DRIVERS for WASTEWATER TECHNOLOGY SELECTION

ASSESSMENT of the SELECTION OF WASTEWATER TREATMENT TECHNOLOGY BY MUNICIPALITIES in relation to the MANAGEMENT CAPABILITY AND LEGISLATIVE REQUIREMENTS

Report to the
WATER RESEARCH COMMISSION
and

SOUTH AFRICAN LOCAL GOVERNMENT ASSOCIATION

by

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EXECUTIVE SUMMARY

Background: Over the past decade, much attention has been devoted to the engineering, science and technological aspects of wastewater treatment in South Africa. More recently, attention has been redirected to assess the performance and compliance status of wastewater treatment facilities, and to identify the challenges and root causes that underpin poor performance – in particular by municipal institutions. The inception of the DWA wastewater services regulation programme has identified and highlighted the need for innovative approaches and appropriate technologies to ensure that sustainable choices are made by municipal decision makers. However, equally important is that the sector takes cognisance of its responsibility to contribute to a municipal environment where it is ***possible*** and within ***reach*** to achieve improved effluent quality and optimal management performance with distinctive impact and lasting endurance.

The predominant focus within the wastewater services domain has recently shifted from that of design and construction to that of wastewater operation, maintenance and management. Whilst the importance of these issues cannot be overstated, a number of other aspects related to plant performance are of great importance in the planning, design and management of wastewater treatment facilities. These aspects would encompass:

- the need for technology which would treat a broader range of constituents;
- the need to comply with more stringent effluent discharge limits; and
- reality that the natural resource base is in recoil and demands 'not-to-exceed' values and standards which are prescribed and regulated by the Department of Water Affairs (DWA).

Project outline: This project proposes to, via a scientific selection of 15 municipal cases (sites) across the country, provide a high level assessment and initial comment on:

- appropriateness of the technological choices in relation to the current ability of the municipality to implement and administer such choices, and
- legislative environment within which these choices are overseen.

Selection of 15 representative WWTPs for assessment: The DWA license database was used to scientifically determine the best spread of plants across the provinces for assessment. Selection criteria included:

- Select at least one "representative" application per province (9), based on what their majority application entail, i.e. sea out fall, oxidation pond, discharge into river. Some provinces seem to have dominant discharge types;
- If a predominance of a Class of works was found in a province, this was also factored into the selection, as to best represent the particular province;
- Select a spread that represent vulnerable versus capacitated municipalities; vulnerable versus less vulnerable receiving environment; and technology type of WWTP;
- The currentness of the documentation, i.e. application in process or most recently issued, was also taken into account to ensure that the information is relevant and current;
- The size of the municipality was also taken into account to ensure that there is a fair spread of lower capacity (more ruralised) to capacitated and larger municipalities in the group;
- The environmental status by means of the River Classification WSAM: Present Ecological State (on the PESC straight mean of imp score) was also taken into account.

Assessment framework: A number of *key levers that (should) influence decisions* when dealing with newly planned- or upgrading to existing municipal wastewater treatment facilities are listed in the report. However, the assessment framework has been designed to cover the most essential pertaining to the legislative requirements, environmental landscape, technology levels employed (existing and new), municipal environment and technology impact. A detailed reference of each parameter used in the assessment is attached as Appendices.

Assessment results: Assessment of 15 facilities was broadened to include 18 wastewater treatment plants. The current trend can be summarised as follows:

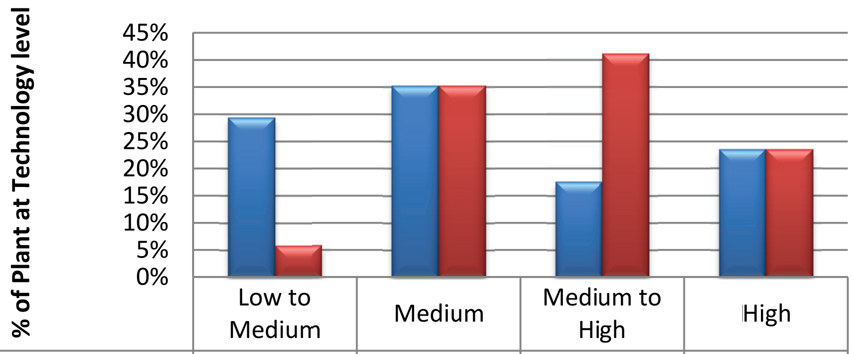
- Current Scenario: Oxidation pond systems account for 39%, activated sludge plants for 61% (of which 36% include BNR) and 6% package plants.
- Future Scenario: Oxidation pond system will reduce to 17%, whilst activated sludge systems will increase to 78%.

This would indicate that a more complex and potentially costly level of technology (medium) enjoys higher preference to the low to medium level technology. Although this could be ascribed to effluent treatment requiring a higher level of technology, land availability, initial cost of expansion and repairs of existing versus capital cost of new system, etc., it is observed that this is not always the situation.

Often, insufficient attention is directed towards investigating sustainable low to medium level alternatives, and/or that the long term cost implication (lack of skills, cost recovery, power consumption) of the high level technology is not realised. This is concerning as sustainability of higher level technologies may not always be within reach of some of the municipalities.

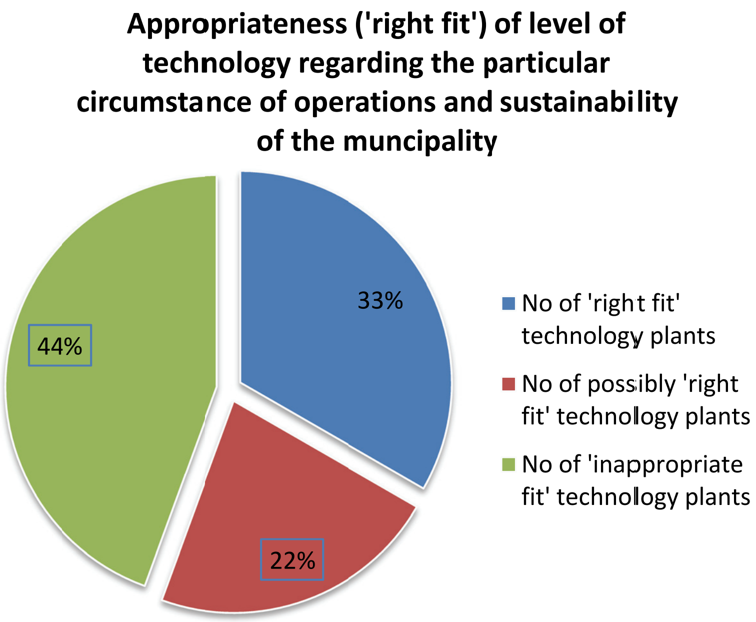
Furthermore, it would appear that in terms of demand growth, the trend is not to extend the existing plant and maintain the technology level, but to upgrade to a higher technology level as shown in the graphs below. This is disconcerting as not all municipalities are necessarily equipped to sustainably manage such a change in circumstances, specifically with regard to skills and financial resource availability.

Technology Level Trends of Known Planned Upgrades



	Low to Medium	Medium	Medium to High	High
Current % Plants at Technology Level	29%	35%	18%	24%
Future % Plants at Technology Level	6%	35%	41%	24%

Assessment of the 18 treatment plants, indicate that 44% (8 plants) may have opted for less suitable (inappropriate) technologies when considering their resource base, capacity to manage and effluent quality requirements. A further 33% (6 plants) technology options are questionable and may be inappropriate, but this conclusion is hampered by the weak evidence trail and support documentation. When applying the 44% statistic to a comparative national base (consisting of 850 municipal plants), it would translate to approximately 374 plants that potentially have unsuitable technologies in place. This number is significant enough to support further investigation and measures to mitigate this as a key risk to sustainable and improved performance in the municipal wastewater services sector.



Aspects taken into account in identifying appropriateness were not only the technology level, but also aspects such as:

- Sensitivity of receiving natural resource
- Legal Requirements / license Requirements
- Capacity of municipality to operate system
- Availability of funding to construct and maintain

Assessment observations and findings: From the information received for the various WWTP and from the literature reviewed, the following observations can be made:

- Few of the supporting documents refers to – or even defines – what alternative technology options were investigated when selecting/ deciding upon the technology choice for a WWTP and or an upgrade to the works;
- No information was provided as to cost comparisons between options and it is appears as if cost-benefit analysis are not a standard practice when informing technology options;
- Motivation/proof as to the municipality skills and resource availability to effectively and sustainably operate the WWTP and or selected technology choice, forms part of the supporting documentation. More often, it is merely (incorrectly) assumed that the municipality have or will acquire the resources;
- When "upgrading a works" it usually would imply that a more specialist / complex technology option is selected, which often may be more costly from a capital, operational and resource perspective;
- Few municipalities prioritise green economics in their decision making process, i.e. the beneficial use of their waste products or water, other than using it for irrigation and in some cases re-used by industry (some of the best efforts found were in KZN and Western Cape);
- The DWA license does not determine the technology option. The requirements of the catchment in terms of the RWQO's do influence the technology used;

- In terms of the authorisation process, the following key findings:
  - License applications are usually prepared and submitted to DWA after or during the plants' construction. Water Quality Objectives are usually provided at commence of a project, but no clear direction is given as to the required effluent quality standards that would be enforced via the final license
  - MIG conditions usually stipulate that the license or authorisation must be in place, which is often not adhered to. It could not be ascertained whether MIG audit such conditions post project implementation
- The most fundamental parameters, when selecting the technology choices are those of flow/strength of wastewater, compliance, capital costs and land availability, insufficient attention to long term sustainability aspects such as operation and maintenance costing over the design lifespan of the infrastructure, skill/resource requirements and constraints, tariff / cost recovery and alternative cost recovery options, i.e. re-use and other green technology options such as gas, ability of community to pay, energy requirements, etc.;
- Licence applications are strongly driven by support consultants in the case of smaller/low-capacity municipalities. It is apparent that in a number of cases, the project decision is driven from the consultant and is not always the product of a joint investigative team of municipal officers and consultants that undertake the technology choice investigations. In some cases, such investigations are not done at all. In the instance of capacitated municipalities, the standard or specification are often developed in-house and the consultant acts in specialist role and/or as Project Manager to oversee the project;
- Sufficient guidance is not available in the SA water sector to guide municipalities as to the options available and their applications under varying circumstances;
- Although not stated directly in any of the documents, it is suspected that socio-environmental requirements, as reflected by the licence limits, place municipalities in situations where they are under pressure to select technological options which are not financially or operationally sustainable. It is not clear what resolutions or remedies are available in the event where a municipality is wholly unable to achieve compliance and sustainability, as most support facilities relate to capital grants, etc. but not ongoing physical and financial support.
- The role of DWA as regulator takes pertinence in the 'Recommendations';
- The DWA 2003 "Aide Mémoire For The Preparation Of A Water Quality Management Report To Support The Application For Licences For Sewage Treatment Works In Terms Of The Requirements Of The National Water Act, 1998 (Act 36 of 1998)", is very comprehensive, but focuses mainly on the situation where the applicant has already decided on a technology choice. Some of the support documentation made limited reference to the use of the aide memoire, however, the extent to which these guidelines are followed by municipalities is uncertain. The guideline does not comment on the need to provide a motivation as to which options were investigated and why the final selection was made in the event of new works or upgraded works;
- Although a plethora of research has been done in the field of wastewater treatment and specific technology options, there would not appear to be a readily accessible manner in which municipalities and/or consultants can by means of a multi-criteria selection basis access a model or a guideline which can assist in the initial identification of potentially appropriate technological options.

- A further positive development would be the development of standards and specifications for technologies that can be used by municipalities to spec and scope their projects with improved confidence.

The report concludes with specific recommendations assigned to the relevant sector players to work towards a future that embrace and promote responsible and appropriate technology choices that will sustain service delivery, public health and the environment in the long run.

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1 BACKGROUND

1.1 PROBLEM STATEMENT

Over the past decade, much attention has been devoted to the engineering, science and technological aspects of wastewater treatment in South Africa. More recently, attention has been redirected to assess the performance and compliance status of wastewater treatment facilities, and to identify the challenges and root causes that underpin poor performance – in particular by municipal institutions. The inception of the DWA wastewater services regulation programme has identified and highlighted the need for innovative approaches and appropriate technologies to ensure that sustainable choices are made by municipal decision makers. However, equally important is that the sector takes cognisance of its responsibility to contribute to a municipal environment where it is ***possible*** and within ***reach*** to achieve improved effluent quality and optimal management performance with distinctive impact and lasting endurance.

> The entire sector carries a responsibility to contribute to a municipal environment where it is ***possible*** and within ***reach*** to achieve improved effluent quality and optimal management performance...

Notably, the majority of wastewater collection and treatment infrastructure in South Africa are either on-line or under construction and/or refurbishment. The predominant focus within the wastewater services domain has thus shifted from those of design and construction to those of infrastructure operation, maintenance and management, particularly in the field of wastewater treatment.

Whilst the importance of these issues cannot be overstated, a number of other aspects related to plant performance are of great importance in the planning, design and management of wastewater treatment facilities. These aspects would encompass:

- the need for technology which would treat a broader range of constituents;
- the need to comply with more stringent effluent discharge limits; and
- reality that the natural resource base is in recoil and demands 'not-to-exceed' values and standards which are prescribed and regulated by the Department of Water Affairs (DWA).

These aspects place a responsibility and burden on the municipal decision makers related to the (existing and new) treatment technology, as well as the drivers along this pathway that (should) ensure that discharged effluent comply with the regulated- and legislated effluent quality specifications and conditions.

With this shift in focus, it is quite appropriate that the National Regulator intensifies its role to incentivise, enforce and achieve compliance to the applicable legislation. Indeed, Department of Water Affairs is taking innovative steps and regulatory strategies in raising the performance of wastewater services in South Africa. However, at the receiving end of all the measures and interventions, are the municipal authorities, who are required to deal with the expectations and pressure to ensure compliance and Green Drop status, whilst having limited resources to their disposal. As the municipal wastewater industry has a remarkably adoptive nature to being vigilant and responsive when called upon, it is not surprising to see that most municipalities are already rising to the prospect of plant improvement, refurbishment and upgrades. Since the initiation of the Green Drop Certification process in 2008, vast resources have been mobilised and redirected to implement upon this urgent national priority. Regrettably, it appears as though insufficient pause were taken to carefully deliberate the appropriateness of technologies as a means to the (compliance) end.

1.2 TECHNOLOGY DECISION DRIVERS

BATNEEC = Best Available Technology Not Exceeding Excessive Cost

The sector would gain from recollecting principles such as BATNEEC when deliberating on strategies, standards and processes to ensure that sector decisions ***support and facilitate responsible decisions*** by local government. The future of wastewater services in South Africa are to a large degree underpinned by appropriate, responsible and sustainable technology choices that is guided and regulated based on well-defined parameters and scientific grounds and requirements.

Given that it is possible to produce treated effluent of almost any quality, drivers that would encourage and guide appropriate solutions and affordable technologies whilst meeting legislative requirements, are more necessary than ever before. The negative perception is that, in general, the industry seems to follow a 'blanket' application to opt for superior and often advanced technologies even if the cost and output are not recoverable, needed or justifiable.

The question arises as to what are the ***key levers that influence decisions*** when dealing with newly planned- or upgrading to existing municipal wastewater treatment facilities. It is to be expected that the specified discharge limits and authorisation requirements would be a primary consideration when treatment technologies are considered by municipalities and their specialist services providers. There are no hard and fast rules when choosing a suitable treatment system. However, the following factors should normally influence the decision as to which treatment system is most appropriate under the circumstances:

- Sensitivity of the receiving water body or land
- Legal requirements in terms of water use licensing
    - e.g. 95% compliance to effluent limits
- Capacity of the local authority to operate and maintain the system
    - e.g. local skills availability to operate the chosen technology
- Availability of funding to construct the facility
- Running cost recovery and consumer's ability to pay for the ongoing operation and maintenance of the system
    - e.g. energy requirements calculation against escalated future electricity costs
- Availability of reasonably priced land
- Projected population growth
- Opportunities for re-use of the treated effluent or value added returns and by-products from the system
- Proximity of the community to the infrastructure
- Availability of fresh water for domestic use
- Acceptance by community

The choice of treatment option can thus initiate a fairly complex study in which social, financial, legal and environmental issues are considered. Alternatively, it can be as simple as taking the recommendation of the consulting engineer, assuming that such Professional Service Provider has the necessary competency (qualification, experience) in the particular field (sector, technology). In order to plan and utilise limited resources more effectively, it is important to determine the factors used by municipalities to inform their decisions. Furthermore, it is important to 'assess' if these factors produce the most appropriate and sustainable choices in the long term life cycle of infrastructure investment and management.

The future is expected to hold ***more challenges*** in terms of meeting both current and future discharge limits and requirements, when status quo constituents such as physical, chemical and microbiological limits are 'topped up' with new-century constituents such as human and veterinary antibiotics, drugs, industrial products, sex and steroidal hormones, etc. – which will require modifications and additional treatment beyond conventional and secondary treatment processes. Not only will qualitative issues become more complex over time, but issues such as the food production/quality and energy security becomes closely linked to wastewater services. Hence, it is

Whilst it is difficult to project exactly what and when some of these future complexities will become a reality in the SA market, it is essential that critical that the CURRENT modus operandi and logic are assessed to plan for the possible FUTURE scenarios. SA is at a 'tipping point' in terms of what is 'required' of municipalities to comply with, what need to be 'achieved', and what is 'appropriate' and 'necessary' to ensure an acceptable and reliable level of performance. With such principled baseline established, the unforeseeable future complexities can be dealt with.

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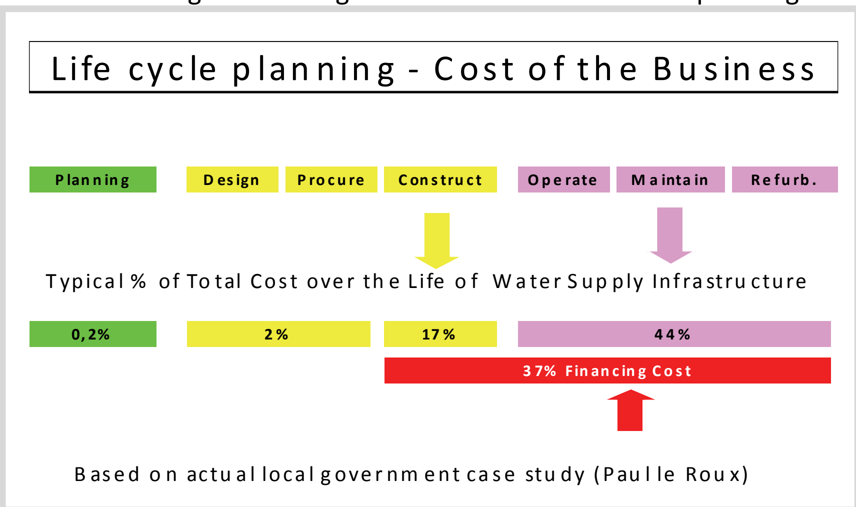
1.3 THE WASTEWATER TREATMENT ENVIRONMENT

Recent audits of the national wastewater treatment plants (WWTPs) in South Africa recognised that the situation of wastewater treatment and compliance with respect to the legislative requirements are in fragile space and potentially critical. Opinions expressed in current literature (Reference Section) would appear to be in agreement on the following issues pertaining to wastewater treatment, these being:

- ***Imbalance between development of new infrastructure versus O&M of existing infrastructure:***

  Recent years has seen the focus shifting to extending the provision of wastewater services, without an equal focus on maintaining the existing infrastructure and effective planning for future sustainable maintenance and operations. This sentiment leads to situations where O&M of plant and equipment are not taking place at adequate levels, leading to regular failures in terms of effluent compliance and in severe cases, inability to achieve compliance. When considering the lifecycle cost of typical wastewater infrastructure (F van Zyl, 2006), it is noted that <20% of total cost is tied up as initial capital, whilst 44% of the lifecycle costs is in operations and maintenance, which must be recovered from the municipal tax base.



- ***Capacity and Demand Management:***

  Existing works are often inadequate for the demands that are being made upon them, most often in terms of physical loading or suitable treatment processes. The demand exceedance is often a combination of different factors, including increased service provision often via housing development (inadequate long term and integrated planning), unplanned extraneous flows allowed to enter the wastewater system thereby placing an artificial hydraulic and chemical load onto the infrastructure (lack of bylaws or implementation thereof to adequately regulate industrial effluent, stormwater ingress, potable water losses, etc.).

- ***Financial constraints regarding O&M:***

  Insufficient funding or fund allocation exist within municipalities to institute effective and adequate preventative maintenance programmes and procedures. Many municipalities seem to follow a reactive maintenance approach, whereby assets are run to failure. The lack of funding can be ascribed to a host of root causes, including low tariffs which are not cost reflective, lack of ring-fencing of the functional cost involved in wastewater treatment, inappropriate and unnecessarily expensive technology choices, billing and revenue collection difficulties.

