site process control sampling taking place.
2) Current compliance is okay.
3) Retention time and excess nitrates are allowing algal growth in ponds.
4) SVI levels are being measured every day, but these are not then being used for actual control.
5) Mlss levels are generally too high

Recommendations

1) Remove 2 of the 4 maturation ponds from service to cut down the residence time, and thus the chance for algal growth.
2) Look at the amount of time aerators are run for. Currently there is too much aeration, which is leading to foam formation and is wasting energy.
   Options may include putting timers on aerators, but caution is needed, as it would not be appropriate to have extended periods with no aeration. A second, longer-term option could be to fit smaller motors to downsize, but not before a full COD and NH3 loading profile is built-up.
3) Ensure that the anoxic mixer and mlss recycle pumps are brought back into service ASAP.
4) Mlss levels are too high, with potential for unstable blankets. Wasting needs to be done to bring these down to around 3000mg/l. This needs to be done with regard to measuring the wasting process and mlss regularly. This will enable the supplied oxygen to more effectively transfer into the actual treatment rather than being consumed by biomass growth.
5) Implement on site daily sampling for ammonia and turbidity.
6) From the above data, determine more realistic and accurate loading patterns to compare to treatment capacity.
7) Implement on site process control sampling as follows:

Daily (field tests)
Ammonia and turbidity (final effluent), dissolved oxygen (continuous in aeration basin).

Weekly (field tests)
Mlss and SVI

Others (laboratory)
COD, suspended solids (both influent and effluent weekly), nitrates (final effluent weekly), phosphates (influent and effluent).

Measurement of mlss and RAS concentrations, along with SVI values will allow more precise determination of wasting requirements. It is likely that wasting will need to occur very regularly, probably every day.

8) Consider the installation of barley straw (or possible alternative) into the maturation ponds. This should be done at a rate of 5g/m2 of pond surface area. It needs to be packed loosely in some form of netting to allow water to pass through. These nets will float, and should be placed across the inlet to the pond. In this case as the pond is already full of algae, it would be necessary to drain and refill first.

Comments on Risk Reduction

Visual signs and available data suggest that hydraulics are not an issue on this site. Although not perceived as a major risk, the compliance is the highest part of the CRR score. From available information this would appear to be more related to the suspended solids than COD or NH3. There is certainly enough aeration capacity, so it is considered that the issue is more likely to be the algal growth in the ponds.

Control of algal growth and reduction of potential for FST blanket loss by reducing aeration and mlss levels should reduce incidents of solids carry-over.

CRR current = 1 * 2 + 4 + 1 = 7

CRR estimated = 1 * 2 + 2 + 2 = 6

Appendix 4 - Swartland Municipality

Three sites in all visited here, Mooreesburg, Riebeeck West PPC, and Riebeeck West.

4.1) Mooreesburg WWTW.

Visit date: 25th January 2010
Risk Score= A* B+C+D
Risk Score= 1 * 2+5+4 = 11

Compliance C therefore perceived as the major issue. Only limited data available from 2008-09 compliance charts:

No data available on COD, suspended solids, nitrates, or faecal coliforms. Ammonia compliant July – Nov, but failed in December 08. Phosphates compliant, but close to the limit Oct and November. Conductivity failed all but 1 of 6 samples.

Plant Capacity – no data available for maximum daily flows or organic loads. Average daily flows said to be 50% of design. Study of on site paperwork indicated flows of between 200 – 600m3/day for January 2010.

Oxidation Capacity

This comprised a single biofilter, in series with an oxidation ditch containing 2 surface aerators. No information as to the size of these units was available, and therefore it was not possible to calculate any capacities.

Comments and Recommendations

Inlet – Basic hand-rakes screening to approx. 20mm, grit channels and some measuring flumes, with all flows then pump lifted into an elevated primary tank.

Primary tank – referred to as “clarigester”. Unit raised above ground. Settlement being achieved, with sludge pumped out to drying beds. Access plates at top of stairs were not very safe and prevented closer inspection.

Biofilter – there was a significant leak on the distribution pipework near the centre column. Feed flows and effluent appeared strong, but the filter did appear wetted and functional.

Aeration ditch – both aerators running, mlss appeared quite dark, indicating high levels.

Final settlement – 2 tanks, but only 1 in use. One tank said to have been out of use for some months whilst the perimeter wall surface was under repair. We were told that it required some special concrete that was difficult to obtain?

FST in use did have some rising sludge and mousse, but considering it was receiving all flows, and did not have a scraper mechanism, it was considered to be doing rather well!

RAS – was being pumped back into the ditch, but wasting arrangements were intermittent and not very measured.

Maturation ponds – 3 large ponds run in series, prior to passing through small chlorination unit immediately before discharge to river or pump to irrigation. All ponds had significant algal growth. Discharge to nearby watercourse deep green in colour. Outfall structure in poor condition. Proximity of chlorination to outfall is such that contact time is likely to be inadequate.

Records – some site records were examined, revealing that daily monitoring of flows, pH and lime addition. The sheets also provided opportunities for recording maintenance and sludge wastage, but entries in these columns were woefully thin. Also, as the pH appeared reasonably neutral, it was not clear why 25kg of lime was being added each day? The recording of this addition was near perfect!

The technical skills section of the CRR score was high. However, the staff member who showed us around on visit day did seem to have a degree of knowledge and interest in the processes.

Recommendations

<u>Short term</u>

1) Fix leak on biofilter distributor.
2) Recommission second FST asap.
3) Ensure primary tank desludged regularly (probably daily)

<u>Medium term</u>

1) Reduce retention time in maturation ponds to less than 50 hours, at least in the summer months. It may be necessary to take some out of service to achieve this.
2) Introduce barley straw at rate of 5g/m2 in mesh netting bags (at inlet) to ponds.
3) Provide field test equipment such as spot ammonia, turbidity and mlss tests. These are simple to use and could be introduced with minimal training, and would provide rapid information for on site process control adjustments.
4) Implement on site process control sampling as follows:

<u>Daily (field tests)</u>
Ammonia and turbidity (final effluent), dissolved oxygen (continuous in aeration basin).

<u>Weekly (field tests)</u>
Mlss and SVI

<u>Others (laboratory)</u>
COD, suspended solids (both influent and effluent weekly), nitrates (final effluent weekly).

Longer term

Install scum boards and rotating scraper bridge on one of the FSTs.

Comments on Risk Reduction

Reinstating the FST and fixing the biofilter leak will improve compliance very quickly. Establishing the site loading and process characteristics will allow quick adjustments to be made and maintained. Subsequent to this, record keeping and provision of this information would reduce the C element of the score.

CRR current = 1 * 2 + 5 + 4 = 11

CRR estimated = 1 * 2 + 2 + 3 = 7

4.2) Riebeeck West WWTW.

Visit date: 26th January 2010
Risk Score= A* B+C+D
Risk Score= 1 * 2+9+4 = 18

Compliance C and technical capability D therefore perceived as the major issue.

Comments and Recommendations

This site consists of only a series of oxidation ponds, with no “active” treatment processes. Signs of original inlet channel structures were just about visible, but these had long since suffered extensive silting and ragging.

Currently flows pass into 3 large and then 4 smaller ponds, with no chlorination. The first pond was cleaned-out approximately 12 months ago, but this only removed plant material and not the accumulated rag, silt and organic sludge.

The risk score for this site will not be reduced without significant expenditure. This could take the form of cleaning out the existing ponds and removing sludge, rag etc for suitable disposal. However, this would be a long and expensive task that would need repeating at intervals in subsequent years. Another option would be to provide some form of “active” treatment processes. Some work has been done on this project, including the nearby areas of Riebeeck Kasteel and Koringberg.

It is highly likely that some degree of passive treatment is being achieved in the ponds, but if left as is, then the organic and inorganic deposition will ultimately fill them up to the point of uselessness.

It may be feasible to implement some form of controlled preliminary and primary treatment on site, but this would still involve clearing up land to site this, and having a controlled method of disposal for the rag, grit and sludges. Furthermore, the road access would need to be dramatically improved to facilitate passage of larger vehicles for construction and maintenance.

Comments on Risk Reduction

If the proposals for a full treatment plant are carried forward and become a reality, then there is no reason why this risk cannot be reduced to virtually zero. Without them, then no realistic change will occur.

CRR current	=	1 * 5 + 9 + 4 = 18
CRR estimated (no new works)	=	1 * 5 + 9 + 4 = 18
CRR with cleaning of ponds estimated	=	1 * 5 + 7 + 4 = 16
CRR with new plant	=	1 * 2 + 1 + 1 = 4

4.3) Riebeeck West (PPC) WWTW.

Visit date: 26th January 2010
Risk Score= A* B+C+D
Risk Score= 1 * 3+9+4 = 16

Little or no information was available for this plant. The C and D score were high due to non-provision of information. The works is small and compact, and serves the domestic flows from the nearby cement works (also run by the Municipality).

The site does have flow monitoring on the inlet, but the readout display was not accessible on the day (in locked building). The normal site operative was on leave at time of visit, so no opinion could be formed on their competence levels.

Comments and Recommendations

Inlet – screening using Huber rotamat screen, followed by flow measurement channel. All seemed clean and operational. Lime added manually to adjust pH (said to be incoming at approx. pH5).

Aeration – small ditch with a single horizontally mounted brush aerator, fitted with slim brush wheels. Drive motor seen to be 5.5KW. Liquor appeared dark in colour, but with no adverse odours. One of the brush wheels was missing.

Final settlement – small FST had significant algal accumulation on the surface, but much of this was being retained by the scum board. Adjacent well contained the sludge return pumps which were said to suffer from "continuous run" problems. No reasons where given for this but the heavy scum accumulation may have been interfering with the stop/start mechanisms.

Chlorination – small chlorination tank post FST, but contact time quite small before discharge. Final effluent rather murky, but this could have been due to either, high COD loading, poor treatment, algal cells, or a combination of all of these.