- ***In-house expertise and knowledge:***

  This not only relates to the actual expertise and knowledge relating to the physical operations and management of the plants and laboratories (technical, scientific and management skills), but also relates to skills and knowledge inability regarding:

  - planning aspects related to wastewater treatment, or
  - the management of PSPs or Water Services Providers (WSP) in relation to either the planning, maintenance or operations of wastewater facilities, where these functions are outsourced.

- ***Inappropriate and unsustainable technological choices:***

  Although this is de-facto covered by a number of the previous aspects mentioned above, this aspect is re-emphasised in the specific context that lower- or alternative technology choices are often not implemented, for reasons such as:

  - lack of local knowledge and experience on the subject matter,
  - lack of focus on the environmental and potentially financial benefits of the effective and safe re-use of wastewater,
  - lack of a South African framework and standards to provide guidance on the selection of treatment options.

- ***Governance and administrative management challenges:***

  Effective operational relationships and management decision support is often undermined by aspects such as:

  - political byplays at the decision maker level,
  - financial management indiscretion,
  - lack of understanding of the benefits of preventative maintenance, appropriate and timely decisions taken re wastewater treatment and the consequence of inadequate treatment along the entire value chain of water services and resources.

From the above, it is clear that the choice of technology forms one of the critical aspects in achieving sustainable and effective wastewater treatment. In order to understand if, or to what extent, technology choices are impacted upon by the legislative- and regulatory requirements, it is imperative to examine the following issues:

- Legislative background,
- Typical licensing process,
- Factors affecting the choice of technology, and
- Factors affecting sustainability.

1.4 PROJECT OBJECTIVE

This project outline proposes to, via a scientific selection of 15 municipal cases (sites) across the country, provide a ***high level assessment*** and ***initial comment*** on:

- ✓ appropriateness of the technological choices in relation to the current ability of the municipality to implement and administer such choices, and
- ✓ legislative environment within which these choices are overseen.

This report aims to achieve the following:

- To conduct a quick and dry desktop investigation of the recent past- and current water use authorisations and requirements pertaining to municipal wastewater treatment facilities;
- To provide an initial comment on the appropriateness of the legislatively required technological choices in relation to the current ability of the municipality to implement and administer such choices
- To comment on the potential impact of these choices and where possible, make recommendations to ameliorate these.

2 METHODOLOGY AND PROJECT SCOPING FACTORS

2.1 BRIEF BACKGROUND TO SOUTH AFRICAN LEGISLATION

Authorisation of WWTP and the disposal of effluent were previously done in terms of the Water Act of 1956, and presently by the application of the National Water Act of 1998. In the 1956 Act the authorisation was known as an Exemption. This exemption contained either the General Standard or Special Standard and required discharging the treated effluent back to the river of origin or an acceptable alternative.

Example, if a town received its water supply from the Rand Water Board and the WWTP effluent did not comply to the quality requirements of the General Standard as promulgated in terms of the 1956 Act, and the effluent was being discharged to the Crocodile River (not back into the Vaal River from where Rand Water abstract raw water), then the town would need an Exemption from the requirements of the 1956 Act for those two deviations (quality and return).

The thinking at the time was to encourage the water users to use water and to return it to its river of origin so that the water could be accessed by a downstream user. This scenario has changed radically as more inter-river basin transfer schemes are being built to transport water to areas where demand exceeds supply and were such transfer can be done in the most economical way.

The National Water Act of 1998 (NWA) requires that all water be authorised in some way. The constitutional right to water is reflected in Schedule 1 of the NWA. General Authorisations are promulgated in terms of the NWA for most of the standard types of water uses, whilst Water Use Licenses are issued for special and more complex water uses.

The guiding factors for allowing (through licensing) any of the water uses are stated right up front in Chapter 1 the NWA, which sets out some of the fundamental principles of the Act-

> ***"Sustainability and equity are identified as central guiding principles in the protection, use, development, conservation, management and control of water resources. These guiding principles recognise the basic human needs of present and future generations, the need to protect water resources, the need to share some water resources with other countries, the need to promote social and economic development through the use of water and the need to establish suitable institutions in order to achieve the purpose of the Act."***

The NWA was the only legislature with the intent of managing the construction of treatment facilities and the disposal of effluents. Since the National Environmental Management Act (NEMA) was promulgated in 1998 and EIA's became mandatory for the construction of WWTP, the Record of Decision (RoD) encapsulated most of the requirements that DWA set out. The NWA remain the primary space that enforce and regulate effluent quality requirements and effluent disposal options.

With the introduction of the NEMA: Waste Act 0f 2008, the legal environment became more complex and involved as all treatment facilities needed to pass a Basic Assessment process (treatment of 2 000-15 000 kl per year), as well as a Scoping- and EIA Process where facilities exceed 15 000 kl per year (=41 kl per day).

Example: A WWTP designed to discharge 50 kl/day (18 250 kl/year) of effluent complying fully with the requirements of the NWA General Authorisations (not requiring a License) will be required to conduct a Scoping- and EIA study according to the requirements of the NEMA: Waste Act of 2008, and be issued a License by the Department of Environmental Affairs.

2.2 TYPICAL LICENSING PROCESS

To approach the "appropriate technologies" subject in a balanced and impartial manner, a standard procedure is involved to determine the conditions and compliance requirements of a new WWTP facility. This standard process is briefly described as follows:

Scenario: a municipality needs to construct a new WWTP for a new housing development, as the existing WWTP facility is overloaded and no gravitational feed is in place to the existing works...

- The municipal Sanitation Masterplan would scope this planned development and the necessary supportive infrastructural requirements. The Masterplan would have been informed by the municipal Spatial Development Plan and other town planning reports,
- The project would be listed and described in the Integrated Development Plan (IDP) of the municipality, and approved by Council
- Available and suitable land and finances need to be secured and earmarked for the new facility,
- Grand funder conditions (e.g. MIG) required the Business Plan for the project to contain information regarding expected O&M over the lifespan of the infrastructure, technical skills requirements, and job creation initiatives,

- Community- and stakeholder consultation would be done from initial conceptualisation phase of the envisaged development. The municipal WSDP and IDP is key in this public consultation process,
- Professional Service Providers will be procured and appointed to prepare to design and oversee the project, although a number of delivery models can be opted for (BOOT, BOT, etc.),
- The WSA Project Leader, PSP and Provincial Water and Environment Affairs will have meetings regarding the legislative conditions and stipulations associated with the project,
- DWA will identify the RWQO's of the catchment where the WWTP will be constructed,
- The PSP will identify 2 or 3 alternative sites where the WWTP could be constructed with minimum impact to the natural environment, and prepare the Scoping Documents required for the EIA process,
- Specialist studies and feasibility studies will be conducted to include the discharge options and receiving environment, as well as the most pertinent drivers that bears relevance to the infrastructure and municipal environment under consideration,
- Included in the specialist studies will the handling of treated and stabilised sludge, in accordance with the WRC Guidelines for sludge disposal and use,
- PSP will identify the technologies for the WWTP which is seen to be most appropriate and/or which is are promoted,
- A Record of Decision is issued which will encapsulate most of the concerns that have been raised by the public participation process,
- The tender and procurement process is followed in accordance with the supply chain management principles,
- The WWTP is constructed,
- The DWA Licence is applied for and issued which captures the quantities, effluent quality, monitoring requirements and selected management requirements.
    - The assessment of the technical managerial competency is not required or regulated as part of the licensing process, although it is stated that competent technical and managerial staff need to be in place, in line with Regulation 2834 and relevant updates as well as Section 12A of the Water Act, 1956 (Act 54 of 1956).

Note:

- The DWA license does not determine the technology option,
- The requirements of the catchment in terms of the RWQO's do influence the technology used
- Critical aspects that would determine the sustainability of the technology, are not interrogated, nor are the requirements to be imposed by DWA.
    - *Example: does the municipality's existing resources (staff, skills and financial) match the technology choice being proposed and are the water quality compliance objectives identified being satisfied by the technology choice? Has any alternatives been considered re the potential value-added of the effluent, sludge, nutrients, energy and does the technology option satisfy and realise these Green Opportunities?*

EXAMPLE:

- A ‘standard’ Extended Aeration Plant are a preferred and often recommendation technology by many engineering firms. If designed and built according to best standards, the plant can be expected to produce a stable, good quality effluent complying with the requirements of the DWA General Limit,
- It is possible that the DWA RWQO’s demand phosphate (P) removal to a specific level if discharged to the catchment,
- It is further possible that a local agricultural use can be applied regarding the effluent and stabilised sludge (biosolids) for irrigation purposes and food production,
- It is probable that such beneficial use of effluent and sludge could produce a quality crop which would generate income, employ people and advance food production (local or export),
- If the climate allows for irrigation to take place throughout the year or where a zero-effluent discharge is foreseen, it may be an option to construct an oxidation or evaporation pond system which will produce an effluent stable enough for the irrigation of crops, but with no capacity to discharge,
- If the local climate allows for irrigation for only part of the year, a Pasveer Ditch system would be appropriate and will ensure irrigation with a General Limit quality effluent,
- Effluent from such system can be treated via (safe) chemical means to reduce the phosphate to GL limits during the (short) periods when irrigation is not needed,
- In the same rationale, more advanced technologies would be appropriate where large volumes of wastewater are received that need to comply with Special Limits and where land is not readily available. In such cases, the technology and design must allow for biological phosphate removal by preference, as result of the adverse impact of P-reducing chemicals and precipitants and on the receiving catchment.

Ideally, the technology choice must be arrived at only ***after*** a process of ***directed*** interrogation and within ***specific*** subject boundaries and suitable to the ***specific*** local situation. This would imply that a number of site specific aspects be interrogated, before a technology could be decided upon. Ultimately, this robust and ‘forced’ evaluation would later benefit the municipality in terms of optimal and sustainable management of the WWTP, complying with the requirements of its license conditions.

2.3 FACTORS AFFECTING THE CHOICE OF TECHNOLOGY

From literature and interviews (Reference Section), factors that appear to affect the choice of technology by municipalities includes:

- Interpretation of the legislation is left to the Engineering Consultant who is in an advisory capacity to its client. There are few guidelines which are used to identify the type of technology required to achieve the objectives of the NWA. Guidelines are given on the Receiving Water Quality Objectives (RWQO’s) and these could give some direction as to the quality of effluent required, if discharged into a water course,
- Consultants at times also use the technology with which they are “comfortable” with, i.e. tried and tested technology. This could sometimes lead to a situation where relatively similar design technologies could be found in an area where a consultant is well established,

- As result of budget constraints or Supply Chain Management (SCM) policies within municipalities, competitive tendering are often weighted towards price (not technical proficiency or experience), forcing consulting firms to cut price by using existing designs that is not tailored around the specific municipal circumstance,
- There is often insufficient technical expertise in lower-capacity municipalities, who would then tend to rely without question, on the Consulting Engineer. Engineering has varied subject (specialist) fields, and competency in design and operations in a particular wastewater technology field is to be assessed as part of the procurement of a PSP. In high-capacity (usually metro municipalities), one generally find that technical staff engage and question technical recommendation more assertively and may even develop the required specification in-house, where the consultant's role is reduced to project management and quality control (e.g. Johannesburg Water's new extension to the Northern WWTP),
- As regulator, DWA should not be selecting technologies on behalf municipalities (even when acting in support role). However, DWA's value would be in setting clear margins and scientifically defendable parameters as to the legislative requirements within the receiving environment. In the future, the Waste Discharge Charge System, Water Demand Management and Water Conservation approaches will increasingly influence the type of technology (e.g. George Municipality has just added advanced Microfiltration and Ammonia Stripping technologies to their WWTP processes as the effluent will be reused as raw water source to the potable water purification).

2.4 FACTORS AFFECTING SUSTAINABILITY

It is a meaningful exercise to analyse feedback from the sector (Reference Section) pertaining to factors that affect the sustainability of WWTP operations, which include:

- DWA not giving sufficient guidance or unable to engage knowledgeable as to what is acceptable in certain sub-/catchments or not communicating the RWQO's in the catchment where the WWTP is situate,
- The inappropriate choice of WWTP technology is often raised: why have sophisticated technology in a rural area with an indigent community and insufficient technical expertise to run the plant? Note: a low technology pond system can take severe neglect and still produce reasonable effluent quality, as opposed to a high technology system which fails rapidly and produce poor effluent qualities upon negligent conditions,
- The lack of suitable expertise in the rural areas to manage and operate equipment which is sophisticated,
- The cost of energy (electricity) – many municipalities are financially burdened and cannot afford the luxury of energy intensive technologies. Early indications are that activated sludge plants will not be sustainable within 7 years, without development of methane gas as alternative energy source to the plant, thereby reducing the intake of ESKOM power,
- Reliance on external service providers to operate and maintain more sophisticated equipment, as result of lack of local expertise.

Similar comments are identified in the DBSA Wastewater Strategy (Ref 6) with regard to constraints that have led to problems incurred in wastewater management, operations and maintenance, the constraints being (extracts only):

- “Expertise and knowledge on wastewater services planning, processes, technologies and support measures – mainly on technical and management levels. This challenge presents a root cause that underlies many of the problems, constraints and restrictions along the wastewater value chain”......
- “Technology options are not always suitable and appropriate to the particular environment, and result in unviable infrastructure and financial measures in the longer term”....
- “Lack of basic wastewater management and good practice. This may vary from basic requirements such as the measuring of flow and effluent quality, to more profound problems such as technology options for plant expansion” ...

The over-riding factor which is common in many municipalities is a lack of capacity (a symptom of inadequate decision making) to manage WWTP on a strategic level and execute planning required for future developments as well as the technical and operational skills required to understand, maintain and operate sophisticated treatment facilities. Increased reliance is being placed on external service providers and emerging practice is to outsource the treatment and discharge of effluent (and sludge).

3 LEGISLATIVE ENVIRONMENT – DWA WWTP AUTHORISATION

DWA is currently implementing a project “Municipal Support Strategy for Authorising Existing Unauthorised WWTPs”, which focuses on fast tracking the licensing of existing non-licensed plants. The data thus provided by DWA relates to the information on their system with regard to this project.

It was commented by DWA officials that there were a number of works which have already undertaken upgrades by time of their license application. In other cases, municipalities engage with DWA at time of planning an upgrade project and the upgrade is then included in the licence application. It was confirmed that the selection of a technical option is as a rule made by the municipality ***prior*** to the licence application process, and that supporting consultants have a substantial influence in the choice of technology in the current environment.

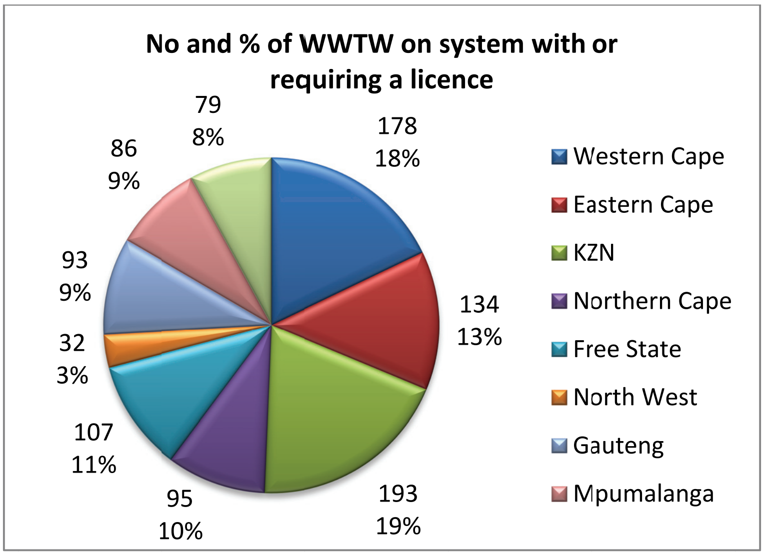
In a communiqué from DWA, it was stated that in terms of processing an application, one of the first aspects which is investigated is the current effluent quality results in comparison to the Resource Quality Objectives (RQO) for the specific river or area. In the event where the RQO is not known, the General or Special Limits are used. In situation where the works previously had an Exemption, the standards set within are also included in the comparison of the RQO and their current results. Draft licences are usually issued by the Regional Offices to the municipality and their consultants for perusal and comment, prior to elevating the application to DWA Head Office for further processing. Thus in the event where the upgrading is taking place in phases, the standards set to be achieved are outlined within the licence conditions. For example, meeting increasingly stringent phosphate standards can be phased (incrementally) and timeframes to coincide with the upgrading programme. In the event where the current results of the works does not conform to the standards, a condition is set within the licence that requires the municipality to provide DWA, within a specific timeframe, a plan of how and when they envisage to achieve the set standards. This time-based requirement can also have a substantial influence on the choice of technology opted for by the municipality.

From the data (DWA’s Inventory of Wastewater Treatment Plants Authorisations 5 – Last updated 23- 07-2010) that was provided by DWA, the following outcomes are pertinent, specifically in terms of assisting in identifying which 15 applications will be further investigated.

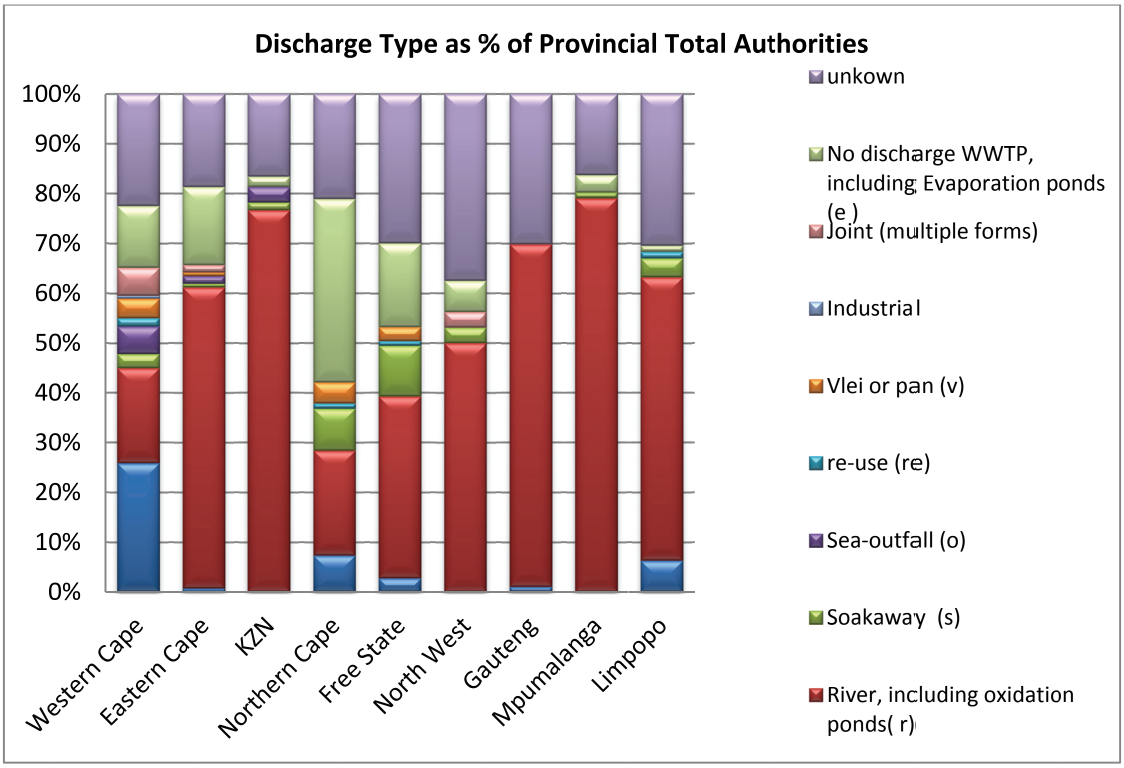
Assumptions for this study:

- Outcomes derived are based on the information provided from DWA,
- Only authorisations where the municipality, Water Boards or formal WSP (i.e. ERWAT), were identified as responsible WSA were included – the latter two would be contracted by the WSA as WSP,
- Regarding types of discharge: Oxidation ponds with indication "no discharge" are viewed for assessment purposes as having similar impact to that of evaporation ponds (one use would include the irrigation of final effluent),
- All other Oxidation ponds are viewed as discharging into the watercourse indicated and or nearest watercourse.

The following graph provides an indication of the existing number of municipal WWTP that are on the database (07/2010), that depict the plants for which applications have been received or which are being processed or for which licences, final or draft, have been issued or which still require licences.



The graph below provides an indication of the types of effluent discharges options of the various WWTPs. The type of discharge of the effluent will have a major impact on the selection of technology used within the WWTP and potentially on the receiving environment. The purpose of breakdown was to assist in indentifying which are the predominant types of discharge and, for the purposed of this study, what discharge options need to be considered that is most representative when selecting 15 WWTPs applications for further assessment.

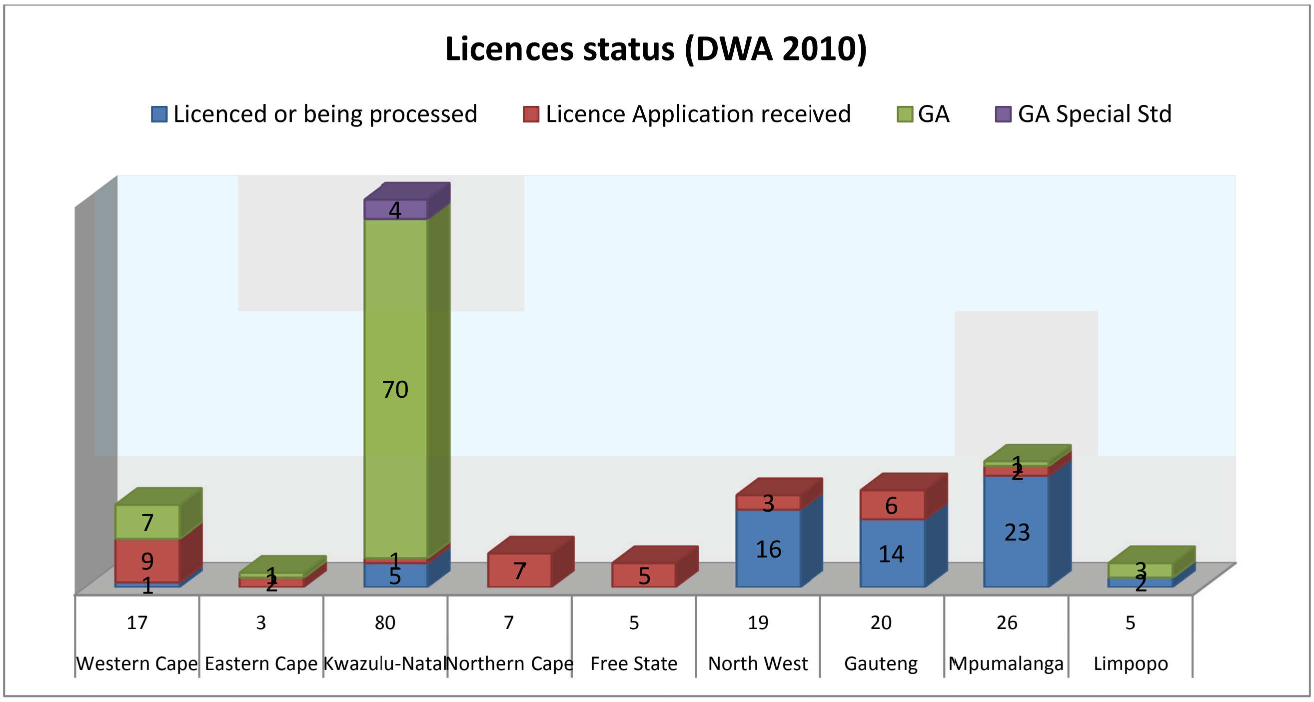


From the above it is observed that:

- The effluents are generally not re-used directly or the discharge has multiple uses such as irrigation, etc. This practice is mainly found in the Western Cape, which is also the only province which indicated industrial effluent re-use practices.
- Western Cape is the only province of which the majority (26%) discharge of effluent is used for irrigation purposes, the remainder of the provinces majority discharge is directly in the watercourse with little or no formalised further re-use.
- KZN (3-4%) and the Western Cape (5-6%) utilise sea-outfalls more extensively than Eastern Cape. Free State has the highest occurrence (12%) of soak away discharge (impact on ground water).

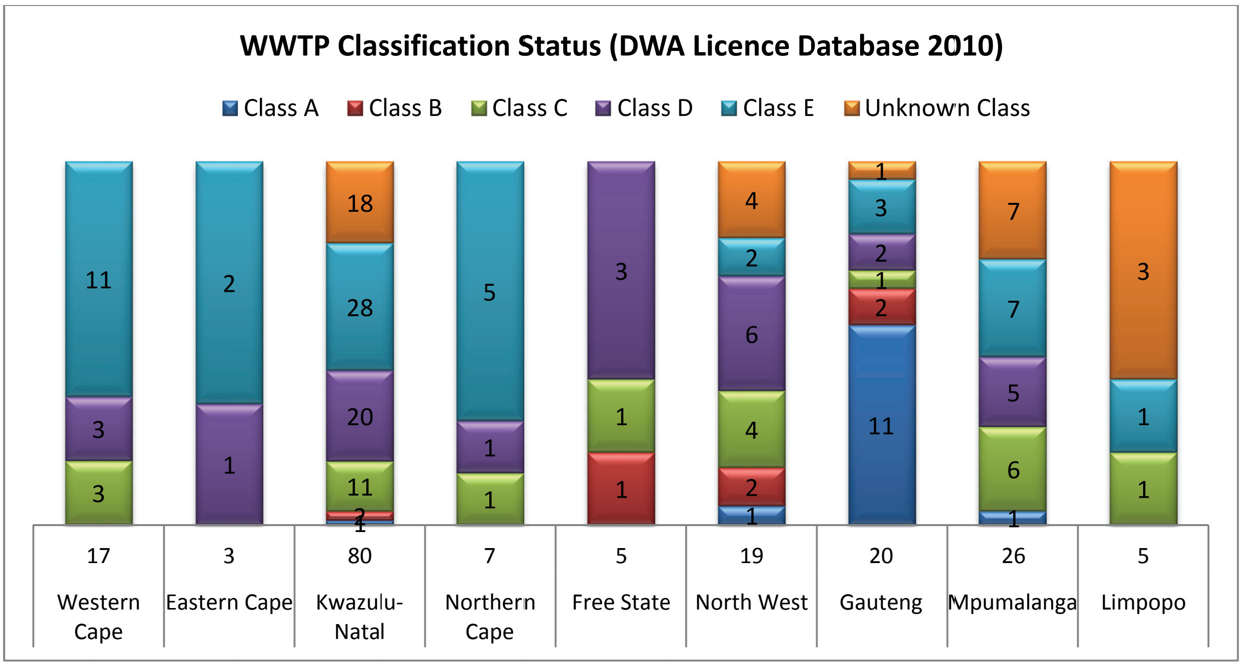
4 METHODOLOGY AND SELECTION FRAMEWORK

Criteria 1 – ***Authorised WWTPs***: The final selection of 15 WWTP authorisations also needed to take cognisance of the availability of information from DWA and municipalities. It was thus reasoned that WWTPs which have an existing licence, have applied for, or which application is being processed or have a GAs, would have the relevant and current information available.



From the above it can be seen that although KwaZulu-Natal has the largest number of licences, most of these (nearly 90%) are General Authorisations, whereas the largest number of applications received, not yet processed, are from the Western Cape. Mpumalanga, North West and Gauteng are the provinces which have the most licences processed or being processed. A representative scientific selection would then suggest that the bulk of the WWTP selected for the study would come from these 5 mentioned provinces.

Criteria 2 – Size and complexity of WWTP: To further refine the selection process, factors such as size and complexity of the WWTP (represented by the Class of WWTP), as well as type of discharge of effluent, were considered. These are illustrated in the following two graphs.

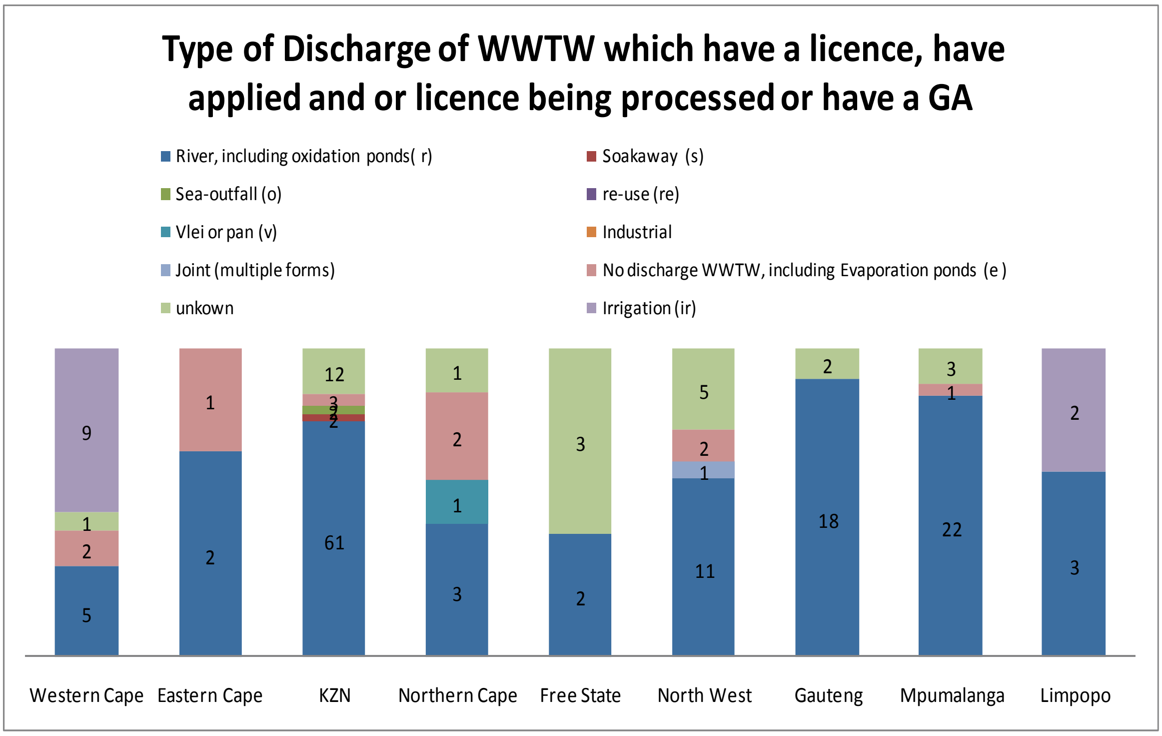


From the graph above it can be seen that:

- The majority of Western Cape licences relate to Class E (11 out of 80 potential licences),
- Eastern Cape, Free State, Limpopo and Northern Cape have the least number of licences, of which the majority are Class E for Eastern Cape and Northern Cape,
- Free State has varied Class WWTPs, being Classes B, C and D, the majority of which are Class D,
- In Limpopo's case, most of the WWTP's class is not known,
- Although KwaZulu-Natal has a spread of the various classes, their majority relate to Class D and Class E,
- North West and Mpumalanga have a fairly even spread of Classes, but each with a majority in Class D and Class C respectively.
- Gauteng, as expected, has the most number of Class A WWTP, although these mostly occur within the larger municipalities, with extensive water borne bulk connector services.

Criteria 3 – Representative national spread of WWTPS: In terms of spread of the various discharges relating to these licences, the graph below indicates that:

- Majority of the WWTPs discharge into the nearest water course, except for Western Cape where substantial number of the works' effluent is used for irrigation,
- Only Kwazulu-Natal has current licences/applications in process relating to sea-outfall and soak-away discharge.



Selection of 15 representative WWTPs for assessment: The above analysis was utilised to determine the best spread of application across the provinces for selection of 15 cases (plus 3 additional added later) for further investigation. Some of the aspects which impacted on the final decision are:

- Select at least one "representative" application per province (9), based on what their majority application entail, i.e. sea out fall, oxidation pond, discharge into river. Some provinces seem to have dominant discharge types,
- The remainder 6 applications to be selected to ensure that one find representation in the following spread:
    - weak versus capacitated municipalities
    - vulnerable versus less vulnerable receiving environment, and
    - type of WWTP
- Where possible and applicable selected licences which represented a specific type, i.e. sea-outfall, Package Plant, Class type, etc., was selected, to ensure that a fairly broad spectrum is covered,
- The currentness of the documentation, i.e. application in process or most recently issued, was also taken into account to ensure that the information is relevant and current;
- The size of the municipality was also taken into account to ensure that there is a fair spread of weaker (more ruralised) to capacitated and larger municipalities in the group;
    - In the case of Limpopo, due to a limited number of licences, only 1 municipality has been selected, that being the most recent – Plant 18 / Municipality A18,
    - Mpumalanga has the majority of applications being processed and can thus potentially provide best information, hence the majority selection was taken from Mpumalanga,
    - Gauteng has the majority of Class A works applications, including from different sized local government structures,
    - If a predominance of a Class of works was found in a province, this was also factored into the selection, as to best represent the particular province;
    - Where possible the environmental status by means of the River Classification WSAM: Present Ecological State (on the PESC straight mean of imp score) was also identified and taken into account.

Based on the aforementioned scientific parameters, the following final selection of WWTP applications/licences were concluded:

Province	No of licenses to be selected	WWTP	Rationale for selection of plant
Western Cape	2	Plant 1	License pending, should therefore have relevant information and represent a middle sized municipality (Class C , irrigation discharge)
		Plant 2	License being processed, should therefore have relevant information and represent a weaker sized municipality (Class E , irrigation discharge)
	Add in	*Plant 3 **	*Only package plant Application for exemption received*

Eastern Cape	2	Plant 4	Only application with information shown on the DWA database, hence selected
		Plant 5	Class B works – registered and licensed
	Add in	*Plant 6***	*Only work indicating a clear investigation regarding more than one technology option – greener technology vs. conventional*
KZN	2	Plant 7	One of two sea-outfalls of which the license is being processed
		Plant 8	Uncertain license conditions and processes – large metro with adequate resources
Northern Cape	1	Plant 9	Only application with vlei discharge
Free State	1 (*Add-in*	*Plant 10****	*Class C works – selected as initially no information was forthcoming on Plant 6, location confirmed – Eastern Cape*
North West	2	Plant 11	Class C Works, fair size
		Plant 12	Only mixed discharge application
Gauteng	2	Plant 13	Class A works, most recent minor metro
		Plant 14	Class A works, most recent, major metro
Mpumalanga	3	Plant 15	Only has 1 application of "No discharge" discharge indicated (Class E)
		Plant 16	Most recent authority, Class D WWTP
		Plant 17	Most recent authority, Class C WWTP
Limpopo	1	Plant 18	Limpopo due to minimum no of licenses, only select 1, being the most recent and irrigation discharge (Class C)

**Plant 3 was added as information became available and had appropriate relevance.*

***Plant 6 was added as it was the only work indicating a clear investigation regarding more than one technology option – greener technology vs. conventional*

****Plant 10 was added as no information for Plant 5 was initially made available and some relevant information was available for Plant 10*

Full details, as per the database is attached as **Appendix A.**

5 ASSESSMENT FRAMEWORK

It is commonly accepted that there are ***key levers*** that influence decisions when dealing with newly planned- or improvement and upgrading to existing municipal wastewater treatment facilities. It is to be expected that the specified discharge limits and authorisation requirements would be a primary consideration when treatment technologies are considered by municipalities and their specialist services providers. There are no hard and fast rules when choosing a suitable treatment system. However, certain baseline parameters need to be considered and used when decisions are taken on upgrades or construction of new plants. The following factors SHOULD normally influence the decision as to which treatment system is most appropriate under the circumstances:

- Applicable flow rate, i.e. stabilisation ponds not necessarily well suited to extremely large flow rates in highly populated areas
- Influent wastewater characteristics impact on the type of process to be used, i.e. chemical or biological
- Potential inhibiting constituents to the treatment process
- Impact of physical climate on treatment processes
- Sludge processing constraints
- Sensitivity of the receiving water body or land
- Legal requirements in terms of water use licensing
- Energy requirements and efficiency
- Ongoing chemical requirements (resources and amounts and effect of additional chemicals on the characteristics treatment residuals and resultant cost of treatment)
- Capacity (mostly technical) of the local authority to operate and maintain the system
- Capacity (mostly scientific) to provide scientific analysis and support to the operational staff
- Availability of funding to construct the facility
- Running cost recovery and consumer's ability to pay for the ongoing operation and maintenance of the system
- Availability of reasonably priced land (non-agricultural land)
- Projected population growth
- Opportunities for re-use of the treated effluent or value added returns and by-products from the system
- Proximity of the community to the infrastructure
- Availability of fresh water for domestic use
- Acceptance by community.

The assessment framework can thus initiate a fairly complex study in which social, financial, legal and environmental issues are considered. A professional engineer, in support of a municipality, would analyse and consider the above parameters and then recommend a suitable appropriate technology that would meet the specific circumstances of the particular municipality. It should not be a scenario where a blanket approach of (e.g.) standard type activated sludge plant is recommended, irrespective of whether it meets the above criteria. In order to plan and utilise limited resources more effectively, it is important to determine the factors used by municipalities to inform their decisions. Furthermore, it is important to 'assess' if these factors produce the most appropriate and sustainable choices in the long term life cycle of infrastructure investment and management.

To investigate and comment on the appropriateness of technology choices within this fairly complex environment and multiple decision-making considerations require an assessment framework that would satisfy the most essential aspects involved in technology choices. The assessment framework has been designed to cover the most essential aspects from the 'decisions drivers' to include the following aspects legislative requirements, environmental landscape, technology levels employed (existing and new), municipal environment and technology impact. The detailed content of each assessment parameters is contained as Appendixes.

i) Legislative background and Environmental landscape :

Defining the type of works, in terms of:

- Historic, Current and Future technology options and the level of selected technology (where information is available)
- Design Capacity (Ml/Day)
- Operational Capacity (Ml/Day)
- Class of Works
- Technology for wastewater treatment and biosolids (***Appendix B***)

Environment

- Impact on Water Resources
- Type of Discharge
- Water Management Area
- River Classification WSAM: Present Ecological State (PESC) ***(Appendix C***)

ii) Licence Requirements and Technology Impact

- This component investigated the situation regarding the current state of licensing the plant, in terms of whether it has a licence, permit or exemption, the requirements attached to these as well as the limitation included. Comment is then made, where possible about the potential impact of these in relation to the choice of technology. ***Appendix C and D*** contains detail where reference is made to "General Authorisation" and "Sea outfall effluent limits".

iii) Municipal environment

- Assessment of the selected municipalities in term of their current ability to implement and administer their technology choices, as per the 2010 CoGTA Spatial Analysis Framework outcomes , with specific focus on
  - Type of Municipality, Socio-economic vulnerability of the municipality; Capacity classification of municipality, Audit outcomes (Auditor General)
  - Comment on municipality's ability / performance to manage the technology option sustainably

Assessment findings

A general summative comment is made for each of the selected plants as to the appropriateness of their technological choice. Aspects taken into account in identifying appropriateness were not only the technology level, but also aspects such as:

- Sensitivity of receiving natural resource
- Legal Requirements / license Requirements
- Capacity of municipality to operate system
- Availability of funding to construct and maintain.

6 ASSESSMENT OF 18 WASTEWATER TREATMENT PLANTS

The following section provides the individual assessment of each of the 18 WWTPs within the respective Provinces, in line with the assessment framework's 5 parameters:

6.1 WESTERN CAPE PROVINCE

6.1.1 Plant A – Municipality A1:

i) Legislative background and Environmental landscape:

Design Capacity (Ml/d): 3
Operational Capacity (Ml/d): 2.5
Class of Works: C
Technology for wastewater treatment: Aerated oxidation ponds (Green Drop report)
Biofilters, maturation ponds and disinfection (June 2009 Report)
Technology for biosolids treatment: Maturation ponds
Impact on Water Resources: Irrigation
Type of Discharge: Irrigation and river
Water Management Area: Olifants / Doorn WMA
River Classification WSAM: Present Ecological State (PESC): Class C – (Moderately modified)

The "Base Information for Risk-based Targeted Regulation: Western Cape Wastewater treatment plants" (June 2009) indicates that the technology choice employed at the works consists of biofilters, maturation ponds and disinfection. The report furthermore comments that at that stage: *"operations at the xxx WWTP would appear to be struggling to function effectively. This comment is based on the number of effluent parameters, which are just within compliance limits or are showing recent non-compliance trends. This is disturbing, specifically in the light that the works has, according to the Green Drop Assessment, been relatively recently upgraded to a 3 Ml/d works. In such an event, one would have expected much stronger compliance. Of specific concern is the Ammonia and Ortho-Phosphate which are non-compliant.*"

Most recent Green Drop assessments indicate that the situation is still problematic in the sense that there is little or no compliance in terms of microbiological constituents (*E. coli*) and limited compliance in terms of chemical compliance, however good compliance with regard to physical elements.

ii) Licence requirements and Technology impact

Licence Requirements:

It would appear that the works is still operating under its historical permit, until such time as the licence is approved. The historical Permit (978 B) allows for:

> *"Quantity of 170 Ml/year (0.5 Ml/day) of treated effluent may be used for irrigation of sport fields and parks, remainder to Olifants River, must comply with General Standards and contain no industrial effluent or abattoir effluent."*

Technology Impact:

Due to limited information received, it is not possible to provide detailed comment. However, other than being able to meet the requirements of the General Standards, significant impact in terms of technology is not foreseen as the treatment system required should be relatively uncomplicated and should be cost effective if good (basic) management practice is in place.

iii) Municipal environment

Municipality Assessment: Municipality A1

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
A1	B3	4	L	Qualified	42.11

The information above indicates that the municipality would appear to be well established. However from the above there may be concerns with regard to financial ability and extent of local government functions being undertaken which could impact on their ability to utilise and manage more complex technological options than their present situation.

i) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 1	A1	Medium	Low to Medium	Class C (Moderately modified)	General limits	Class 4 – Performing well, Financial constraints	Small Towns & Rural community – high indigents – funding constraints	**Appropriate**

Assessment comment: In light of DWA's requirement for a General Standards, and the application of effluent for irrigation, it is foreseen that the current treatment technologies could remain and be sustained, and no need for extensive and high end technologies would be required.