Sludge management – there did not appear to be any set basis for returning RAS, or wasting to the sludge beds. Wasting is achieved by temporarily diverting the RAS line. We were told that this wasting had only been done once in the past 6 months. Mlss tested once a month, SVI once a day (although no records seen).

Recommendations

1) Implement series of monitoring to fully establish the incoming loads and the ability of the plant to deal with them. This to be done by carrying-out a series of composite (24hr) samples of inlet and outlet. Suggest weekly for one month. Analysis of these samples to be for COD, suspended solids, ammonia, total oxidisable nitrogen (TON), faecal coliforms.
2) In the same period, monitor and test mlss and RAS concentrations weekly. SVIs to be determined at least weekly for both of these.

3) Monitor dissolved oxygen is the ditch every day (could use hand held devices), and record flows and aerator run hours.
4) Use the above information to calculate the loadings on the site, the input of oxygen, and the floc (mlss) growth and health.
5) With these calculated and measured values, adjust the site to effect some process control.
6) Once control is established, it is likely that many of these tests could be done less frequently, dependent on resources.

Comments on Risk Reduction

CRR current	=	1 * 3 + 9 + 4 = 16
CRR after initial adjustments estimated	=	1 * 2 + 7 + 4 = 13
CRR after process control established **	=	1 * 2 + 4 + 3 = 10

** It should be noted that this is merely an estimate. No actual analytical data has been seen, so it is difficult to judge at this stage how compliant the site can become. However, merely establishing the current condition and implementing some directed control should improve this element.

Worked Example:

Flows were observed to be light, at an estimated 2 l/s. If the incoming average COD were say 500mg/l, and the ammonia 50mg/l then this would calculate:
Flow of 2 l/s equates to approximately 200m3/day

COD load = 200m3/day * 500mg/l
= 100 kg/day COD

NH3 load = 200m3/day * 50mg/l
= 10kg * 4 (as need 4x the amount for NH3 treatment)
= 40kg/day NH3

Capacity = 5.5 KW motor (or 5.5kg/hr oxygen)
= 132 kg/day capacity

Therefore, the total demand would be approx. 140kg of oxygen against a capacity of approx. 132kg/day. This would give the plant a reasonable chance of treating much of the load.

Appendix 5 - Witzenburg Municipality

Only Tulbagh WWTW visited.

5.1) Tulbagh WWTW

Visit date: 26th January 2010
Risk Score= A* B+C+D
Risk Score= 2 * 2+7+2 = 13

Note: This score derived from information provided, as the Annex A WWTW Risk Profile did not include this site.

Compliance C therefore perceived as the major issue. Only limited data available from 2008-09 compliance charts:

COD

Largely compliant, with only a marginal failure in October 09

Suspended Solids

Trend well within limit, other than a failure on February 09. The 2008 charts show that high solids "spikes" are possible.

Ammonia

Several failures, and a rising trend from mid 09 onwards. This is coupled with erratic nitrate levels, with several failures. This is indicative of either insufficient treatment capacity, or incorrect site operation.

Other Parameters

Phosphates, conductivity and pH all seemed to be compliant.

Oxidation Capacity

The capacity of the plant to deal with COD and NH3 is made up from the AS plant. The plant is split into 2 treatment lines, an aeration lane, and a Pasveer ditch. Both of these lines have surface mechanical aeration, but the ditch has horizontally mounted brushes.

Flows are divided approx. 60:40 in favour of the lane. Flow measurement taken on the day read 0.61Kl/hr, but it was stated that winter storms do lead to significant increases in flow.

AS lane has 2 * 10KW surface aerators = 20KW capacity
= 20 kg/hr oxygen supplied
= 480 kg oxygen capacity per day

Ditch has 2 * 11KW aerators = 27KW capacity
And 1*7KW unit = 27kg/hr oxygen supplied
= 648kg oxygen capacity per day

Total aeration capacity = 480 + 648
= 1128 kg oxygen per day (all 5 aerators)

COD and NH3 Removal (oxidation)

Organic load determined to be = 741kg/day

Hence, this would suggest that the site has more than enough capacity.

However, on the day of the visit only 3 of the 5 aerators were in use, reducing this capacity down to approx. 680kg/day.

Comments and Recommendations

Inlet – hand raked screen only. Manual lime addition for pH adjustment. Generally well kept and tidy, but evidence of screenings passing through to the works.

Pasveer Ditch (ditch 1) – receives 40% of flow. Has 3 brush aerators, but not all working.

Aeration lane/ditch 2 (Latzak-Ettinger reactor)– receives 60% of the flow. Has 2 floating aerators (in series), which are operated on a timer basis (post anoxic zone). This did mean that significant periods of time pass where flows pass through the first half of the lane with no treatment. This would have been limiting the time for full treatment. Mlss recirculation pumps not operating correctly (1 had been out for a month).

RAS screws were said to be deprived of flow by the RAS pumps for the aeration lane. This did seem evident and suggestion was made to try altering pump start levels. The RAS rate into ditch 2 was too high; resulting in low mlss levels in ditch 1.