6.1.2 Plant 2 – Municipality A2:

i) Legislative background and Environmental landscape

Design Capacity (Ml/d): 0.701
Operational Capacity (Ml/d): 0.39 (prior to upgrading)
Class of Works: E
Technology for wastewater treatment: Oxidation pond system – to be upgraded to Activated Sludge Process
Technology for biosolids treatment: Land use (sludge)
Impact on Water Resources: Irrigation (currently), discharge to river (after upgrade)
Type of Discharge: Irrigation (effluent) and land use (sludge)
Water Management Area: Olifants / Doorn WMA
River Classification WSAM: Present Ecological State (PESC): Class C – Moderately modified
-

Municipality A2's "[Plant 2] Wastewater treatment plants: Water Quality Management Report in Support of a Water Use License Registration Application", states that:

- Currently the [Plant 2] sewage treatment system is based on an oxidation pond system. The existing WWTP received wastewater from the town of Vanrhynsdorp, as well as from collecting suction tanks that service the catchment area in and around Vanrhynsdorp. The existing WWTP consist of 3 anaerobic ponds, a primary pond, a secondary pond, 3 tertiary ponds and an irrigation pond.
- The municipality is in the process of constructing Phase 2 of a new housing development consisting of 330 units as well as a new prison facility, thus necessitating an upgrade of the existing Plant 2 in order to accommodate the future sewage flow (12 year design horizon) of Vanrhynsdorp.
- The sewage will be treated to an effluent quality that will comply with the Special Limit Values in terms of the National Water Act (Act 36 of 1998).
- The treated effluent from the activated sludge system will be retained in the secondary, tertiary and irrigation dams prior to release for irrigation. The overflow from the last storage dam (irrigation pond) will gravitate to the chlorine contact channel to be disinfected. The disinfected effluent will then be retained in a pump sump prior to irrigation to the following areas:
    - · ±5 ha open field adjacent to (west of) the WWTP
    - · 1.5 ha of sport fields in Maskamsig
    - · 1 ha of small farmers land currently being irrigated
    - · 2.5 ha of small farmers land adjacent to the sports fields
    - · ±25 ha of surrounding commercial farmers' land

  This equals to a total area of ±35 ha available for irrigation.

ii) Licence Requirements and Technology Impact

Licence Requirements:

It would appear that the works is still operating under its historical exemption, until such time as the licence is approved. The Historical Exemption (1685 B) allows for:

> "*Quantity of 164.5 Ml/year (0.392 Ml/day) to be discharge to oxidation dam system, with final effluent to be used for irrigation of natural veldt or grazing land. Provision of storage for 8 days equivalent irrigation quantity must be made and sludge must be disposed of / re-used / stored and or transported in accordance with legislation.*
>
> *Maximum Faecal Coli: 1000 FC/100 ml*"

However, from the licence application motivation report, it is stated that the wastewater will be treated to an effluent quality standard that will comply with the Special Limit Values in terms of the National Water Act (Act 36 of 1998). These being:

SUBSTANCE/PARAMETER	GENERAL LIMIT	SPECIAL LIMIT
Feacal Coliforms (per 100 ml)	1 000	0
Chemical Oxygen Demand (mg/l)	75 *	30 *
pH	5,5-9,5	5,5-7,5
Ammonia (ionised and un-ionised) as Nitrogen (mg/l)	3	2
Nitrate/Nitrite as Nitrogen (mg/l)	15	1,5
Suspended Solids (mg/l)	25	10
Electrical Conductivity (mS/m)	70 mS/m above intake to a maximum of 150 mS/m	50 mS/m above background receiving water, to a maximum of 100 mS/m
Ortho-Phosphate as phosphorous (mg/l)	10	1 (median) and 2,5 (maximum)
Chlorine as Free Chlorine (mg/l)	0,25	0
Fluoride (mg/l)	1	1
Soap, oil or grease (mg/l)	2,5	0
Dissolved Arsenic (mg/l)	0,02	0,01
Dissolved Cadmium (mg/l)	0,005	0,001
Dissolved Chromium (Vi) (mg/l)	0,05	0,02
Dissolved Copper (mg/l)	0,01	0,002
Dissolved Cyanide (mg/l)	0,02	0,01
Dissolved Iron (mg/l)	0,3	0,3
Dissolved Lead (mg/l)	0,01	0,006
Dissolved Manganese (mg/l)	0,1	0,1
Mercury and its compounds (mg/l)	0,005	0,001
Dissolved Selenium (mg/l)	0,02	0,02
Dissolved Zinc (mg/l)	0,1	0,04
Boron (mg/l)	1	0,5

** After removal of algae*

However considering that the works will only be treating domestic sewerage, as there is no industrial activity in the town, not all of the parameters may be applicable. As per general authorisation, the municipality currently undertake water quality measurements once a month for pH, conductivity, faecal coliforms, COD, ammonia, nitrate, SS and ortho-phosphates.

Technology Impact:

Based on the information provided, the licence is still being processed, thus the actual criteria of the licence has not been finalised. From the information available, it would appear that the technology choice selected by the municipality for their upgrade may be appropriate and suitable to meet the DWA Special Limits requirements. What is uncertain is DWA's requirement for Special Limits, as the effluent is mostly earmarked for irrigation to various locations. Should it be required that a small portion of the final effluent be discharged to a river body, then a polishing step of the balance of flow (after irrigation) would be a more practical and cost effective approach. The documentation does not explore such alternatives.

iii) Municipal environment

Municipality Assessment: Matzikama Municipality

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
A2	B3	4	M	Unqualified	78.95

The information above indicates that the municipality would appear to be well established, fairly financially sound and is undertaking the majority of the local government functions. From the above they may well be able to utilise and manage more complex technological options than their present situation.

Factors taken into account by the Municipality for Plant 2:

The supporting report indicates that the following factors have been taken into account:

- The current system would be unable to cope with the increased load, hence the upgrade necessary.
- The selected wastewater treatment process for the upgrading of Plant 2 is an aerated activated sludge system. This is considered to be the best suited method to achieve the required treated effluent standards (Special Limit Value).
- All 11 possible re-uses of effluent have been considered and the proposed disposal practice of re-using the treated effluent by means of irrigation is also considered the appropriate option as discharge of treated effluent to the Troe-Troe River is not

permitted. Also, the area is arid and the irrigation of treated effluent will be beneficial for the sport fields and adjacent land.

- To ensure that the WWTP complies with the required treated effluent standards, an adequate training programme for relevant personnel will be provided to ensure that the WWTP is operated and maintained correctly.
- Operational and Maintenance (O & M) Manuals will also be provided to ensure correct operation and maintenance of the plant and equipment.

It would appear that the municipality, with the assistance of the consultants, has extensively looked at their current and future situation, environment and envisaged effluent discharge requirements and had planned accordingly. What is not clear from the report are the following:

- What other and less complicated technology options were available and investigated, and would still able to provide the desired effluent quality results (i.e. extension and aeration of oxidation pond system, dedicated anaerobic treatment). Although it is indicated in the report as being the most viable option, no proof to the statement was proved (in the documentation received).
- What are the cost impacts on the municipality in terms of capital, operations and maintenance costs and will this not make them potentially vulnerable, specifically as the housing expansion is low cost housing with little potential of cost recovery.

iv) Assessment findings

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 2	Municipality A2	Medium to High (future)	N/A	Class C (Moderately modified)	Exemption (Historically) Special Limits (Future)	Class 4 – Performing well, some financial constraints	Small Towns & Rural community – high indigents – funding constraints	Possibly Appropriate

Assessment comment: In light of DWA's requirement for a Special Standards, it makes sense that the municipality opts for activated sludge upgrade on top of the oxidation pond systems. However, if considering that the effluent will largely be irrigated, the Special Limits requirement seems excessive. If the case is that a balance of the effluent need to be discharged to the river body, the assessment of a polishing step would have seemed a logical and DWA should have been engaged on alternatives prior to deciding on an activated sludge process.

6.1.3 Plant 3 – Municipality A3:

i) Legislative background and Environmental landscape

Design Capacity (Ml/D): 0.156 Ml/d
Operational Capacity (Ml/D): Unknown for existing plant & for newly proposed plant
Class of Works: C
Technology for wastewater treatment: Historically: oxidation ponds (Green Drop Info)
Planned: Package plant – Bio-Disc unit (Biofilters by Beacon Control)
Technology for biosolids treatment: Sludge to be disposed to the evaporation pond
Impact on Water Resources: Discharge into Groot River on northern side of township
Type of Discharge: River
Water Management Area: Fish to Tsitsikamma WMA (Gamtoos sub-area)
River Classification WSAM: Present Ecological State (PESC): Class B – largely natural with few modifications

The "Base Information for Risk-based Targeted Regulation: Western Cape wastewater treatment plants" (June 2009) indicates that the technology choice employed at the works consists of oxidation ponds.

However, other documentation, including an application for exemption, indicates that in 2009, Municipality A3 envisaged upgrading {Plant 3] oxidation pond system. This was due to the existing dams leaking and it was decided to utilise a sewerage treatment package plant, which is to be used in conjunction with the existing three tertiary dams to polish the treated effluent. These dams were to be lined, but the primary and secondary dams were to be emptied and taken out of use.

ii) Licence Requirements and Technology Impact

Licence Requirements:

It would appear that exemption was applied for, but put on hold. In the exemption it was stated that the package plant will comply with General Standards.

Technology Impact:

Due to limited information received, it is not possible to provide detailed comment. However, of concern is that there was an existing relatively unsophisticated system in place (oxidation ponds), which could have been repaired, but a fairly complex and costly package plant was selected as the technology of choice. The technology of choice will serve a fairly small and resource poor community, and no plans for significant expansions or new revenue streams are evident. Although the initial cost of the repairing of the oxidation system may have been substantial, the lower long term operational cost would still make it attractive to the municipality, specifically if the capital cost could have been obtained from sources such as MIG.

iii) Municipal environment

Municipality Assessment: District Municipality A3

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
District Municipality A3	C1	4	M	Unqualified	68.42

The information above indicates that the district municipality would appear to be a fairly strong municipality, but the drainage area under discussion is considered a District Management Area which consists mainly of ruralised communities, fairly financially sound and is undertaking the majority of the local government functions. From the above they may well be able to utilise and manage more complex technological options than their present situation; however it is unlikely that the local community would be able to sustainably afford a sophisticated system with high operational and energy costs.

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 3	District Municipality A3	Low to Medium (current), but Medium to High (future)		Class B (Largely Natural with few modifications)	General limits	Class 4 – Performing well, some financial constraints	Rural community – high indigents – funding constraints	Possibly Inappropriate

Assessment comment: In light of DWA's requirement for General Standards, and the seepage problems with the existing pond system, it makes for a sensible approach to upgrade or refurbish the existing infrastructure. However, putting an energy intensive fairly advanced package plant to produce a lower quality effluent seems hard to defend. It seems possible that the technology options do not match the municipality's resource base. No evidence of alternatives explored could be detected.

6.2 EASTERN CAPE PROVINCE:

6.2.1 Plant 4 Oxidation Ponds – District Municipality A4

i) Legislative background and Environmental landscape

Design Capacity (Ml/d): Current Oxidation Ponds = 0.56
Future Activated Sludge plant = 1.75
Operational Capacity (Ml/d): estimated current flow was 809.3 m^3/day, although not metered – (information obtained from the Scoping Report and Appendix2 (Ref 43 & 44)
Class of Works: E
Technology for wastewater treatment: Currently consisting of 6 oxidation ponds – aerobic facultative pond type, but planned upgrade is for an activated sludge plant that would operate in combination with the existing oxidation pond system
Technology for biosolids treatment: Unknown for proposed plant
Impact on Water Resources: Planned discharge to the Kaga River for the activated sludge plant
Type of Discharge: no discharge at present
Water Management Area: Fish to Tsitsikama WMA
River Classification WSAM: Present Ecological State (PESC): Suspect Class C – Moderately modified

From the Scoping Report and Appendix 2 (Ref 43 & 44) it is understood that Plant 4 Wastewater Treatment Works is designed to treat sewerage flows of 560 m^3/day, whereas current loads are estimated to be in the order of 890 m^3/day and are expected to increase to 1750 m^3/day by 2025. The design loads used in the report are as follows;

- Population (estimated future population in 2025): 23000
- Volumetric loading: 1750 m^3/day (76 l/c/day)
- Organic loading: 2500 kg COD/day
- TKN loading: 273 kg TKN/day

The report identifies that the envisaged activated sludge proposal is to feed 75% of raw screened sewage to the existing anaerobic dam, with 25% of raw sewage to the new reactor. After the anaerobic dam, 35% of the effluent would go to the existing oxidation pond system, and 65% to the new reactor – resulting in 1 290 m^3 /d being fed to the new reactor. It would be a single reactor of 3000 m^3 and aeration capacity of roughly 85 kW, with a 25 day sludge age. The reactor will have a dedicated secondary settling tank of 18 meter in diameter. Disinfection would be via chlorine gas in a contact channel before discharge partly to the golf course, and partly to the river.

ii) Licence Requirements and Technology Impact

Licence Requirements:

Currently it would appear that the works is still operating under its old Exemption (1985) which allows for the following:

- Disposal of a maximum of 182.5 Ml/year of water used for industrial purposes and effluent resulting from such use (sewerage) into oxidation ponds for evaporation and the disposal of any overflow from the oxidation ponds by means of irrigation of fodder.
- Disposal of sludge (desludging of ponds) may only be used on:
  - flowers and crops which are not eaten in raw state by humans, e.g. sugarcane, fruit trees and vines, provided that it is well mixed with the soil.
  - Crops which are used as dry fodder for animals, plantations, trees- and plant nurseries and parks and sport fields where there is limited player contact with the ground, e.g. golf, cricket, hockey and soccer fields, but only during development stages
- May not be used on lawns for forage production for animals, on sport fields or public parks or tuberous, bulb type or low growing vegetables.

Technology Impact:

The municipality investigated two distinct options, these being the activated sludge option and an Integrated Advanced Pond System (IAPS). From the information provided (Ref 43), the municipality's strategy for decision making was twofold: first, political leaders in the DM handed the decision to its own technical staff, and second, it opened the decision making process to a broad spectrum of decision makers to particularly assess the risks it would run in pursuing this innovative approach to wastewater treatment.

The report states that the process of consulting experts produced a very interesting debate, centring on the issue of risk, and how it is interpreted; it also produced follow-up actions, some of which led to considerable uncertainty among DM technical officials. Added to this was, was the institutional pressure in the form of a directive from the Department of Water Affairs and Forestry (DWAF, now DWA) to solve the pollution problems in the town immediately, which induced a decision from the DM in May 2009 to revert to an activated sludge technology for the town. The "uncertainty" about the new technology was cited as a reason for this decision. This decision also saw a reversion from the relatively open, consultative process (although this was confined to a circle of experts and did not include any public participation) to an in-house decision by risk-averse officials.

From the information provided it is possible that the IAPS option, with further interaction may have provided an appropriate and sustainable solution, whereas the activated sludge system will achieve the desired results, on condition that sufficient funds and skills are available to operate it effectively and that critical components such as electricity and chemicals are sustainably available and affordable.

iii) Municipal environment

Municipality Assessment: Amatole District Municipality

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
District Municipality A4	C2	2	H	Qualified	21.05

Although Plant 4 falls within a local municipality's boundaries, the Water Services Authority functions are located under the District Municipality, of which this LM forms part. This would indicate that the immediate area (LM) is most probably financially and resource constrained.

The District Municipality, although a large district municipality, which includes well established areas, is categorised as a C2 municipality, indicative of a largely rural character, low urbanisation rate, as well as, limited municipal staff and budget capacity. It would also appear to be performing poorly in terms of socio-economic vulnerability, but coping well with financial aspects.

Based on their municipal classification, C2, there may be concerns as the municipality's ability to operate and manage complex and sophisticated systems such as activated sludge systems sustainably. This aspect is further supported by comments in their IDP, which states that challenges that faced the municipality are aspects such as attracting and retaining key professional and management staff, lack of capacity to plan and manage infrastructure projects and report accordingly and lastly, limitations of supply chain management processes to support the delivery process and supervision of key staff.

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 4 oxidation ponds	DM A4	Low to Medium (current), but Medium to High (future)	Low to Medium (current), but Medium to High (future)	Suspect Class C (Moderately modified)	Exemption (Historically)	Class 2 – Performing well financially, socio-economic constraints	Small Towns & Rural community – high indigents – funding constraints	Possibly Inappropriate

Assessment comment: The municipality made a decision based on risk aversion and was under time pressure to comply with the DWA Directive. The activated sludge system may not be the most appropriate choice given the current municipal environment, but the IAPS option required further investigation, specifically in terms of the potential economic and environmental benefits that may have assisted in long term sustainability. A feasibility study should have addressed these questions, prior to making a decision.

6.2.2 Plant 5 – Local Municipality A5

i) Legislative background and Environmental landscape

Design Capacity (Ml/d): 2.5
Operational Capacity (Ml/d): 1.6-1.8
Class of Works: D
Technology for wastewater treatment: Activated Sludge – plant upgraded from aeration pond to activated sludge in December 2007
Technology for biosolids treatment: Sludge drying beds
Impact on Water Resources: Botha's River
Type of Discharge: River
Water Management Area: Fish to Tsitsikama WMA
River Classification WSAM: Present Ecological State (PESC): Suspect Class C – Moderately modified

ii) Licence Requirements and Technology Impact

Licence Requirements:

Licence allows for the following discharge:

- Into the Bothas River: Average 2.5 Ml/d of treated effluent (Maximum of 912.5 Ml/year)
- Into the maturation ponds: Average 2.5 Ml/d of treated effluent (Maximum of 912.5 Ml/year)
- Disposal of sludge to drying beds: Maximum of 0.165 Ml/d.

The Licence imposes the following limits in terms of the effluent quality discharged to the Bothas River:

Determinant	License Limits for Plant 3	General Limits
pH	5,5-9.5	5,5-9.5
Electrical conductivity (EC)	150 mS/m	250 mS/m
Chemical Oxygen Demand (as COD)	75 mg/l	75 mg/l
Chlorine (Free Chlorine as Cl)	0.25 mg/l	0.1 mg/l
E. coli / Feacal Coliforms per 100 ml	0 (nil) CFU/100 ml	0 (nil) counts/100 ml
Ammonia as nitrogen (NH_3 as N)	1.0 mg/l	1.0 mg/l
Nitrate/ nitrite as nitrogen (NO_3 / NO_2)	15 mg/l	15 mg/l
Ortho-Phosphate as phosphorus (PO_4 as P)	1.0 mg/l	1.0 mg/l
Soap, oil and grease (Total Oils)	2.5 mg/l	2.5 mg/l

In addition the impact of Plant 5 on the Bothas River, the plant shall not exceed the Interim Resource Quality Objectives (surface water) stipulated for the area, which are:

Variable	Unit	Desired Ecological State
		Quality
pH		6.1-8.8
Magnesium sulphate ($MgSO_4$)	mg/l	16
Sodium sulphate ($NaSO_4$)	mg/l	20
Calcium chloride ($CaCl_2$)	mg/l	<21
Ammonia (as N)	mg/l	<0.1
Phosphate (as PO_4)	mg/l	<0.281
Total inorganic Nitrogen	mg/l	<1.91
Sodium chloride (as NaCl)	mg/l	<175
Calcium sulphate ($CaSO_4$)	mg/l	<351

Technology Impact:

It is not possible to comment in detail, as the design configuration of the ASP and effluent compliance results from the plant is not available. The latter is as result of the lack of operational and compliance monitoring regime since the 2007 upgrade. This has recently been rectified. It appears as though the municipality experienced difficulties with regard to the WWTP to such extent that DWA mobilise the Emergency Response Facility (ERF – an external contract with service provider that assist municipalities in critical care). Some of the problems identified relate to aspects such as lack of O & M skills, non-compliance regarding effluent quality monitoring and sampling and the need to implement a basic O&M plan. The Green Drop results for Plant 4 reflect similar results.

This information points towards an observation that an ASP plant might have been the correct choice when considering the strict DWA effluent quality standards – particularly the ammonia and phosphate standards of 1.0 mg/l. However, the municipality did not allocate the required resources to match this technology in terms of O&M, monitoring requirements and skills competencies. It appears as though the upgrade from the oxidation ponds (simplistic system) to an activated sludge (more sophisticated system), may not have been the most appropriate technological option, based on the capacity of the municipality. The options available to the municipality as the time would have been: engage with DWA as to relaxation on the P and N standards and to apply more stringent standards in a phased approach (5 years) whilst the municipality build the capacity to operate the new plant; or to enter into an agreement with an experienced service provider for the O&M function of the plant (shared with the other 2 local plants, which seems to experience similar difficulties).

iii) Municipal environment

Municipality Assessment: Local Municipality A5

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
Municipality A5	B2	4	M	Adverse	76.32

Local Municipality A5 is a well-established municipality, which is undertaking a high percentage of the local government functions and appears to be performing well in terms of their socio-economic vulnerability. There would appear to be concerns with regard to their financial aspects. This could imply that although the municipality is currently coping well with their existing technology choice, they may not be able to sustainably manage these options.

Of concern also, as mentioned earlier, is the fact that there would appear to be serious problems with regard to their management of their water treatment plant and, based on Green Drop information, potentially their wastewater treatment plants. Their problems would not all appear to be related to financial management, but also to operational management aspects. The latter situation would lead one to believe that they may not be able to sustainably manage complex technological options without effective intervention. If it were technically possible, their original technology option of aeration ponds, may have been better suited to their ability to sustainably manage it, rather than the more complex and expensive activated sludge technology which they currently employ. However, the receiving Resource Quality Objectives and subsequently, the effluent quality standards with stringent P and N requirements leave the municipality little choice but to opt for high end technology. It does leave one to pause if rather considering "load contribution" instead of flow and concentration separately, this might have swayed DWA from enforcing such strict standards and allow a slight relaxation and lower end technology.

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 5	Local Municipality A5	Medium	Low to Medium	Suspect Class C (Moderately modified)	Specific Limits close to General Limits, but with IRQO	Class 4 – Performing well, some financial & operational constraints	Large town settlement	Possibly Inappropriate

Assessment comment: In light of the RQO and Ecological State of the receiving water body, it is can be understood why DWA would impose stringent P and N standards onto Plant 5. The appropriate technology was opted for by the municipality, but seemingly without a clear understanding and actioning to put the required resources in place to match the technology choice. A phased approach would have delivered better results and still ensured stricter compliance in future, whilst currently, all standards may be compromised.

6.2.3 Plant 6 – Municipality A6:

i) Legislative background and Environmental landscape

Design Capacity (Ml/Day): 1 Ml/day and 0.1 ML/day Operational Capacity (Ml/Day):
Class of Works: B
Technology for wastewater treatment: Combination of Activated Sludge & biofilters
Technology for biosolids treatment: Sludge drying beds
Impact on Water Resources: Gariep Dam – Oranje River
Type of Discharge: River
Water Management Area: Upper Orange
River Classification WSAM: Present Ecological State (PESC): Unknown suspect Class B

In the Scoping Report on the proposed development of a new Sewerage Purification Plant for Plant 6 undertaken in 2002 (Ref 42) it was commented that the then existing two 'primitive' purification plants were not operating effectively and posed a health risk to residents and environment. The proposed purification plant was an activated sludge treatment plant with a capacity of 3 Ml/day which would provide greater operation reliability and flexibility. Included with the system was a fully automated batch treatment tank. Treated effluent from the reactors would flow through a chlorination channel for final treatment. Final sludge from the reactors will be discharge onto sludge drying beds. The solid waste generated is to be disposed of at an approved landfill site.

Due to proximity of the Gariep Dam, special care needed to be taken to ensure that no contamination takes place.

However from the licence application, which includes 2 plants (including Plant 6), and the draft licence information obtained (only pertaining to Plant 6), it would appear that the capacity of the plants are 1 Ml/day (2^{nd} plant) and 0.1 Ml/day (Plant 6). It is not clear if this is a single plant catering for both towns or of there are two separate plants. Information provided in the licence application referred only one plant only, being an activated sludge system with biofilters (1 Ml/day), however the licence refers to a 0.1 Ml/day plant.

ii) Licence Requirements and Technology Impact

Licence Requirements:

Only a copy of a draft licence could be obtained from DWA. The draft licence for Plant 6 allows for the following: discharge treated effluent to the Gariep Dam – Oranje River:

- Average 0.1 Ml/day of purified/treated effluent (Maximum of 365 00 Ml/year)

The Licence imposes the General Standards:

Determinant	License Limits for Plant 6	General Limits : for discharges below 2 Ml/day
pH	6,0-9.0	5,5-9.5
Electrical conductivity	70 mS/s increase above that intake to a maximum of 150 mS/m	70 mS/s increase above that intake , not to exceed 150 mS/m
Nitrate (as N)	15 mg/l	15 mg/l
Ammonia (as N)	<0.03 mg/l	3 mg/l
Chemical Oxygen Demand (as COD)	< 75 mg/l *(after removal of algae)*	75 mg/l *(after removal of algae)*
E. Coliforms	1000 counts/100 ml	1000 counts/100 ml
Ortho-Phosphate (as P)	1.0 mg/l (median) & 2.5 (maximum)	1.0 mg/l (median) & 2.5 (maximum)
Suspended solids	< 25 mg/l	25 mg/l

As mentioned all the parameters are equivalent for General Authorisation, except for Ammonia, which would appear to be exceptionally strict. It is possible that the value reflected in the draft licence is in error and should have read 3 mg/l.

Technology Impact:

As mentioned, the licence application and draft licence would appear to differ by an order of 10. However, irrespective of this, a 0.1-1 Ml/day plant qualifies as a relatively small plant. Two aspects regarding this plant remain unexplained: that DWA would impose a very strict ammonia standard (0.03 mg/l) and phosphate standard (1.0 mg/l), but relaxed nitrate standard (15 mg/l) onto a micro-sized plant, and secondly, that the municipality would opt for a sophisticated activated sludge plant when the resource base is limited. Also, based on its size, the municipality could have engaged WA in terms of the <2 Ml/day relaxation.

iii) Municipal environment

Municipality Assessment: Local Municipality A6

Municipality	**Category A, B1,B2,B3,B4 and C1 and C2**	**COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing**	**NT Capacity Classification (High Medium Low)**	**Audit Outcomes**	**MDB % of functions**
District Municipality A6	C1	2	L	Disclaimer	7.89

The District Municipality would appear to be a small municipality performing poorly in terms of socio-economic vulnerability and a low national treasury classification and undertaking a low percentage of municipal functions

From the above one could conclude that they may either not have the finances and skills to undertake and or manage a highly complex technological option. Very strict licence limits, requiring a complex technology, could place such a vulnerable municipality in dire straits and will in all probability lead to failures unless alternative measures are put in place, i.e. guidance regarding a simpler technological options (if possible), relaxation in quality limits (if possible) and or direct ongoing support or assistance.

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	**MUNICIPALITY**	**Technology employed for effluent**	**Technology employed for sludge**	**Sensitivity of receiving natural resource**	**Legal Req / license Req**	**Capacity of municipality to operate system**	**Availability of funding to construct and maintain**	**General Comment on "appropriate ness" of Technology (Current & Future)**
Plant 6	Municipality A6	Medium	Medium	suspect Class B (Largely Natural with few modifications)	General Limits for discharge s below 2 Ml/day	Class 2 – Performing weakly	Rural community – high indigents – funding constraints	Possibly Inappropriate

> ***Assessment comment:*** Two aspects seem uncorroborated by the evidence and logic of this analysis: firstly, the excessive standards required by DWA in terms of ammonia and phosphate to a micro-sized plant and a municipality with a low resource base, and secondly, the sophisticated technology choice (ASP) made by the municipality seems unjustified.

6.3 KWA-ZULU NATAL PROVINCE:

6.3.1 Plant 7 – Municipality A7:

i) Legislative background and Environmental landscape

Design Capacity (Ml/d): 230
Operational Capacity (Ml/d): 193.58
Class of Works: B
Technology for wastewater treatment: ASP, secondary settling, flocculation, laminar plate settling, adsorption with GAC, ozonation and chlorination unit processes
Technology for biosolids treatment:

- Line 1: raw sludge is abstracted and transferred to the sea outfall pipeline
- Line 2: wash-water and waste sludge are transferred to the sea outfall line

Impact on Water Resources: Indian Ocean
Type of Discharge: Sea Outfall
Water Management Area: N/A
River Classification WSAM: Present Ecological State (PESC): Undetermined

The system is described in the license motivation as follows:

"There are two sewer lines entering Plant 7's from pipelines 1 and 2 (Old Works and New Works respectively). Line 1 consists approximately of a 60:40 ratio of industrial to domestic wastewater while Line 2 comprises approximately 15:85 ratio of industrial to domestic wastewater. After automated screening and degritting on both lines, the wastewater is passed to primary sedimentation tanks where raw sludge is abstracted and sent to the sea outfall pipeline (anaerobic digester plant has been shut down). The primary effluent from line 2 is passed to Vivendi Water System' secondary and tertiary treatment plant in which the wastewater is recycled for re-use by industry. The Vivendi plant is located within Plant 7 and consists of activated sludge, secondary settling, flocculation, laminar plate settling, adsorption with GAC, ozonation and chlorination unit processes prior to discharge for sale to industry. The wash-water and waste sludge are sent to the sea outfall line. If the re-use water storage tanks are full, then the Vivendi water plant may discharge excess water to the Stanvac Canal under the authority of the Municipality A7.

In addition there is a tanker effluent receiving point on the sea outfall line together with a pipeline receiving point for industrial effluents." "The tankers discharge industrial waste into the works by agreement and the pipeline from companies such as Engen, Shell Chemicals, etc. are discharged into the works by tariff agreement."

The motivational report states that Plant 6 plays a major role in the specific Industrial Basin as a means of disposal of large volumes of industrial waste via its sea outfall, while treating domestic wastewater as well. Historically the works operated under a permit, which expired in 2002.

In the municipality's application, a continuation of the relaxation of General Standards granted in their permit for the Stanvac Canal discharge was requested, which applies to COD, EC and *E. Coli*-based on the fact that the receiving environment is often of a poorer quality than that of the anticipated discharge.

ii) Licence Requirements and Technology Impact

Licence Requirements:

The new licence quantities of discharge are basically the same as per the previous exemption issued in 1999, but with the following differences:

- The maximum quantity of effluent supplied to industry for re-use increased from 12 800 Ml/year to 17 600 Ml/year,
- Maximum limits of water quality variables of the effluent discharged to through the sea outfall has become stricter, specifically for Arsenic, Cadmium, Chromium, Copper, Nickel and Lead.

Licence allows for the following discharge:

- 230 Ml/d of screened wastewater via sea outfall, max 326 Ml/day (Maximum of 84 000 Ml/year),
- 48 Ml/day of excess treated wastewater for industrial use, max 50 Ml/day (Maximum of 17 600 Ml/year)

Licence imposes the following limits for sea outfall:

Determinant	Plant 7 Limits	General Limits ito Exemptions for sea Outfalls
pH	5,5-9.5	5,5-9.5
Arsenic as As	3.3 mg/l	5.0 mg/l
Cadmium as Cd	1.1 mg/l	1.5 mg/l
Chromium as Cr	2.2 mg/l	3.0 mg/l
Copper as Cu	1.4 mg/l	3.0 mg/l
Mercury as Hg	0.05 mg/l	0.05 mg/l
Nickel as Ni	6.8 mg/l	10.0 mg/l
Lead as Pb	3.2 mg/l	5.0 mg/l
Zinc as Zn	6.8 mg/l	10.0 mg/l
Cyanide as Cn	5.0 mg/l	5.0 mg/l
Sulphides as S	20.0 mg/l	20.0 mg/l

DDT and Derivates	0.5 ug/l	0.5 ug/l
Pesticide residue	< 0.01 ug/l	< 0.01 ug/l
Free and saline ammonia	To be reported	3 mg/l
Chemical Oxygen Demand	To be reported	75 mg/l
Soap, oil and grease (Total Oils)	To be reported	2.5 mg/l
Suspended solids	To be reported	25 mg/l

Discharge for industries re-use via Stanvac canal:

Discharge need to comply to General Standards, except for relaxation ito the COD, Electrical Conductivity and *E. coli*, which are as follows:

Determinant	Plant 7 Limits	General Limits
Chemical Oxygen Demand	120 mg/l	75 mg/l
Electrical conductivity	120 mS/m	75 mS/m above intake
E. coliforms	1000 counts/100 ml	0 counts/100 ml

Technology Impact:

From the above it can be seen that stricter limits have been set for the heavy metals, potentially requiring technology that would allow for improved settling/precipitation and consequently more advanced sludge handling processes. These processes could include various treatment methods such as chemical precipitation, reverse osmosis, ion exchange, solvent extraction, coagulation and adsorption. Although some of these processes are very cost effective, others, although necessary, have high capital and operational costs as well as the problem of safe disposing of the residual.

However, the supporting licence application documentation included effluent quality and flow records, which indicated that at the time of the application, the effluent quality was already within the defined limits set with the stricter constraints. Hence compliance to the new limits would not impose a substantial change to current operations.

iii) Municipal environment

Municipality Assessment: Municipality A7

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
Metropolitan Municipality A7	A		H	Unqualified	

The Municipality is a metropolitan municipality, well established, financially sound and able to utilise and manage complex technological options. However, cost and specifically the ability to recover cost, remains an issue. Although this can be achieved to a certain extent through cross-subsidisation and smart revenue enhancement strategies employed by the metro, many of the works serving areas of low cost recovery potential are a substantial financial drain to the municipality, hence a less complex technological technology or green technology may be preferable.

Factors taken into account by the Municipality for Plant 7:

From the information provided, Plant 7 started operations in 1968 and have thus been in operation for well over three decades. It would not appear that any additional work, expansion, etc., is being planned to accommodate the licence requirements as the effluent quality records indicate that works have in the past been able to achieve on average standards well within the limits imposed by the licence.

No comment is made within the documentation regarding the financial impact of the licence requirements other than that cost recovery of industrial waste discharge is being achieved.

It would appear that the following aspects form part of the municipality standard operating procedures and as such would impact decisions made with regard to the operations of the works and hence the technology employed:

A strict monitoring programme of effluent quality and receiving environmental impact is being maintained, internally as well as through external organisations such as the CSIR by means of environmental reviews.

Similarly maintenance condition inspection of the infrastructure is being undertaken, utilising external organisations

Community participation is undertaken with stakeholders through public meetings , specifically with regard to the licence application and impacts of the revised limits

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 7	Municipality A7	Medium to High	Low	Sea outfall	Slightly Stricter than General Limits ito Exemptions for sea Outfalls	Metro – Performing well	Urban area, little funding constraints	Possibly Appropriate

Assessment comment: The municipality and DWA agreed on the increased flow for industrial reuse and on stricter discharge standards pertaining to heavy metals. The plant is already complying to a large degree to the requirements, hence no or limited impact on current practice and resources is expected, and the technology choice would thus appear to be appropriate.

6.3.2 Plant 8 – Municipality A7:

i) Legislative background and Environmental landscape

Design Capacity (Ml/D):	10 (13)
Operational Capacity (Ml/Day):	6.02
Class of Works:	B
Technology for wastewater treatment:	
	Current: ASP, biofilters with humus tanks
	Future: New activated sludge plant (aerobic reactor), two new clarifiers
Technology for biosolids treatment:	unheated digesters, hubermat dewatering
Impact on Water Resources:	Umdloti River
Type of Discharge:	River
Water Management Area:	Mvoti-Umzimkulu WMA
River Classification WSAM:	Present Ecological State (PESC): Class B – largely natural with few modifications

ii) Licence Requirements and Technology Impact

Licence Requirements:

The Licence allows for the following discharge into an unnamed tributary of the Mdloti River:

- Average 12.5 Ml/day of treated effluent, maximum 17.0 Ml/d (Maximum of 620.5 Ml/year)

The Licence imposes the following limits:

From the limitation it would appear that the discharge need to comply closely to the General Standards for Irrigation at 2000 m^3/day, the Licence limits being:

Determinant	License Limits for Plant 8	General Limits	General Limits Irrigation : 2000 m^3/Day
pH	5,5-9.5	5,5-9.5	5,5-9.5
Free and saline ammonia (as Nitrogen)	6 mg/l to be reduced to 2 mg/l in 5 years	1 mg/l	3 mg/l
Nitrate/Nitrate (as Nitrogen)	10 mg/l	15 mg/l	15 mg/l
Chemical Oxygen Demand	75 mg/l (after algae removal)	75 mg/l	75 mg/l
Soap, oil and grease (Total Oils)	No limit set in licence	2.5 mg/l	2.5 mg/l
Suspended solids	25 mg/l	90 mg/l	25 mg/l
Oxygen dissolved	No limit set in licence	75%	
Electrical conductivity	to reduce to 70 mS/m above intake to a max of 150 mS/m within 3 years	250 mS/m	70 mS/m above intake to a max of 150 mS/m
Faecal Coliforms	1000 counts/100 ml	0 (nil) counts/100 ml	1000 counts/100 ml
Chlorine (Free Chlorine)	0.25 mg/l	0.1 mg/l	0.25 mg/l
Ortho-Phosphate (as phosphorus)	6.0 mg/l to be reduced to 1 mg/l in 5 years	1.0 mg/l	10 mg/l
Fluoride	No limit set in licence		1 mg/l

Where reduction of limits over a given timeframe is applicable, the municipality is to provide a detailed action plan on how this will be achieved within the first 3 years, except for EC which needs to be submitted within the first 2 years after the issuing of the licence.

The system is described in the license motivation as follows:

The works is able to treat industrial and domestic effluent. This works consists of a 4 Ml/day activated sludge plant constructed in 1993 and a pre-1965 6 Ml/day biofilter plant. The works discharges treated effluent into the Mdloti River. The sequential treatment steps at Plant 7 are as follows:

Process Step	Details
• Preliminary treatment	Screening & degritting of raw sewerage
• Biofilter	Attached culture system: high rate and standard rate filters
• Activated Sludge (Conventional)	Suspended culture system
• Secondary settling	Settling tanks to separate sludge from clarified effluent
• Sludge wasting	Sludge is wasted from the return activated sludge line
• Digesters	Primary raw sludge is digested in unheated digesters
• Dewatering	Huber rotamats dewater waste activated sludge and primary digested sludge
• Chlorination	Effluent is disinfected with injection of chlorine gas

The licence motivation report highlights the following problems experienced at the works:

- The final effluent has consistently breached the DWA General Standards discharge requirements for COD, due to the biofilter process being inefficient,
- While the activated sludge plant produces an effluent of very good organic quality, generally less than 50 mg/l COD, the poorer effluent from the humus tanks had an overall negative impact on the combined final effluent, pushing it consistently above the General Standard legal limit of 75 mg/l,
- The poor final effluent quality emanates from the humus tank, which is the cause of the problems associated with the biofilter plant,
- Records of the final effluent suspended solids indicate that the activated plant is currently overloaded and would not be able to accommodate increasing volumes of incoming sewerage (projections up to 2020),
- Deteriorating incoming effluent quality,
- Psychoda flies, which negatively impact on surrounding residents,
- Odours, and
- Poor final effluent quality which impacts on the receiving environment (river ecology and downstream farmers).

Based on the above, the municipality investigated the various options available to them to ameliorate the problems, being:

- Decommission the current works and replace it with a new larger regional works, or
- Upgrading the current works.

The licence information stated that the new regional works option was not found to be viable at this stage for reasons:

- given the low anticipated growth in the generation of wastewater in the area,

- the municipality does not consider the development of as “greenfields” development desirable at this stage, and
- objections have been raised with respect to the selected site for the regional works, specifically with regard to its potential impact on the Mdloti River and estuary.

The municipality considers that the upgrading and modernisation of the existing Plant 8 works represent the most cost efficient and timeous option and although not eliminating the impacts on the neighbouring communities entirely, will result in significant reduce impacts on the community. The municipality envisages that the upgraded works should be of a modern design with measures included to mitigate odours and fly problems and have an increased capacity of 12.5 Ml/d to accommodate the 2020 projected loading. The following was proposed and form part of the licence application:

- the biofilters are to be decommissioned,
- a new activated sludge plant (aerobic reactor) would be constructed to the north of the existing activated sludge plant,
- two (2) new clarifiers to be constructed for the new aerobic reactor, and
- construction of a new enclosed inlet works.

Interim measures that were put in place include:

- Covering the biofilters with shade netting to reduce the fly impact, and
- Discontinuation of the on-site storage of de-watered sludge and removal of the then existing sludge.

Technology Impact:

The limits, specifically the reduction limits of ammonia (6 mg/l to be reduced to 2 mg/l over 5 years) and phosphate (6 mg/l to be reduced to 1 mg/l over 5 years), imply the need for an advanced secondary treatment process with nutrient removal or possibly tertiary treatment, depending on the quality of the raw wastewater. However, the works had difficulty operating within the compliance limits of the General Standards, hence the decision to upgrade and modernise.