Final settlement – there was a distinct difference in performance between the 2 FSTs. The unit serving ditch 1 was stable and clarifying well. The other tank serving ditch 2 faired far worse, showing the relative lack of treatment occurring. It was also stated that this tank tended to suffer from wash-out of its contents during high flows. The plug flow design of the ditch would indeed be more vulnerable to this than the "circular" flow in the Pasveer ditch. However, if more aeration (and therefore treatment) was applied, then the settlement would be more stable and less prone to washing out.
Maturation ponds – only 1 pond was in use on the day. Another former sludge lagoon was undergoing a clean-out using excavators, for conversion to a storm handling pond. The

pond appeared to be working well, with no visible signs of algal growth. Ensure that retention is kept to less than 50 hours.

General – staff stated there was an issue with vegetable fats being discharged into the network and causing problems at the works. A survey was soon to be carried-out to identify sources and controls to try and address these problems.

Septic tank wastes were being discharged into the sludge drying lagoons. It would be preferable for these to be discharged into the works inlet (in a controlled way) for proper treatment.

Records were being kept, and these did include a site log book. However, these tended to focus on daily flow and pH, but lacked crucial information pertaining to process control on site (e.g. mlss levels).

Recommendations

1) Implement on site process control sampling as follows:

<u>Daily (field tests)</u>
Ammonia and turbidity (final effluent), dissolved oxygen (continuous in aeration basin).

<u>Weekly (field tests)</u>
Mlss and SVI

<u>Others (laboratory)</u>
COD, suspended solids (both influent and effluent weekly), nitrates (final effluent weekly), phosphates (influent and effluent).

3) Measurement of mlss and RAS concentrations, along with SVI values will allow more precise determination of wasting requirements. It is likely that wasting will need to occur very regularly, probably every day.
4) Waste sludge from both ditches until a stable mlss level of approx. 4000mg/l is achieved, and a sludge age not exceeding 10 days.
5) For ditch 1, run 2/3 aerators initially, if effluent ammonia levels go above 3mg/l, run all 3. For ditch 2, run both aerators continuously and monitor effluent ammonia.
6) Rebalance RAS by pump adjustments, reducing to ditch 2, increasing to ditch 1.
7) Consider passing all flows above normal treatment capacity to the storm ponds, and pump back into works at lower flows. This would be costly, but would protect the integrity of the biological process. It may also be possible to refurbish and modify an existing sludge pumping station to do this.
8) Provide on site test kits and training so staff can do their own daily tests for parameters such as ammonia, turbidity and mlss.

Comments on Risk Reduction

Some quick wins could be achieved with compliance (factor C) by increasing aeration, balancing RAS flows and controlling mlss levels. These actions could reduce this factor down to 2, or even lower. Hydraulic capacity is okay in dry weather, but storms can exceed it, so this remains at 2.

CRR current	=	2 * 2 + 7 + 2 = 13
CRR after process control established	=	2 * 2 + 2 + 2 = 8

Appendix 6 - Berg River Municipality

Three sites in all, Veldriff, Picketburg and Porterville WWTWs.

6.1) Veldriff WWTW

Visit date: 22nd January 2010
Risk Score= A* B+C+D
Risk Score= 1 * 2+9+1 = 12

Compliance C therefore perceived as the major issue. Very limited information was submitted to this study for compliance, therefore it was not possible to score anything other than a 9.

A report study was provided on site for future investment, but this did not actually provide any actual analytical data. It did suggest that the COD load was approx. 810kg/day, with an estimated COD concentration of 1000mg/l. Study report did imply that the site was overloaded, but did not contain detail as to why or how.

The site does receive septic tank imports. No data was available for strengths and volumes, but these types of imports are often of higher strengths. Also, without sufficient buffering they do have the potential for shock loading to a works.

COD

Not possible to judge as no details available. Main treatment done by a raised plastic media biofilter. This was said to be overloaded, and its effluent quality did support this claim. However, the relative lack of "primary" treatment would not have been helping this.

Suspended Solids

Also not possible to judge as no details available. Flows are directed into an anaerobic pond first, but this was heavily loaded with semi-dried sludge and other debris. No flow through could be observed due to the surface crusting.

Ammonia

Not possible to judge as no details available.

Oxidation Capacity

Treatment capacity is provided by a 4m tall "roughing" biofilter. The design appeared to be reasonably typical of such a plant. Quoted loading values have been observed to be around 5-10m3/m2/day. Biological loading rates are quoted as typically 1kg/m3/day. Ammonia loading rates are approx. 0.08kg/m3/day.

However, to carry-out such a calculation, it would be necessary to have details of the media surface area. If these loading rates are used, then it is possible to achieve COD removal approx. 50% and NH3 removal approx. 50-60%. (Not accounting for any removal over any primary treatment).

Comments and Recommendations

Generally well kept aesthetically, with no major issues of cleanliness or tidiness. This did suggest a certain degree of pride in the site operators.

Inlet – clean and operational. Receives flows from the nearby septic tank discharge point. Some discharges were witnessed and these significantly increased flows for a short period. Huber rotamat screening.