Based on the comments from the municipality, the stricter limits will not be achievable on an immediate basis, but would be achievable once the upgrading had been completed and with careful management of the works. From the licence documentation it would appear that these constraints had been recognised by DWA and allowance incorporated for a limited time period, with the proviso that clear definitive action by the municipality, in the identified timeframes, is shown in achieving the upgrade and ultimate WWQ limits.

iii) Municipal environment

Municipality Assessment: Municipality A7

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
Municipality A7	A		H	Unqualified	

The Municipality is a metropolitan municipality, well established, financially sound and able to utilise and manage complex technological options. However cost and specifically the ability to recover costs remains an issue. Although this can be achieved to a certain extent through cross-subsidisation and smart revenue enhancement strategies employed by the metro, many of the works serving areas of low cost recovery potential are a substantial financial drain to the municipality, hence a less complex technological technology or green technology may be preferable.

Factors taken into account by the Municipality for Plant 8:

From the documentation provided, the following comments are relevant with regard to the operations of the works and hence the technological options selected:

- Through monitoring and other processes the municipality had recognised the need to upgrade and modernise the works in order to ensure compliance to general standards
- Various options were investigated and aspects such as, the one listed below impacted the decision:
    - Financial viability and projected growth
    - Impact on receiving environment, ecological as well as social
    - Envisaged licence requirements
    - Urgency / timeframes available for resolving the problem
- Stronger control measures and monitoring is to be instituted on industries with regard to improving the quality of their influent. By achieving this, the technological options to be employed at the works could be of a less complex nature than if the influent is not also controlled.

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 8	Municipality A7	Medium to High	Medium to High	Class B (Largely Natural with few modifications)	Fairly Similar to the General Standards for Irrigation at 2000 m^3/day	Metro – Performing well	Urban area, little funding constraints	Possibly Appropriate

Assessment comment: The municipality and DWA agreed that the non-compliance could not continue and set a plan in place to meet more stringent effluent quality standards over a 5 year period. The municipality assessed the technology options and made a defendable decision to decommission the biofilter plants and expand the activated sludge plant to meet the stringent P and N standards. The analysis seems rational and science-based, the paper trail is in place, the licensing process is consulted throughout and the municipal resources seem to be in place.

6.4 NORTHERN CAPE PROVINCE

6.4.1 Plant 9 – Municipality A9

i) Legislative background and Environmental landscape

Design Capacity (Ml/Day):	4
Operational Capacity (Ml/Day):	1.25
Class of Works:	C
Technology for wastewater treatment:	Activated sludge
Technology for biosolids treatment:	Sludge Drying Beds
Impact on Water Resources:	Vlei
Type of Discharge:	Vleiland
Water Management Area:	Lower Vaal WMA
River Classification WSAM:	Present Ecological State (PESC): Unknown suspect Class B – largely natural with few modifications

The Local Municipality historically operated Plant 9 and a number of smaller WWTPs which serviced outlying villages. The municipality was also busy with providing housing for low-income earners and upgrading existing service levels in these villages. The municipality determined that it would be more cost effective and efficient to operate one regional WWTP, servicing all areas, rather than operate a number of smaller works that produced poorer effluent quality and that diluted the existing skills base. With the assistance of MIG funding, Plant 9 was upgraded from a 2.67 Ml/day plant to 4 Ml/day.

From the MIG application (2005), which included a technical report (Kwezi V3 Engineers), the following information is relevant regarding their upgrade (to be concluded by 2008):

The then existing WWTP comprised of a common inlet works, followed by two identical Orbal type biological reactors and two clarifiers. Settled effluent flows under gravity to a chlorine contact tank before being released to the works. Sludge drying beds receive sludge wasted from the reactors. The then existing WWTP had the hydraulic capacity to treat the estimated flows until approximately 2014, but the biological load would exceed the then design capacity. It was thus proposed to:

- Re-equip the then existing decommissioned reactor and clarifier (capacity of 1.33 Ml/d ADWF), modify existing reactor with additional platforms to support vertical shaft aerators, new mechanical equipment including aerators, an adjustable overflow weir and an electrically actuated sludge draw-off valve.
- All mechanical equipment in the decommissioned clarifier to be replaced and new sludge return (RAS) pumps provided.
- Replace the aerators on the existing reactors in order to introduce oxygen more effectively and build additional sludge drying beds.
- Replace all old equipment , such as inlet screens and detritor at inlet works

MIG specified the importance of the EIA in determining the technology option, and also required that a license is in place for the said plant. Refer to extract from MIG approval hereunder:

The committee supports the overall outcomes and objectives of the project. Both the options suggested by the municipality will address the problems currently experience and do not impose any contradictions in relevant policies.

Certain factors that must be taken into consideration;

- The fact that the project is based on the assumption that the I I works can accommodate extra capacity is a risk. The suggestion was therefore made that should the municipality identify this option as the most appropriate, a detail investigation should first be conducted.
- The outcomes of the EIA should be a major indicator in selecting the appropriate option.
- Caution must be taken in Option A concerning the possible contamination of groundwater in the area.
- The municipality should quantify the operation and maintenance cost for the two different options. This should also be seen as an indicator in the selection process.

The necessary license must be in place before the project can commence.

ii) Licence Requirements and Technology Impact

Licence Requirements:

No information provided, use General Limits until license issue can be resolved. DWA has no record of a license application for this plant.

Technology Impact:

It was not possible to comment in detail, specifically as to appropriateness of the technology choice, due to lack of information. From the original technical report, it would appear that aspects such as cost effectiveness and efficiency (sustainability) did form part of the municipality's decision to establish a regional (more complex system) rather than a series of less complex smaller systems.

However, from Green Drop information it would appear that the works achieves compliance and that the plant is operational and maintained. It is noted (photos) that some of equipment is out of commission and this raise some concern. Overall, indications are that the existing technology choice, being activated sludge and sludge drying beds, are successfully implemented and managed, and that centralisation was a suitable decision.

v) Municipal environment

Municipality Assessment: Municipality A9

Municipality	**Category A, B1,B2,B3,B4 and C1 and C2**	**COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing**	**NT Capacity Classification (High Medium Low)**	**Audit Outcomes**	**MDB % of functions**
Municipality A9	B3	3	M	Disclaimer	65.79

Although a fairly well established municipality, which is undertaking the fair percentage of the local government functions, there would appear to be slight concerns with regard to their socio-economic vulnerability and financial aspects. This could imply that although the municipality is currently coping well with their existing technology choice, they may not be able to utilise and manage more complex technological options.

vi) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 9	Municipality A9	Medium	Low to Medium	suspect Class B (Largely Natural with few modifications)	General limits (assumed)	Class 3 – Performing fairly well, some financial constraints	Small Towns & Rural community – high indigents – funding constraints	**Appropriate**

Assessment comment: The municipality made a case to decommission a number of small decentralised plants and replace it with a centralised plant, funded by MIG. Limited comment can be made on this case due to the lack of a license, license application and technical support documentation. It is possible that the MIG conditions have not been fully complied with. Apart from this, the plant seems to be functioning well, although some repairs and maintenance work needs to be prioritised.

6.5 FREE STATE PROVINCE:

6.5.1 Plant 10 – Municipality A10:

i) Legislative background and Environmental landscape

Design Capacity (Ml/Day): 1.2 Ml/day (existing), 4.5 Ml/day (new)
Operational Capacity (Ml/Day): Unknown
Class of Works: C
Technology for wastewater treatment: Existing: Oxidation pond system with 4 aerators –have recently designed activated sludge system with grey water re-use
Phase 2: BNR plant to cater for 6871 household's development, sludge drying dam, emergency dam, and secondary settling dam – for demand up to 2020
Technology for biosolids treatment: No further detail
Impact on Water Resources: Unknown
Type of Discharge: Unknown
Water Management Area: Lower Vaal
River Classification WSAM: Present Ecological State (PESC): Unknown suspect Class C

In the MIG application supported by the Technical Report and motivation for Phase 2 of this plant, it is proposed that a 4.5 Ml/day plant be constructed, to replace the existing 1.2 Ml/day aerated oxidation pond system (which is 9% overloaded). It is reasoned that the new plant would cater for the demand up to 2020.

The report covers many aspects, but do not provide any alternatives such as the refurbishment of the existing pond system or lower technology options. It further creates the impression that Municipality A10 has the skill and resources to maintain and operate this plant, which is quite the contrary when considering the fact that Municipality A10 experiences significant financial, management and governance issues and has been under Section 39 administration for some time.

The report is further silent on critical issues that would impact on the sustainability of choice, such as the low income base which render this technology virtually unaffordable. Of interest is that very low flow is received at the existing pond system, and the need for an additional 4.5 Ml/day flow could not be verified. Flow meters are not in place at the plant to monitor the actual flow to the plant, and the DWA official confirms that very little flow is received at the existing plant, despite the Technical Report's evidence of 9% overload.

1.5 SUSTAINABILITY INDICATORS

The existing water supply system from the Vaal River has been adequately sustained over the past 10 years.

No sustainability problems are foreseen for the future.

3.1.3 Income Level and Sources of Income:

More than 70% of households in Monyakeng/Wesselsbron earn less than R1 500 per household per month.

	Cost summary		
Source	Original amount	Additional amount	Amount Revised
Municipal Infrastructure Grant:	R12 437 623.00	R7 062 377.00	R 19 500 000.00
Nala Local Municipality:	R0.00	R0.00	R0.00
Total Project Cost:	R12 437 623.00	R7 062 377.00	R 19 500 000.00

Furthermore, the O&M of the plant will be a responsibility of the municipality. The projected costs do not match the requirements of this plant (4.5% of capital value). The necessary capital could not be raised by the municipality (hence the motivation for additional MIG funding), and it is doubtful if it could raise the O&M funds and skills for this level of technology.

7.4 OPERATION AND MAINTENANCE COSTS

The responsibility to operate and maintain the works, and the continuity of the service lies with the NALA Local Municipality. The NALA Local Municipality has the municipal infrastructure and the capacity to adequately maintain the works, and the service.

It is envisaged that the maintenance and operational cost will be budgeted for in the annual budget of the Local Council

ii) Licence Requirements and Technology Impact

The next table shows the expected maintenance and operation cost.

ITEM	DESCRIPTION	(2006/7) 50% CAPACITY	(2007/8) 100% CAPACITY
1.	Electrical Consumption (R/Year)	R190 528.00	R199 500.00
2.	Chlorination Cost (R/Year)	R48 000.00	R96 000.00
3.	Labour Cost (R/Year)	R400 000.00	R400 000.00
4.	Maintenance Cost (R/Year)	R200 000.00	R200 000.00
5.	Total Cost (R/Year)	R838 528.00	R895 500.00

Licence Requirements:

No information has been provided by DWA. However, the municipality claim to have submitted a license application in January 2010. It is taken that the plant will have to comply with General Limits, as default standards assumption.

Technology Impact:

Considering the informal discussions with DWA regional office and supported by the evidence in the Technical Report, it is understood that the selected technology may not be the most appropriate for the local conditions and may be too sophisticated for sustainable operations. The report does not put forward a case that is convincing of the requirement for a new plant, neither does it raise confidence that sustainability issues were considered and alternatives explored to inform and inclusive decision-making process. Finally, compliance to General Limits or even more relaxed effluent quality standards, would not justify BNR technology as appropriate option.

iii) Municipal environment

Municipality Assessment: Municipality A10

Municipality	**Category A, B1,B2,B3,B4 and C1 and C2**	**COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing**	**NT Capacity Classification (High Medium Low)**	**Audit Outcomes**	**MDB % of functions**
Municipality A10	B3	2	M	Outstanding	60.53

Although a fairly well established municipality, which is undertaking the fair percentage of the local government functions, there would appear to be concerns with regard to their socio-economic vulnerability and financial aspects. This could imply that although the municipality is currently coping well with their existing (oxidation pond) technology choice, they may not be able to utilise and manage more complex technological options.

In addition through informal discussion with DWA it is understood that the municipality has been under administration for the past two years, one of which their problems included not having the capacity to send out billing. It is thus of concern that the upgrade envisaged for the municipality is that of an activated sludge plant, which is cost and energy intensive and where there is no clear revenue stream to maintain it sustainably. In addition it is not clear if the plant will be receiving sufficient loading to be operating at an optimal level.

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 10	Municipality A10	Low to Medium (current), but Medium to High (future)	Medium	Suspect Class C (Moderately modified)	Unknown	Class 2 – Performing weakly	Small Towns & Rural community – high indigents – funding constraints	Possibly Inappropriate

Assessment comment: It seems unlikely that an activated sludge BNR plant with additional facilities is the appropriate choice and 'right fit' for the particular municipality.

6.6 NORTH WEST PROVINCE

6.6.1 Plant 11 – Municipality A11:

i) Legislative background and Environmental landscape

Design Capacity (Ml/Day): 8
Operational Capacity (Ml/Day): 7.9
Class of Works: C
Technology for wastewater treatment: Activated Sludge Process
Technology for biosolids treatment: 3 Sludge Lagoon dams (4^{th} proposed as part of expansion to 16 Ml/day and bypass to Plant 11)
Impact on Water Resources: Paardekraalspruit, tributary of the Hex River
Type of Discharge: River

Water Management Area: Crocodile West WMA
River Classification WSAM: Present Ecological State (PESC): Unknown suspect Class C

ii) Licence Requirements and Technology Impact

Licence Requirements:

The Licence allows for the following:

- discharge into the Paardekraalspruit at an average 8.0 Ml/day of treated effluent, (Maximum of 2 920 Ml/year)
- disposal of sludge at a maximum of 151.557 Ml into the sludge lagoons
- license conditions are subject to revision once DWA have higher confidence in the Reserve determination for this area.

The Licence imposes discharge limits, into the Paardekraalspruit, that are stricter than those imposed by the General Standards for some aspects and relaxed for others, the Licence limits being:

Determinant	**Licence Limits – Plant 11**	**General Limits**
pH	6,5-8.5	5,5-9.5
Boron as B	1.0 mg/l	0.5 mg/l
Copper as Cu	0.005 mg/l	0.02 mg/l
Phenolic compounds as Phenol	0.1 mg/l	0.01 mg/l
Iron as Fe	0.3 mg/l	0.3 mg/l
Manganese as Mn	0.1 mg/l	0.1 mg/l
Lead as Pb	0.01 mg/l	0.1 mg/l
Zinc as Zn	0.1 mg/l	
Total Hardness (as CaCo3)	50 mg/l	
Free and saline ammonia (as Nitrogen)	1 mg/l	1 mg/l
Nitrate/Nitrate (as Nitrogen)	17.5 mg/l	15 mg/l
Chemical Oxygen Demand (as COD)	75 mg/l	75 mg/l
Suspended solids	50 mg/l	90 mg/l
Total Dissolved Solids (TDS)	1000 mg/l	
Magnesium (Mg)	50 mg/l	
Calcium (Ca)	150 mg/l	
Chlorides (Cl)	175 mg/l	
Sulphates (SO_4)	400 mg/l	

Electrical conductivity	150 mS/m	<75 mS/m increase above intake, not to exceed 250 mS/m
Faecal Coliforms	0 (nil) counts/100 ml	0 (nil) counts/100 ml
Chlorine (Free Chlorine as Cl_2)	0.25 mg/l	0.1 mg/l
Ortho-Phosphate (as phosphorus)	1.0 mg/l	1.0 mg/l
Sodium (Na)	max 90 mg/l above intake	
Sodium Absorption Rate (SAR)	8.0 Mmol/l	90 mg/l above intake water's intake

In addition, the protection of the water resources are considered in terms of the licence requirements that quantifies the impact of the WWTP on:

- the Hex River (upstream of Bospoort Dam), should not exceed the Interim Resource Quality Objectives as stipulated for the water quality reserve for this area, being:

Variable : **Upstream of the Bospoort dam**	**Unit**	**Desired Ecological State**
		Quality
pH		7.5-8.5
Total Dissolved Solids	mg/l	2000
Total Suspended Solids (TSS)	mg/l	< 50
Total Inorganic Nitrogen (TIN)	mg/l	4.0
Nitrate (NO^3)	mg/l	< 17.5
Ammonia (as N)	mg/l	< 0.1
Orthophosphate (as P)	mg/l	< 0.281
Total Phosphorus (as P)	mg/l	< 0.422
Chloride (as Cl)	mg/l	< 175
Sulphate (as SO_4)	mg/l	< 400
Sodium (as Na)	mg/l	< 200
Calcium (as Ca)	mg/l	< 150
Magnesium (as Mg)	mg/l	< 50
Sodium Absorption Ratio (SAR)	Mmol/l	< 8.0

- the groundwater (upstream of Bospoort Dam), should not exceed the Ground Water Interim Resource Quality Objectives as stipulated for the water quality reserve for this area, being:

Variable : Upstream of the Bospoort dam	Unit	Desired Ecological State Quality
Chloride (as Cl)	mg/l	20.7
Sulphate (as SO_4)	mg/l	10.7
Sodium (as Na)	mg/l	14.4
pH		5.0-9.5
Electrical Conductivity	mS/m	42
Nitrate (as N)	mg/l	0.8

Technology Impact:

Due to lack of information it was not possible to provide detailed comment. However, from the Green Drop reports it is understood that there are plans in place to extend the works (by 8 Ml/d – BNR) as it already exceeds it design capacity (Design capacity = 8 Ml/day, receives 8-10 Ml/day). The existing plant is an activated sludge plant and is already well maintained and performing above average. The municipality appears uninvolved in the operations of the plant, and have an agreement in place with an external oversight body, the Rustenburg Trust, who again has agreement with a WSP (Magalies Water) to operate and maintain the plant. The municipality seems heavily dependent on the expertise of the PSP to ensure plant compliance, planning and general management.

iii) Municipal environment

Municipality Assessment: Municipality A11

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
Municipality A11	B1	4	H	Qualified	71.05

A11 is a large municipality performing well in terms of socio-economic vulnerability and a high NT classification and undertaking a high percentage of municipal functions. From the above they may well be able to utilise and manage more complex technological options, such as their planned BNR. Their plant performance is hampered by the overloading of the works. It is acknowledged that they employ external expertise to operate and maintain the WWTPs, whilst keeping a project management and oversight function.

i) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 11	Municipality A11	Medium	Low to Medium	Suspect Class C (Moderately modified)	Stricter than General Standards, IRQO	Class 4 – Performing well	Urban area, little funding constraints	Possibly Appropriate

Assessment comment: Further expansion to the existing Plant 11 is foreseen as the plant is exceeding its current capacity. In light of the successful operations of the existing activated sludge plant, a similar type technology seems appropriate, given the standards that the plant needs to comply with. The good performance of the plant seems to rely heavily on a service agreement and external service providers.

6.6.2 Plant 12 – Municipality A12:

i) Legislative background and Environmental landscape

Design Capacity (Ml/Day): 3.585 (2.55 Ml/day for ASP and 0.85 for Trickling filter)
Operational Capacity (Ml/Day): 3.585
Class of Works: D
Technology for wastewater treatment: Combination of ASP and Trickling Filter
Technology for biosolids treatment: The plant is supported by two (2) anaerobic digester; eight (8) sludge drying beds, and a series of sludge ponds on the western side of the plant
Impact on Water Resources: Portion sold to Khumba and rest to Rooikuilspruit
Type of Discharge: Reuse and river
Water Management Area: Crocodile West and Marico WMA
River Classification WSAM: Present Ecological State (PESC): suspect Class B – largely natural with few modifications

ii) Licence Requirements and Technology Impact

Licence Requirements:

No information provided. However, it has been confirmed that a compliance monitoring programme is in place, which takes place in accordance with an existing water use license (286B). The following determinants were monitored on a monthly basis: pH, EC, SS, COD, NH-N, Nitrate, O-PO_4, FC and *E. coli* up to September 2009, after which the monitoring discontinued as result of payment issues to the laboratory (according to WSA).

Technology Impact:

Due to lack of information it was not possible to provide detailed comment. However, from DWA assessment, it is understood that the plant was hydraulically overloaded, as it receives flow of approximately 4 Ml/day against an ADWF design of 2.53 Ml/d. One consequence of the overload conditions is the chemical and bacteriological failures on the effluent quality certificates that were made available.

A further comment was that there were concerns as to the sludge management practices at the WWTP, which could imply that the technology choice utilised is potentially too complex.

Municipal environment

Municipality Assessment: Local Municipality A12

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
Municipality A12	B3	3	L	Disclaimer	39.47

Although a fairly well established municipality, it is undertaking a low percentage of the local government functions. There would appear to be slight concerns with regard to their socio-economic vulnerability and financial aspects. This could imply that the municipality may not be able to utilise and manage more complex technological options.

Aspects of the above were verified through the Green Drop reports, where due to financial constraints certain operational necessities (i.e. liquid chlorine gas) could not be purchased and sampling reports could not be received due to non-payment of the account. Although the basic O&M of the plant would appear to be satisfactory there were concerns raised with regard to the sludge management, which are not all due to the overloaded capacity.

i) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 12	Municipality A12	Medium to High	Low to Medium	Suspect Class B (Largely Natural with few modifications)	Unknown	Class 3 – Performing fairly well, definite financial constraints	Small Towns & Rural community – high indigents – funding constraints	Possibly Inappropriate

Assessment comment: Insufficient information to make a definite conclusion. Based on the problems experienced with the existing technology, specifically with regard to sludge management, the selected technology may be inappropriate.

6.7 GAUTENG PROVINCE

6.7.1 Plant 13 – Municipality A13:

i) Legislative background and Environmental landscape

Design Capacity (Ml/Day): 24
Operational Capacity (Ml/Day): 13
Class of Works: A
Technology for wastewater treatment: Biological filters combined with Biological Nutrient Removal (BNR) activated sludge process
Technology for biosolids treatment: Anaerobic digestion and land application
Impact on Water Resources: Vaal River
Type of Discharge: River
Water Management Area: Upper Vaal WMA
River Classification WSAM: Present Ecological State (PESC): Class C – moderately modified

The “First Order Assessment of Wastewater treatment plants in Gauteng” (November 2008) indicates that the technology being employed by Plant 13 consists of Biological filters combined with Biological Nutrient Removal (BNR) activated sludge processes, with anaerobic digestion and land application of stabilised sludge. Considering that the design capacity of the works substantially exceeds the average operational flow of 13 Ml/d, it would be expected that the works should be able to comply with effluent standards. The report however comments that there has been a history of problems, often relating to aspects such as sewer pipe blockages, aging of the sewer infrastructure, vandalism of cables at sewer pump stations, design issues and a maintenance backlog, but that these were being addressed by the municipality. It further comments that Plant 13 had responded well to the then recent upgrading of the plant and equipment, as indicated by the improved compliance parameters. This is one of the reasons why Plant 13 had been awarded the 2008 WISA Wilson Award (second place) for high performing WWTP's in South Africa. This is quite contradictory when considering the poor performance by one of the sister-plants, which is also owned and operated by Municipality A13. A strong champion and cohesive team is often the determining factor when such exceptions are apparent in an otherwise failing organisation.

ii) Licence Requirements and Technology Impact

Licence Requirements:

The Licence allows for the following:

- Discharge into the Vaal River, through a 11.2 km canal:
    - Average 13.0 Ml/day (ADWF) of treated effluent (Maximum of 4 745 Ml/year)
    - Maximum daily discharge may not exceed 20 Ml/day
    - Treated water containing waste may be sold or alienated on condition that Municipality has a contract with the other party, which includes the specifications of quantity and quality of the wastewater and that this use must be licensed
- Disposal of an annual maximum quantity of 9 395 m^3 of generated sewerage sludge (only) onto the allocated sacrificial land.

Additional specific conditions of the licence are:

- That there may be no discharge of treated effluent to the Pan.
- That the licence is only valid for a period of 1 year
- That an updated geohydrological report must be submitted before the licence expires
- That an updated technical report, in line with DWA's "Aide Memoire" must be submitted within 6 months of the issuing of the current licence, before a more long term licence would be considered. This report must address and identify rectifying plans and actions for the problems identified in the initial technical report. (Note – the latter report was not provided). In addition the report needs to identify the proposed plans to ensure that the treated effluent quality discharged will meet those of the Vaal Barrage Water Quality Objectives
- That the plans for 2 suitably lined emergency dams at the WWTP, must be included in the future submission for a long-term licence.

The Licence imposes discharge limits that are slightly stricter than those imposed by the General Standards, the licensed limits being:

Determinant	Licence Limits for Plant 13	GENERAL LIMIT
pH	6,5-8,0	5,5-9,5
Electrical Conductivity (mS/m)	70 mS/m above intake to a maximum of 150 mS/m	70 mS/m above intake to a maximum of 150 mS/m
Nitrate (as N)	10 mg/l	15 mg/l
Ammonia (as N)	5,0 mg/l	3 mg/l
Chemical Oxygen Demand (COD)	70 mg/l (After removal of algae)	75 * mg/l (After removal of algae)
Feacal Coliforms Units (FCU)	1 000 counts/100 ml	1 000 counts/100 ml
Ortho-Phosphate(as P)	5 mg/l	10 mg/l
Suspended Solids (SS)	25 mg/l	25 mg/l

Technology Impact:

The information provided was of the initial short term (1 year) licence that was issued to this works, which indicated that there were concerns as to the extent of existing plans and action to ensure that the WWTP complies with the effluent quality standards of the Vaal Barrage Water Quality Objectives. As there is no detail as to the extent of the information required, it is not possible to comment on the extent of impact that the licence conditions may have on the choice of technology.

However the current licence limits must also be seen in context, in that they are applicable for a short period of time and that the municipality ultimately will have to comply with standards that meet the Vaal Barrage Water Quality Objectives. Eutrophication (nutrient enrichment), caused by excessive inputs of nitrates, ammonia and phosphates, is a vital threat to the water quality within the Vaal River system. Thus, it is critical that the municipality comply with effluent standards. Any upgrade in future is likely to be influenced by the effluent quality requirements by DWA. As the plant is already incorporating biofilter and ASP processes, expansion of the same type of technology would be expected. The risk in this is that the underlying causes that impacted negatively on the other two plants in the municipal area will also infiltrate Plant 13.

Of further and related interest, is the proposal to replace the existing plants with a bulk regional Plant, at a significant cost. Such option will have to be substantiated with very strong specialist studies and plans, as the existing plants still carries a significant useful remaining life. In addition, the extraneous flows into sewer systems and treatment plants are a well-known fact, and careful analysis is needed to ensure that investment is made where highest returns can be achieved. In this case, it would seem prudent to invest in an intensive extraneous flow management programme which is responsible for artificial loading of the existing (and same for new plant), whilst the diluted nature (food:microorganism ratio) of the wastewater compromises the biological nutrient removal process.

iii) Municipal environment

Municipality Assessment: Local Municipality A13

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
Municipality A13	B1	4	H	Disclaimer	73.68

A13 is a large municipality performing well in terms of socio-economic vulnerability and a high NT classification and undertaking a high percentage of municipal functions. From the above they should be well able to utilise and manage more complex technological options. It is thus disconcerting that given the above; there were serious concerns as to the extent of existing plans and actions to ensure that the WWTP complies with the effluent quality standards of the Vaal Barrage Water Quality Objectives. Such concerns may imply that there are problems in the utilisation and management of the existing technology.

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriate ness" of Technology (Current & Future)
Plant 13	Municipality A13	High	Medium to High	Suspect Class C (Moderately modified)	Slightly stricter than General Standards (Vaal Barrage WQO)	Class 4 – Performing well	Urban area, little funding constraints	**Appropriate**

Assessment comment: Plant 13 seems to be operated well, which is a contradiction to the dilapidated state of the sister-plant Rietspruit. The combined ASP and biofilter technology is well maintained and suitable to meet the stringent effluent requirements of the interim DWA license. The sensitivity of the (Vaal) catchment would require high end technology to meet the stringent P and N standards. In the case, the appropriate technology was opted for, but the institutional arrangements to operate and manage the facility might be the primary risk determinant.

6.7.2 Plant 14 – Municipality A14

i) Legislative background and Environmental landscape

Design Capacity (Ml/Day):	65 (further extension of 30 Ml/d in progress due 2012)
Operational Capacity (Ml/Day):	55
Class of Works:	A
Technology for wastewater treatment:	Combination of BNR activated sludge and biofilters
Technology for biosolids treatment:	Primary sludge fermentation, sludge thickening, mechanical gravity belt thickener and anaerobic digesters
Impact on Water Resources:	Hennops River
Type of Discharge:	River
Water Management Area:	Crocodile – Marico WMA
River Classification WSAM:	Present Ecological State (PESC): Class B – largely natural with few modifications

The "First Order Assessment of Wastewater treatment plants in Gauteng" (November 2008) indicated that the technology being employed by Plant 14 consisted of activated sludge and biofilters. However, the design capacity of the works at that stage was 45 Ml/day, and the plant received an average flow of 55 Ml/day – indicating that 122% (10 Ml/day) of the design capacity is being exceeded. The plant was later extended by 20 Ml/day to avail the current capacity. The extension included a primary settling tank, a flow balancing tank, a BNR activated sludge bioreactor, two secondary settling tanks, a chlorination facility, two primary sludge fermenters, two primary sludge thickeners, a wastewater sludge mechanical gravity belt thickener and two anaerobic digesters.

Further information indicates that a consulting group have been appointed to undertake a further upgrade of 30 Ml/day to the existing 65 Ml/day. It is commented that the "project challenges include that Plant 14 was developed and extended over a protracted period of time. All extensions employed the best available technology at the time to meet the applicable statutory requirements. Stricter standards for treated effluent from the works forced later extensions to meet a higher effluent standard than that required from the works as a whole".

A biological nitrogen and phosphorous removal activated sludge plant is proposed that should achieve a P-level of 0,62 mg/l and an ammonia level of 2 mg/l during winter months. Provision has been made to pre-precipitate phosphorous from the waste sludge to prevent struvite formation in the existing anaerobic digesters. Dewatering filtrate will also be blended with the pre-precipitation overflow to allow for ammonia stripping."

ii) Licence Requirements and Technology Impact

Licence Requirements:

The Licence allows for the following:

- Disposal to the Hennops River of treated effluent:
    - Average 62.6 Ml/day based on average dry weather flow (Maximum of 22 849 Ml/year)

- Disposal to irrigated land (Plant 14's garden) of treated water containing waste:
    - Average 12.166 Ml/month (Maximum of 146 Ml/year)
- Disposal of treated sewage effluent:
    - Average 12.166 Ml/month (Maximum of 146 Ml/year)

Additional specific conditions of the licence are:

- Specific relaxations were granted, of which faecal coliforms (to 1000 CFU/100 ml) was temporarily granted until a more effective alternative of disinfection is developed and proofed.

Licence imposes the following limits:

- Disposal to the Hennops River are in general stricter than those imposed by the General Standards and for some aspects closer to Special Limits, but with other relaxed:

Determinant	Licence Limits for Plant 14 (Hennops River)	General Limits
pH	6,5-8.5	5,5-9.5
Electrical conductivity	≤ 65 mS/m	<75 mS/s increase above that intake , not to exceed 250 mS/m
Nitrate (as N)	≤ 8 mg/l	15 mg/l
Ammonia (as N)	≤ 3 mg/l	1 mg/l
Chemical Oxygen Demand (as COD) *after removal of algae*	≤ 65 mg/l	75 mg/l
Faecal Coliforms	≤ 150 cfu/100 ml	0 (nil) cfu/100 ml
Ortho-Phosphate (as P)	≤ 0.9 mg/l	1.0 mg/l
Suspended solids	≤ 15 mg/l	90 mg/l
Residual Chlorine	≤ 0.2 µg/l	0 (nil) mg/l

Relaxations were granted in terms of:

- Ortho-phosphate to max of 1.5 mg/l (monthly total must still equate to below 0.9 mg/l)
- Faecal Coliforms (temporarily) to max of 1000 cfu/100 ml
- Nitrate to max of 10 mg/l
- Residual Chlorine to max of 0.1 mg/l
- Suspended Solids to max of 20 mg/l (monthly total must still equate to below 15 mg/l)

- Disposal by irrigation:

The water quality limits may not exceed the following values or range as shown below, which appears to be that for General Limits Irrigation up to 500 m^3/day:

Determinant	Licence Limits for Plant 14 (irrigation)
pH	6.0-9.0
Electrical conductivity	200 mS/m
Nitrate (as N)	15 mg/l
Ammonia (as N)	3 mg/l
Ortho-Phosphate (as P)	10.0 mg/l
Fluoride	1.0 mg/l
Chemical Oxygen Demand (as COD) *(after algae removal)*	400 mg/l
Faecal Coliforms	100 000 cfu/100 ml

In addition, the licence requires that the impact of the WWTP be considering the protection of the water resource in terms of:

- the groundwater – should not exceed the groundwater quality management objectives as stipulated for the water quality reserve for this area, being:

Determinant	Unit	Groundwater Quality Reserve
Electrical Conductivity	mS/m	56
Sodium (as Na)	mg/l	11
Magnesium	mg/l	34
Calcium	mg/l	52
Chloride	mg/l	13
Sulphate	mg/l	14
Nitrate	mg/l	2.5
Fluoride	mg/l	0.15
pH		6.0-9.5

- Disposal of treated sewage effluent: To protect the water resources the licence requires that the impact of the WWTP on the groundwater should not exceed the groundwater quality management objectives as stipulated for the water quality reserve for this area, being:

Determinant	**Unit**	**Groundwater Quality Reserve**
Electrical Conductivity	mS/m	56
Sodium (as Na)	mg/l	11
Magnesium	mg/l	34
Calcium	mg/l	52
Chloride	mg/l	13
Sulphate	mg/l	14
Nitrate	mg/l	2.5
Fluoride	mg/l	0.15
pH		6.0-9.5

Technology Impact:

The existing works and the further expansion being under taken, are fairly complex technology options, requiring high level of skills, capital and operational funding, of which energy consumption would contribute significantly. Considering that A14 is one of the larger metropolitan municipalities, one would believe that they would be able to manage such technology effectively and sustainably.

Of concern however, were comments made in SA-PAWS Report March 2009, referring to another wastewater treatment works (Ref:39). The report mentions that the site comprises of three separate works, East, West and North. The East works was the first to be built in 1954 as biological filter plant. The West works, also a biological filter plant, followed in the early 1960s, and the larger North works as an activated sludge plant in 1984.

From a technology perspective, both plants represent fairly complex plants, which are prone to similar problems. Some of the relevant comments from this independent technical report are as follows:

- Hydraulic Conditions:
  - lack of reliable flow measurement
  - due to flow diversions on site , the north works was heavily overloaded and had to deal with virtually all flows, whilst the other two works were in effect being wasted
  - the rationale for this decision was not known, which implied a lack of current knowledge or expertise.

- a 2008 consultant report commented more on the need to upgrade the North works, than to address the lost capacity in the east and west works with little attention regarding the more fundamental issues of what was actually on site and how it was being managed. This was largely due to the initial scope of the report. The executive summary stated that it was a feasibility study for the upgrading not extension of the site. However, the report did not appear to fully consider the root causes of the problems, and therefore perhaps did not fully address the correct issues.

- Organic or Biological Loading:
  - Substantial capacity reduction due to diversion of flows, through the closure of one site and the poor condition of the other
  - Restrictive purchasing rules experienced by staff, preventing effective repairs / replacements. Specific comment was made in the report that relatively simple cost-benefit analysis would almost certainly have concluded that the re-treatment of effluent and management of it all though one works was more costly that undertaking the necessary repairs / replacements on the other two works.
- BNR Configuration:
  - It was commented that the configuration both by design and modification was considered unlikely to be successful at reliably removing both N and P whilst achieving full carbonaceous and ammonia removal and that this need to be critically examined
- Staff Quantity and Quality:
  - Lack of actual skilled technical resources including lack of effective experienced skilled supervision, with little or no role definition amongst staff. It was implied to the report writers that the constraints of Regulation 2834 were causing issues as it stipulates the staff types and numbers required. The report specifically states that a large and complex works such as this requires a much greater flexibility to recruit more technical roles at the cost of less technical ones and possibly outsource some of the less technical functions if necessary.
- Other aspects mentioned:
  - The need to set-up and implement localised monitoring and supervisory regime across the whole site
  - Lack of standby power generation, which poses a huge threat to continued compliance and operations

iii) Municipal environment

Municipality Assessment: Metropolitan Municipality A14

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
Municipality A14	A		H	Qualified	

A14 is a metropolitan municipality, well established, financially sound and able to utilise and manage complex technological options. No additional information was provided which could assist in identifying potential problems or concerns that could assist in commenting on the municipality technology choices in relation to Plant 14, however by implication the comments made in the SA PAWS report, regarding Rooiwal, also part of the same municipality, could imply that the current technology choices may not be best suited to their current management abilities. Given the size and the potential risk involved in the macro-sized plants, it may not leave the municipality much choice as to utilise sophisticated technologies. However, the municipality must prioritise and ensure that highly skilled staff be appointed and retained, and that adequate resources be allocated for optimal functioning of the plants.

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 14	Metropolitan Municipality A14	High	High	Class B (Largely Natural with few modifications)	Stricter than General Standards & some aspects closer to Special Limits	Metro – Performing well	Urban area, little funding constraints	Possibly Inappropriate

Assessment comment: Analysis of Plant 14 documentation, supported by analysis of the sister plant, lead to some concern regarding the more fundamental issues pertaining to the resource base that is allocated to operate the sophisticated technology. The technology in itself is 'appropriate' and a best fit to the circumstances, as the plant needs to produce high quality effluent for discharge to a sensitive catchment. However, the assessment comment of "possibly inappropriate' refer to inadequate resources and to support the technology decisions.

6.8 MPUMALANGA PROVINCE:

6.8.1 Plant 15 – Municipality A15:

i) Legislative background and Environmental landscape

Design Capacity (Ml/Day): 1.5
Operational Capacity (Ml/Day): 1.0
Class of Works: E
Technology for wastewater treatment: Oxidation ponds
Technology for biosolids treatment: No information

Impact on Water Resources:	No discharge other that irrigation of land adjacent to oxidation ponds
Type of Discharge:	irrigation
Water Management Area:	Olifants WMA
River Classification WSAM:	Present Ecological State (PESC): Suspect Class C – moderately modified

ii) Licence Requirements and Technology Impact

Licence Requirements:

No current license information was available. It is thus possible that the plant may still be operating under the expired Exemption. The exemption authorises the disposal of effluent to oxidation ponds and through the discharge into catchment of an unnamed stream, by irrigation of the land adjacent to the oxidation ponds:

- Average daily disposal of effluent 570 m^3/day, to a maximum daily discharge of 650 m^3, Maximum annual quantity: 210.445 Ml/a
- Oxidation pond system shall at all times have a minimum of 25 days retention time.

The effluent discharged into the catchment of the stream shall at all times comply with the then General Standards (18 May 1994), with the exception of faecal coliforms which was limited to 250 plate count /100 ml.

Technology Impact:

Unable to comment in detail due to lack of information. However the “First Order Assessment of Wastewater treatment plants in Gauteng” (November 2008) indicates that the technology being employed by Plant 15 consists of oxidation ponds, which at that stage had appeared to be well run with sustained compliance indicated. This would indicate that this low level of technology was suitable, appropriate and manageable.

However, the Local Municipality’s Capex Projects Sanitation 2010/11, indicates that the existing oxidation ponds at Plant 15 are operating at full capacity and to upgrade would not be economical. It indicates that the ponds should be rather used for pre-treatment and the effluent pumped to the new [Ekangala] WWTP (proposed to be a biological wastewater treatment plant).

iii) Municipal environment

Municipality Assessment: Municipality A15

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
Municipality A15	B2	4	M	Outstanding	47.37

The municipality is well established, performing well in terms of socio-economic vulnerability and has a fair NT classification, but undertakes a relatively low percentage of municipal functions. There would appear to be slight concerns with regard to their financial aspects. This could imply that the municipality may potentially experience problems in utilising and managing more complex technological options as suggested with the proposed biological wastewater treatment plant planned for Ekangala.

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 15	Municipality A15	Low to Medium	Low	Suspect Class C (Moderately modified)	Exemption (Historically)	Class 4 – Performing well, some financial constraints	Large town settlement	**Appropriate**

Assessment comment: Insufficient information and unable to provide meaningful comment regarding the technology. However, from the information provided, which indicated that at that stage (2008) the works had appeared to be well run with sustained compliance would indicate that this low level of technology was suitable, appropriate and manageable. With the consideration of the bypass to a different more complex works, this may not be necessary remain so.

6.8.2 Plant 16 – Municipality A16

i) Legislative background and Environmental landscape

Design Capacity (Ml/Day): 1.1 (Green drop information indicated 1.5 ML/day)
Operational Capacity (Ml/Day): 0.8
Class of Works: D (Class B, based on certificate of Dec 2009)
Technology for wastewater treatment: Activated sludge BNR
Technology for biosolids treatment: Unknown
Impact on Water Resources: Gladdespruit
Type of Discharge: River
Water Management Area: Inkomati WMA
River Classification WSAM: Present Ecological State (PESC): Suspect Class C – moderately modified

ii) Licence Requirements and Technology Impact

Licence Requirements:

Licence allows for the following:

- Disposal of sludge to irrigated land: Average 9.64 m^3/d, (Maximum of 3.5186 Ml/year)
- Irrigation of *Eucalyptus saligna* over a 1.5926 ha area
- Discharge of water containing waste into the Sand River: Average 0.408 Ml/day, (Maximum of 148.920 Ml/year)

The Licence imposes the following limits: disposal into the Sand River. From the limitations it would appear that the discharge limits are closer aligned to General Limits than those imposed for Special Limits (Schedule 1 areas). There is however a substantial relaxation of the Ammonia limits and a stricter limit for faecal coliforms and ortho-phosphate.