Anaerobic pond – heavily ragged and sludged. Very much in need of a clean out. If used properly then this may be able to remove a quantity of biological loading before the biofilter. It does though require regular desludging, for which no ready mechanism currently exists.

Biofilter – no ready access to this as it was raised above ground. However, effluent observed to be of poor quality. It was cloudy and contained solids. High probability that treatment being affected by lack of pre-load removal.

Final settlement – poor quality operation. Desludge line said to be blocked. No rotating scraper mechanism. Flows from biofilter split between ponds and the humus tank. Chlorination said to be done here, but merely by dropping in some tablets – rather inadequate and unscientific!

Maturation ponds – series of ponds, with ultimate recycle to the anaerobic pond (humus tank effluent does not go via the ponds, but is stored in 2 smaller ponds prior to being used for irrigation off site. Maturation ponds contained algae, but this may well have been more down to the retention times.

Comments

1) Insufficient on site process control monitoring taking place.
2) Current compliance not measurable but looked poor.
3) Retention time and excess nitrates allowing algal growth
4) Septic tank discharges having significant influence.

Recommendations

1) Implement series of on site and laboratory sampling to establish both process control and evaluated loading on the plant.

Daily (field tests)
Ammonia (influent, post filter and final effluent), turbidity (influent and final effluent)

Others (laboratory)
COD, suspended solids, nitrates (both influent and effluent weekly)

2) From the above data, determine more realistic and accurate patterns to compare to treatment capacity.
3) Obtain actual design characteristics for the biofilter and attempt to match loading to them.
4) Clean-out the anaerobic pond to maximise its potential for reducing the load on the Biofilter.
5) Remove blockage preventing desludge of humus tank.
6) Consider application of barley straw at inlet to maturation ponds.

Comments on Risk Reduction

Visual signs and available data suggest that hydraulics are not an issue on this site.

Previous risk score for compliance is 9, due to lack of information. This could be improved rapidly by instigating suggested sampling regimes. This will not necessarily in itself make the site fully compliant with standards, but it will lead to improvements.

Provision of information has the potential to improve score from 9 to 7. Management of the anaerobic pond and reduction of load on the biofilter should help reach compliance biologically.

Plans are in place to provide for various extensions, including the installation of an aeration plant. It may well be necessary in the longer term, but it is recommended that efforts are made to more accurately match flows and loads to site capacity first. Give the plant chance by removing loads before they reach the biofilter.

It is unlikely that this site will become fully compliant as the oxidation process is apparently heavily loaded. However, this should be reviewed over a period of months before committing to extra construction and costs on site.

CRR current = 1 * 2 + 9 + 1 = 12

CRR after process control established = 1 * 2 + 7 + 1 = 10

CRR possible estimated longer term = 1 * 2 + 6 + 1 = 9

6.2) Picketburg WWTW

Visit date: 25th January 2010
Risk Score= A* B+C+D
Risk Score= 1 * 3+3+1 = 7

B flow Capacity and C Compliance perceived as the main issues although the overall score of 7 is relatively low when compared with other assessed WWTWs.

Very little analytical data was available on the day of visit. A recent technical report compiled by "Water and Wastewater Engineering" did provide some data that suggested compliance had been rather erratic over the past 6 years.

Parameter	Fails	Total Samples Quoted
COD	2	5
Suspended solids	1	5
NH3	3	5
Nitrates	3	5
Phosphates	4	5

Oxidation Capacity

The site is equipped with a basic anaerobic dam, which acts as a form of primary tank.

Biological Treatment –aeration reactor in a modified UCT (University of Cape Town) process:-

i.e. an Anaerobic/Anoxic/Aerobic Activated Sludge process designed to biologically remove phosphorus and nitrify/denitrify to meet the General Standards for P, NH3 & NO3.

However, there was some confusion at time of visit as to the precise order of flows.

Comments and Recommendations

Inlet -1 mechanical (screw type) + 1 hand raked bar screen, 2 constant velocity grit channels, flow measurement and flow split – to current works and to potential extension. Generally tidy and clean, other than a degree of lime caking in the measuring flume. Said to be due to manual addition of lime for pH correction.

Design flows to plant said to be approx. 1.8MLD, but peaks of between 2.3 and 8 MLD said to be received. Normal flows quoted as between 1.8 and 2 MLD.

Anaerobic dam – provides basic primary settlement of sludges, which are withdrawn from a central channel every 2 weeks.

Biological treatment – effected by a modified UCT process reactor. It was not possible to fully ascertain the precise flow patterns, but a clear issue was that only 1 of 3 aerators was running in the aerobic zones (this was said to be standard procedure – usually 1 runs during the day and 3 at night). This would have been impacting on the degree of treatment possible or achieved.

Final Settlement -1 x radial tank, deemed to be of inadequate capacity, especially in high flow periods when washout of mlss occurs (causing sludge to be deposited in the maturation pond as well as loss of nitrification and denitrification due to loss of biomass.) The final tank effluent clarity was good on at the time of the visit. Single FST quoted as having a capacity of 0.9 MLD, which certainly makes it a bottle-neck.

Maturation Pond - effluent from the FST then flows through the maturation pond where it is chlorinated before being diverted for irrigation or discharging to a tributary of the River Berg. There was evidence of sludge and grass growing as well as dilapidated dividing walls at the time of visit.

Sludge Treatment - Wasted sludge is stored in two sludge ponds which appeared to be almost full at the time of visit.

Comments

Site is deemed to be both hydraulically and organically overloaded, so much so as to be holding up further housing development until treatment capacity is increased.

As a result of the above Water & Wastewater Engineering produced a technical report in July 2009 highlighting deficiencies and making recommendations which were understand are being implemented by the Municipality.

The following is a brief summary of their findings:-

Capacity - Current Population 9270; predicted population 22900(a 250% increase)
To accommodate the increase in load the following work was proposed:-

Phase 1 - refurbish/replace existing mechanical equipment -completion June 2010

Phase 2 - Upgrade to treat up to 2.05 ml/day (current design1.85 ml/day) – completion June 2011.

Phase 3 - Double capacity to 4.15 ml/day - completion June 2012.

i.e. Phase 2 includes upgrading and modification of the existing AS plant -
replace existing 15 KW aerators with 22 KW; modify UCT process to MLE (modified Ludzack Ettinger) – this converts the anaerobic stage to an additional anoxic zone, thereby removing the ineffective BioP stage* and increasing denitrification;
Providing an additional Final Sedimentation Tank , doubling current capacity;
Removal of sludge from both the Maturation and Sludge ponds (the latter will have to be lined and the former will require the dividing wall to be refurbished); Provision of a standby chlorination plant.

*The existing Anaerobic Pond removes 50% of the COD resulting in insufficient readily biodegradable COD being available for the downstream anaerobic zone of the UCT to biologically remove sufficient P.

The general level of site monitoring was seen to be insufficient. That is, no dissolved oxygen measurement or control was in place, mlss and COD sampling only monthly. SVIs were being done daily, but wasting done on this rather than on mlss levels.

Recommendations

In general we agree with the expansion proposals with the following additions:-

Aeration as well as upgraded aerators we would add dissolved oxygen control to both provide more consistent effluent quality and potentially save energy.

P removal Water & Wastewater Engineering comment that there will be insufficient P removal and predict that the final effluent P level will average at 15 mg/l which exceeds the General Limit of 10 mg/l; they also comment that chemical removal of P with ferric chloride is an option but its not included in the schemes – we suggest that this should be included in Phase 2.

Algae W&WWE quote FE COD results meeting the general limit of 75 mg/l with "algae filtered out"; we recommend that Barley Straw is installed in the maturation pond during the winter months at a rate of 5g/m2 surface area on an annual basis so as to reduce the likelihood of algal blooms in the summer. Merely quoting post filtered samples does not in itself actually represent what is actually being discharged, nor does it truly reflect any denitrification issues in the process.

Process Control and Effluent monitoring

Monitoring of critical parameters such as mlss/ DO/FE NH3, NO3, Turbidity & P on at least a weekly basis using widely available portable on site equipment /spot sample kits – this would increase both effluent quality and ownership of the site processes.

1) Implement series of on site and laboratory sampling to establish both process control and evaluated loading on the plant.

<u>Daily (field tests)</u>
Ammonia (influent, post filter and final effluent), turbidity (influent and final effluent)

<u>Weekly (field tests)</u>
Mlss, SVI, ammonia and nitrate and phosphates (final effluent).

<u>Others (laboratory)</u>
COD, suspended solids, nitrates (both influent and effluent weekly)

2) Consider application of barley straw at inlet to maturation ponds.

Comments on Risk Reduction

Whilst the attitude and knowledge of the site representatives was clearly good, the erratic nature of the compliance did imply that a revision of initial risk score was appropriate.

CRR current	=	1 * 3 + 3 + 1	= 7
CRR revised	=	1 * 3 + 7 + 1	= 11
CRR estimated short term	=	1 * 2 + 3 + 1	= 8
CRR possible estimated longer term (with expansions)	=	1 * 1 + 1 + 1	= 4

6.3) Porterville WWTW

Visit date: 25th January 2010
Risk Score= A* B+C+D
Risk Score= 1 * 3+4+1 = 8

B flow Capacity and C Compliance perceived as the main issues although the overall score of 8 is relatively low when compared with other assessed WWTWs.

Very little analytical data was available on the day of visit. Flows were said to be around 1.2MLD, but could easily rise to 2.8MLD in rainfall.

Oxidation Capacity

Treatment capacity is provided by a small aerobic reactor, containing 2, 15KW aerators. These would provide a capacity of approximately

2 * 15KW aerators	=	30KW/hr
	=	30Kg / hr oxygen supplied
	=	30Kg / hr COD/ or NH3 treatment.

One of these aerators was being turned-off at night for a 12 hour period. It was not clear exactly why this was being done, and there was no analytical data to compare this capacity to.

Comments and Recommendations

Inlet- Huber mechanical screen and hand raked bar screen; 2 x constant velocity grit channels; flow monitor and storm bypass.

Biological -activated sludge plant consisting of anoxic zone with mechanical stirrer
2x aerobic zones with mechanical surface aerators and recycle to anoxic zone

Final Settlement- 2 x radial tanks, one smaller than the other; the smaller of the two has no scraper and receives less flow than the larger; RAS was pumped back to the aerobic aeration zones. The surface of both FSTs had significant foam indicating low f:m ratio/ high sludge age however, the effluent from these tanks was of visually good quality.

Tertiary Treatment -Flow passed through 2 maturation ponds in series. The contents were green and turbid – caused by algae. The effluent was then chlorinated before being discharged to the watercourse. Site staff stated that this was a problem that normally only existed in the summer months.

Sludge treatment - sludge was stored and thickened in 3 x evaporation ponds. Local farmers had been expressing an interested in using the thickened product, but no lack of classification was said to be preventing this.

Other Observations / Comments

We were informed by the plant manager that the plant was occasionally flooded in high flow conditions.

There was evidence of good record keeping including maintenance records and the local process controllers and supervisor seemed highly motivated and interested in producing a high quality effluent. Simple lists of instructions were observed. These gave clear guidance to all operatives for daily, weekly and monthly tasks.

Recommendations

As there was very limited analytical data available, it is necessary to establish the precise nature of the influent flows and loadings, and compare these to the expected treatment capacities. This could be achieved by

1) Implement series of on site and laboratory sampling to establish both process control and evaluated loading on the plant.

<u>Daily (field tests)</u>
Ammonia (influent, post filter and final effluent), turbidity (influent and final effluent)

<u>Weekly (field tests)</u>
Mlss, SVI, ammonia and nitrate and phosphates (final effluent).

<u>Others (laboratory)</u>
COD, suspended solids, nitrates (both influent and effluent weekly)

2) Once this data obtained, use it to adjust the plant and optimise the amount of aeration being applied.
3) Provide basic field test equipment and training so site staff can monitor effluent and influent quality for themselves.
4) The algal blooms in the maturation ponds may be reduced by reducing retention to less than 48 hours in the summer months and/or dosing with barley straw at the inlet of the ponds at a rate of 5g per m2 surface area during the winter.
5) Consider investing in some form of storm management system, albeit this would take some significant investment.

Comments on Risk Reduction

Generally the site seemed well run, and the attitude of site management should be commended to others. There is the opportunity to optimise the site capacity and enhance compliance capabilities. Doing these things should bring down the CRR score.

Dealing with the site sludge was said to be a limiting factor to operating the site. There are 3 sludge lagoons that rely on evaporation only. Lack of removal of sludge from these lagoons was limiting wasting of sludge from the process.

Whilst there was no physical evidence, it was said that significant flooding did occur, affecting all of the maturation area. This would certainly impact on final effluent quality.

CRR current	=	1 * 3 + 4 + 1	= 8
CRR estimated short term	=	1 * 3 + 3 + 1	= 7
CRR possible estimated longer term (with storm and sludge investment)	=	1 * 1 + 2 + 1	= 4

References

The bulk of this report was based on the inspections and advice given at the time. It was not intended to be a wholly scientific paper, and so the number of direct references made is limited. Much of the literature used was for background reading. The following lists 3 documents specifically used, but the technical detail used is available in a number of sources not cited.

Activated Sludge – Theory and Practice N.F.Gray, Oxford Science Publications 1990 ISBN 0-19-856341-8

Oxidation Ditch Technology Oxidation Ditches: The Up and Coming Solution for the UK? A.J. Rachwal The Institute of Public Health Engineers and The British Water and Effluent Treatment Association Central Conference Centre London 29th March 1984.

The following list includes documents used for information, but also some suggested useful sources of technical information (some previously used by the authors in production of the Gauteng Province Report of 2009).

DWA Report, *Municipal Wastewater Treatment - Base Information for Targeted Risk-Based Regulation, Western Cape Province, Status at June 2009.*

Department Water Affairs and Forestry. *First Order Assessment of Wastewater Treatment Works in Gauteng* (December 2008).

Dabkowski, R. *Black Magic can Work Wonders for Wastewater Treatment. Detailed theory of oxidation reduction potential* (2007). www.waterwastewaterasia.com/WWA_archive/JanFeb07/24t28.pdf

Jansen, P.M.J; Stowa, K; Meinema, H.F. van der Roost. *Biological Phosphorus Removal* (2002). IWA Publishing, ISBN 1843390124, 9781843390121.

Khumalo, G. *Memorandum of Understanding between Joburg Water and University of Johannesburg* (2009). http://www.skillsportal.co.za/learning/higher_education/0901222-memorandum-university-water-sanitation.htm

Mosia, Sipho. Presentation given 26/9/07. City of Cape Town, *Water and Sanitation.* Accessed via http://www.capetown.gov.za

Partners for Water and Sanitation, *Wastewater Treatment Works Assessments, Gauteng Province, South Africa.* DWA, PfWs and Tom Wayling & Rob Smith, Anglian Water. March 2009.

Park, Jae K. *Wastewater Characterisation for Evaluation of Biological Phosphorus Removal* (2006). Wisconsin, Department of Natural Resources. www.dnr.state.wi.us/org/water/wm/ww/biophos/1intro.htm

Pitman, A.R. (1998). *Management of biological nutrient removal plant sludges – Change the Paradigms?* Elsevier Science Ltd. www.sciencedirect.com/science

Purcell J. Patrick. *Design of Water Resources Systems, Technology and Engineering* (2003), page 185. Reached on http://books.google.co.uk/books

Snyman, H.G; van Niekerk, A.M; Rajasakran, N. *Sustainable Wastewater Treatment – What Has Gone Wrong and How Do We Get Back on Track?* Paper given at the WISA Biennial Conference and Exhibition, Durban 2006. www.ewisa.co.za/misc/WISAConf/default2006.htm

Tchobaboglous, G; Burton, F.L. Metcalf and Eddy Inc. *Wastewater Engineering, Treatment, Disposal and Re-Use,* 3rd Edition (1991). McGraw-Hill Book Co. ISBN 0-07-100824-1.

Van Ryneveld, M.B; Sproule, SL. *Development of a Methodology to Assess Knowledge Uptake by Technical Professionals and Decision-Makers for Developmental Water Services* (August 2007). Report to the Water Research Commission. WRC Report No 1519/1/07. ISBN 1-77005-499-5.

Wastewater Handbook. On-line resource authored by van Haandel, A; van de Lubbe, J. Available at www.wastewaterhandbook.com

Glossary of Terms

This section contains an outline and definition of common terms used in wastewater treatment. Whilst they are not necessarily all used in this report, some are included for information.

DWA – Department of Water Affairs. Government body responsible for control and regulation of wastewater treatment in South Africa.

BNR – Biological Nutrient Removal. Type of wastewater treatment process designed to remove nutrients using biological techniques. Primarily focused on nitrogen and phosphorus.

Nutrients – Biological compounds found in wastewater that are used by micro organisms. Primarily nitrogen and phosphorus, commonly found in the form of nitrates and phosphates. These are important growth factors and can lead to significant pollution and harmful affects in watercourses.

Eutrophication – Enrichment of water bodies with nutrients, which promotes rapid and extensive growth of algae. This impacts directly on water quality, often leading to reduced dissolved oxygen levels and difficulty with downstream treatment for potable purposes.

COD – Chemical Oxygen Demand. An expression of the polluting capacity of a substance. COD measures the amount of oxygen consumed by the breakdown of the substance into simpler, stable and less harmful products.

MLD – Mega litre per day. A common expression of flow. One MLD = one million litres. Flow is often expressed as litres / second, but MLD is more convenient when dealing with much larger values.

PST – Primary sedimentation or settlement tank. A process unit commonly used at wastewater treatment works to settle out heavy organic solids under gravity. The resulting solids are known as *sludge* or sometimes as *biosolids*.

FST – Final settlement tank. Very similar to PSTs, but used to settle finer solids produced by the treatment process.

Activated Sludge – A form of wastewater treatment process. It works by “suspending” micro organisms within the body of wastewater that they are treating. Activated sludge has the appearance of a light brown semi-solid “soup”.

WAS or SAS – Waste, or surplus activated sludge. The treatment process is biological, and results in the rapid growth of micro organisms. There is always more produced than is required, so control is exerted by wasting or surplussing the excess. WAS then requires further treatment and disposal.

Digestion – A process of breaking down the structure of the sludge. This converts the complex compounds into simpler and less harmful products. These can then be further treated, or in some cases (e.g. methane), drawn-off for useful purposes.

Aerobic – Process using elemental or molecular oxygen, usually sourced direct from the atmosphere.

Anaerobic – Process in the absence of oxygen.

Anoxic – Process of no molecular oxygen, but with other forms of "bound" oxygen. Typically this will be nitrates and phosphates that contain oxygen molecules as part of their structure. Within aeration plants these compounds are then utilised for energy and as an oxygen source, depending on the stage of treatment.

MLSS – Mixed liquor suspended solids. A measurement of the amount of micro organisms contained within the secondary treatment phases. The mixed liquor is the brown, semi-solid mass present in the reactors. The mixed liquor normally refers to the live organisms carrying out the actual treatment, but the mix will also contain a certain amount of inert matter (e.g. grit). Usually expressed in mg/l.

Cake – A form of sludge solids after it has been subjected to removal of water (dewatering). The term cake comes from the largely solid nature and appearance. Sludge will become a cake when dewatered to around 15% dry solids.

Dry Solids – The measurement of the actual solid content within a sludge. Applicable to either liquid or cake forms. The "% ds" expresses the actual percentage of solids, and is equivalent to mg/l. That is, 1% ds is equivalent to approximately 10,000mg/l.

SCADA – A system of remote sensors and computers that can be used to monitor and control any number of treatment processes. Usually confined and monitored on a single site.

Telemetry – Similar to scada, but tends to be used more for monitoring rather than control. Also, these systems usually monitor a number of remote sites, which then communicate with a centralised control and monitoring centre.