Determinant	Licence Limits for Plant 16	GENERAL LIMIT	SPECIAL LIMIT
pH	5,5-9,5	5,5-9,5	5,5-7,5
Electrical Conductivity (mS/m)	70 mS/m above intake to a maximum of 150 mS/m	70 mS/m above intake to a maximum of 150 mS/m	50 mS/m above background receiving water, to a maximum of 100 mS/m
Nitrate (as N)	15 mg/l	15 mg/l	15 mg/l
Ammonia (as N)	6,0 mg/l	3 mg/l	2 mg/l
Chemical Oxygen Demand (COD)	75 mg/l (After removal of algae)	75 mg/l (After removal of algae)	30 mg/l (After removal of algae)
Feacal Coliforms Units (FCU)	0 (nil) counts/100 ml	1 000 counts/100 ml	0 (nil) counts/ 100 ml
Ortho-Phosphate(as P)	1 mg/l	10 mg/l	1 (median) and 2,5 (maximum) mg/l
Suspended Solids (SS)	25 mg/l	25 mg/l	10 mg/l

In addition, in order to protect the water resources, the licence requires that the impact of the WWTP on the Sand River should not exceed the in-stream water quality objectives as stipulated for the water quality reserve for this area, being:

Variable	Unit	Desired Ecological State
		Quality
Total Dissolved Solids	mg/l	< 254
Sodium	mg/l	< 30
Magnesium	mg/l	< 19
Potassium	mg/l	< 1.1
Calcium	mg/l	< 20
Chloride	mg/l	< 18
Sulphate	mg/l	< 14
Soluble Phosphate	mg/l	< 0.055
Total Inorganic Nitrogen	mg/l	< 33:1
pH		5.6-8.1

Technology Impact:

No specific information available to make an assessment, but based on Green Drop information the works had maintained a high level of compliance to the water quality standards as identified with in their original permit. This would lead one to believe that their current technology choice was appropriate and applicable to their situation.

iii) Municipal environment

Municipality Assessment: Local Municipality A16

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
Municipality A16	B1	3	H	Qualified	44.74

A16 is a large municipality performing fairly in terms of socio-economic vulnerability and a high NT classification, but under takes a relatively low percentage of municipal functions. There would appear to be slight concerns with regard to their socio-economic vulnerability. This could imply that the municipality may potentially experience problems in utilising and managing more complex technological options. Although the information indicates that they are successfully managing the medium technology (Plant x – oxidation ponds) and the more complex technology (Plant 16 – BNR).

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriate ness" of Technology (Current & Future)
Plant 16	Municipality A16	High	High	Suspect Class C (Moderately modified)	Closer aligned to General Limits than for Special Limits (Schedule 1 areas)	Class 3 – Performing fairly well	Urban area, little funding constraints	**Appropriate**

Assessment comment: The current combination of medium and high-end technology seems to be well operated by the municipality and compliance is achieved.

6.8.3 Plant 17: Municipality A16

i) Legislative background and Environmental landscape

Design Capacity (Ml/Day): 12 (ADWF)
Operational Capacity (Ml/Day): 5.3
Class of Works: C
Technology for wastewater treatment: Oxidation ponds, Biological filtration, chlorine contact tank
Technology for biosolids treatment: Two anaerobic ponds and 4 drying beds
Impact on Water Resources: Crocodile River
Type of Discharge: River
Water Management Area: Inkomati WMA
River Classification WSAM: Present Ecological State (PESC): Suspect Class C – moderately modified

From the operational Environmental Management Plan (Ref 40), it is understood that the retention time in the ponds is equal to 16.7 days. All critical components (pista grit removal system, mechanical screens, biofilter system and chlorine contact facilities) are duplicated to ensure 100% standby capacity and the reticulation pumps have a 50% standby capacity. The pond system is designed in such a way that it consists of two separate series of ponds that can function separately.

ii) Licence Requirements and Technology Impact

Licence Requirements:

Licence allows for the following:

- Discharge of water containing waste into the Crocodile River: Average 12 Ml/day, (Maximum of 4 380 Ml/year)

Licence imposes the following limits for effluent discharged into the Crocodile River / Pedro pond system. From the limitations it would appear that the discharge limits are closer aligned to General Limits than those imposed for Special Limits. There is however a substantial relaxation of the Ammonia limits and a stricter limit for faecal coliforms and ortho-phosphate.

Determinant	**Licence Limits for Plant 17**	**GENERAL LIMIT**	**SPECIAL LIMIT**
pH	5,5-9,5	5,5-9,5	5,5-7,5
Electrical Conductivity (mS/m)	75 mS/m	70 mS/m above intake to a maximum of 150 mS/m	50 mS/m above background receiving water, to a maximum of 100 mS/m
Nitrate (as N)	15 mg/l	15 mg/l	15 mg/l
Ammonia (as N)	6,0 mg/l	3 mg/l	2 mg/l
Chemical Oxygen Demand (COD)	75 mg/l (After removal of algae)	75 mg/l (After removal of algae)	30 mg/l (After removal of algae)
Feacal Coliforms Units (FCU)	0 (nil) counts/ 100 ml	1 000 counts/100 ml	0 (nil) counts/ 100 ml
Ortho-Phosphate(as P)	1 mg/l	10 mg/l	1 (median) and 2,5 (maximum) mg/l
Suspended Solids (SS)	25 mg/l	25 mg/l	10 mg/l

Technology Impact:

Insufficient information was available to make an assessment, but based on the information provided the oxidation pond system is a relatively low to medium level of technology. Green Drop information the works had maintained a high level of compliance to the water quality standards as identified with in their original permit. This would lead one to believe that their current technology choice was appropriate and applicable to their situation. It was however commented that the municipality is currently compiling a masterplan that would include extension of the works.

iii) Municipal environment

Municipality Assessment: Local Municipality A16

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
Municipality A16	B1	3	H	Qualified	44.74

A16 is a large municipality performing fairly in terms of socio-economic vulnerability and a high NT classification, but under takes a relatively low percentage of municipal functions. There would appear to be slight concerns with regard to their socio-economic vulnerability. This could imply that the municipality may potentially experience problems in utilising and managing more complex technological options. Although the information indicates that they are successfully managing the medium technology (Plant 17 – oxidation ponds) and the more complex technology (Plant 16 – BNR).

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 17	Municipality A16	Medium	Low to Medium	Suspect Class C (Moderately modified)	Closer aligned to General Limits than for Special Limits (Schedule 1 areas)	Class 3 – Performing fairly well	Urban area, little funding constraints	**Appropriate**

Assessment comment: The current lower end technology option seems to be well operated by the municipality and high compliance is achieved. However, the stricter standards required by DWA, especially the 1 mg/l PO_4 and the 0 faecal coliforms would necessitate the municipality to review the treatment technology, or to engage DWA for a relaxed standard on phosphate.

6.9 LIMPOPO PROVINCE:

6.9.1 Plant 18 – Local Municipality A18

i) Legislative background and Environmental landscape

Design Capacity (Ml/Day):	3
Operational Capacity (Ml/Day):	1.75
Class of Works:	C
Technology for wastewater treatment:	BNR Activated Sludge
Technology for biosolids treatment:	Maturation ponds & sludge dams
Impact on Water Resources:	Irrigation
Type of Discharge:	Irrigation
Water Management Area:	Limpopo
River Classification WSAM:	Present Ecological State (PESC): Suspect Class B – largely natural with few modifications

The system is described as follows:

In terms of process layout, the modified Ludzack-Ettinger and Wuhrmann configuration was used in the design of the works, where the first (1^{st}) reactor (anoxic zone) is left un-aerated and the second (2^{nd}) reactor (aerobic zone) is aerated. The nitrate generated in the second reactor is transferred to the first reactor via the under-flow and an inter reactor (internal cycle), from the end of the aerator basin to the inlet of the first reactor.

The overflow from the aeration reactor is diverted to two (2) clarifiers, from where the overflow is diverted to a series of maturation ponds. Excess sludge is wasted directly from the aeration reactor to the two (2) sludge dams alternatively and the old drying beds are also put back into use for screenings and detritus for later removal to the refuse dumping site. Provision has also been made for disinfection with chlorine gas.

ii) Licence Requirements and Technology Impact

Licence Requirements:

Licence allows for the following:

- Disposal of wastewater to irrigated land: Average 6.0 Ml/month, (Maximum of 686 Ml/year)
- Irrigation of crops of Lucerne (majority use) and lawns (cemetery and sports grounds) over a 28ha area
- Disposal of water containing waste, based on flow from the anaerobic pond system to the irrigation pond system: Average 3 Ml/day, (Maximum of 700 Ml/year)
- Disposal of digested sludge to sludge drying beds: Average 0.016 Ml/day, (Maximum of 1100 Ml/year)

Licence imposes limits for effluent to be used for irrigation, as well as the quality of the wastewater disposed into the irrigation pond system, to be the same. From the limitations it would appear that the discharge limits are slightly less strict than those imposed for Special Limits (Schedule 1 areas).

Determinant	License Limits for Plant 18 (Irrigation water)	Special Limits (Schedule 1 area)
pH	5,5-9.5	5,5-7.5
Electrical conductivity (EC)	175 mS/m	250 mS/m
Ammonia (as N)	3 mg/l	1 mg/l
Nitrate (as N)	15 mg/l	1.5 mg/l
Chemical Oxygen Demand (as COD)	70 mg/l (after algae removal)	30 mg/l (with Chloride correction)
Ortho-Phosphate (as phosphorus)	10 mg/l	1.0 mg/l
Suspended solids	25 mg/l	10 mg/l
Fluoride	1.0 mg/l	1.0 mg/l
Manganese as Mn	0.4 mg/l	0.1 mg/l
E. coli / Feacal Coliforms per 100 ml	0 (nil) CFU/100 ml	0 (nil) counts/100 ml

In addition to the limitation above the impact of the wastewater works on the ground water resource must not exceed the following groundwater management objectives for the area:

Parameter	Groundwater Quality Reserved
Electrical conductivity (EC)	55 mS/m
Sodium	37 mg/l
Magnesium	21 mg/l
Calcium	39 mg/l
Chloride	20 mg/l
Sulphate	14 mg/l
Nitrate	6 mg/l
Fluoride	1.0 mg/l
pH	5.0-9.5

Technology Impact:

From documentation reviewed it would appear that some of the impacts of the limits, as set in the licence, are that:

- the municipality initially believed that General Standards, with a relaxed *E. Coli* limit of 1000/100 ml will be set for the irrigation water, as the majority was used for the Lucerne, and that chlorination would thus not be necessary. It is suspected that the stricter limits were set due to the water being used for irrigation of the sport fields. The documentation also indicated that chlorination would be uneconomical in such a situation.
- As the works only accepts domestic sewerage, the testing for ortho-phosphate, manganese and fluoride was also viewed as being unnecessary and an appeal to have these omitted from the licence will be lodged.
- Of concern to the municipality the base of such strict limits as these would in essence "force" a sophisticated technology whilst in this case (with land available) an oxidation/evaporation pond would be adequate.
- Similarly it is not understood why such a sophisticated technology choice was followed by the municipality, this specifically seen against their potential access to resources in terms of skills and funding.

iii) Municipal environment

Municipality Assessment: Local Municipality A18

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
Municipality A18	B3	4	M	Outstanding	52.63

From the CoGTA information it would appear that although a relatively small municipality (B3), the municipality in terms of its allocated functions (53%) is performing fairly well and is economically stable based on the National Treasury classification. From this one would infer that they are coping with their existing functions which include the operation of their WWTP. However, as mentioned previously, what is not clear and thus of concern, is that why such a sophisticated and costly technology was proposed for what is in effect a relatively poor rural municipality with poor access to resources.

Factors taken into account by the Municipality for Plant 18:

Informal documentation indicates that the plant was commissioned in 2005. The decision process as to the selected choice of technology is thus not available, but evidently the ongoing monitoring/testing of the raw sewerage, sludge and effluent quality and loading is used in managing the current effectiveness of the operations, as well as to assist in identifying when there would be a need for extension to the facilities in future.

iv) Assessment findings

Summative comment regarding appropriateness of technology choice

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 18	Municipality A18	High	Medium	Class B (Largely Natural with few modifications)	Close to Special Limits (Schedule 1 areas)	Class 4 – Performing well, some financial constraints	Small Towns & Rural community – high indigents – funding constraints	Possibly Inappropriate

Assessment comment: It is encouraging to note the WSA's engagement with DWA on the requirements of strict standards that would 'facilitate' a more sophisticated technology that what can potentially be afforded or maintained. As the majority of the effluent is used for lucerne irrigation, the enforcement of strict manganese, faecal coliforms and phosphate standards are not necessarily meaningful.

7 COMPARATIVE ANALYSIS AND OBSERVATIONS OF 18 PLANTS

The licence applications and their supporting documentation were investigated against a set framework to determine which (if any) of the mentioned parameters act as levers and input to the decision of choice of technology.

The level of details was not as readily available as one would have assumed, considering the requirements by funders prior to disposing capital for the planned infrastructure (i.e. feasibility studies, business plants, technical reports, etc.). The information level indicated that the scope and depth of the factors affecting technology choice varied between the various municipalities. Although most of the selection was linked to the technological aspects of the plant, i.e. loading, treatment requirements, effluent standards, human and health aspects (smell, flies, etc.), little evidence was found that related the ability of the municipality to sustainably operation and financially manage the system, specifically taking into account aspects such as the cost of power in future, skill availability and cost recovery.

The table overleaf provides an indication of mainly the various secondary and sludge treatment technology options / levels utilised by the selected municipalities. In addition, a general comment is provided on the combined treatment plant system in terms of sophistication (capital cost, operational cost, power consumption, level of technology and maintenance requirements). The general comment is based on the summative comments as per the table developed in ***Appendix B*** for the wastewater plant system as a whole.

Where information was available with regard to historic and planned extension / upgrades of the various plants, the historic technology option and their current technology option as well as current to planned technology options were included. The purpose thereof was to identify the trend of extension versus upgrades, i.e. do the municipalities where possible stay with a lower level of technology (if functioning sustainably) and just extend the plant, or is there a tendency to upgrade the plant to a different technology level.

Table: Indication of mainly the various secondary and sludge treatment technology options and levels utilised by the selected municipalities

Province	WWTP	Municipality	Oxidation Pond System	Aerated	Biofilters	Activated Sludge System	BNR System	Package Plant	Maturation Ponds	Disinfection	General Comment on Technology (Historic)	General Comment on Technology (Current)	General Comment on Technology (Future)
Western Cape	Plant 1	A1	Current	Current	Current				Current	Current		Medium	Medium *
	Plant 2	A2	Current			Future						Low to Medium	Medium to High
	Plant 3	A3	Current					Future				Low to Medium	Medium to High
Eastern Cape	Plant 4	A4	Current	Current		Future						Low to Medium	Medium to High
	Plant 5	A5	Historic			Current					Low to Medium	Medium	Medium to High
	Plant 6	A6			Current	Current						Medium	Medium *
KZN	Plant 7	A7				Current						Medium to High	Medium to High *
	Plant 8	A7			Historic	Current				Current	Medium	Medium to High	Medium to High *
Northern Cape	Plant 9	A9				Current						Medium	Medium *
Free State	Plant 10	A10	Current			Future						Low to Medium	Medium to High

Province	WWTP	A1	Oxidation Pond System	Aerated	Bio-filters	Activated Sludge System	BNR System	Package Plant	Maturation Ponds	Disinfection	General Comment on Technology (Historic)	General Comment on Technology (Current)	General Comment on Technology (Future)
North West	Plant 11	A11				Current						Medium	Medium *
	Plant 12	A12			Current	Current						Medium to High	Medium to High *
Gauteng	Plant 13	A13				Current	Current					High	High *
	Plant 14	A14			Current	Current	Current					High	High *
Mpumalanga	Plant 15	A15	Current									Low to Medium	Low to Medium *
	Plant 16	A16				Current	Current					High	High *
	Plant 17	A16	Current		Current					Current		Medium	Medium *
Limpopo	Plant 18	A18				Current	Current					High	High *

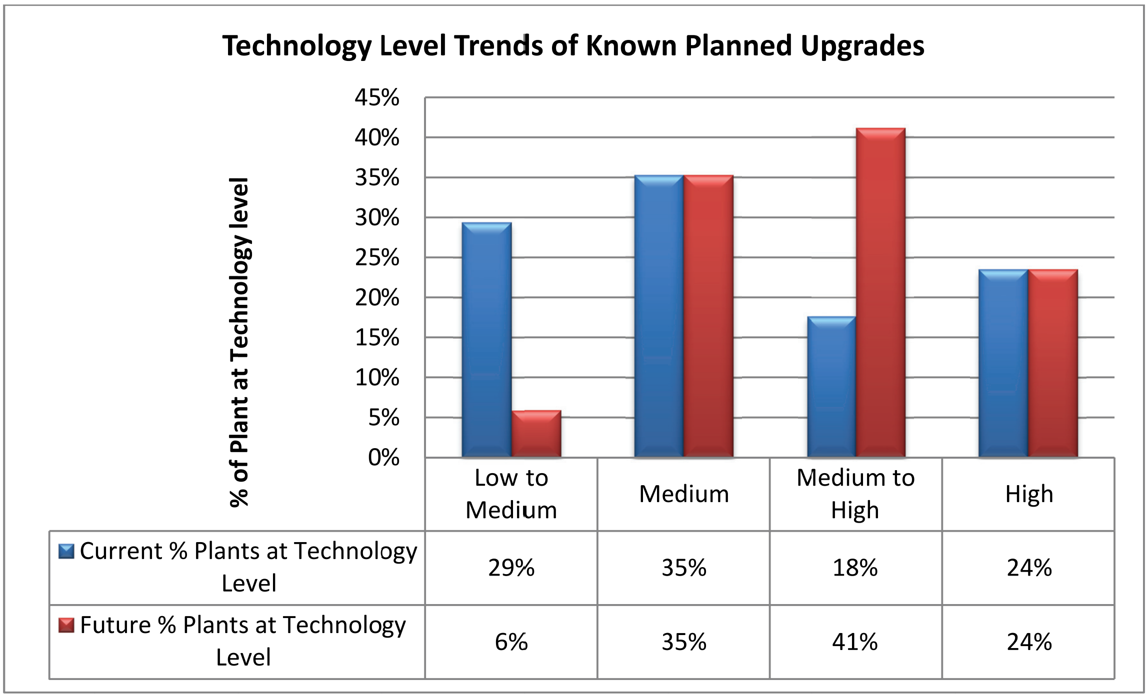
**: denotes that it is assumed that there are no immediate plans for extension or upgrade of the works, and hence the current technology option will stay the same.*

The following outcomes of the selected works from the information provided in the previous table are relevant:

- Current Scenario: Oxidation pond systems account for 39%, activated sludge plants for 61% (of which 36% include BNR) and 6% package plants.
- Future Scenario: Oxidation pond system will reduce to 17%, whilst activated sludge systems will increase to 78%.

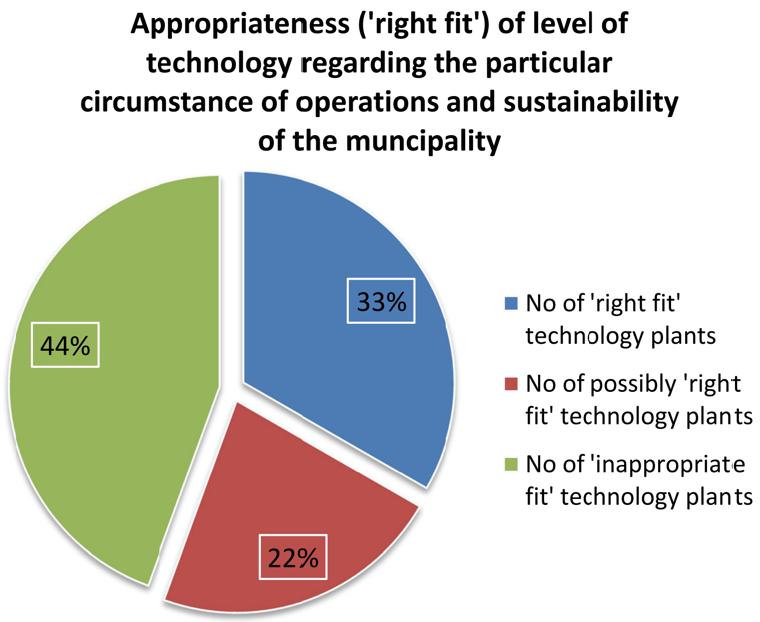
This would indicate that a more complex and potentially costly level of technology (medium) enjoys higher preference to the low to medium level technology. Although this could be ascribed to effluent treatment requiring a higher level of technology, land availability, initial cost of expansion and repairs of existing versus capital cost of new system, etc., it is observed that this is not always the situation. Often, insufficient attention is directed towards investigating sustainable low to medium level alternatives, and/or that the long term cost implication (lack of skills, cost recovery, power consumption) of the high level technology is not realised. This is concerning as sustainability of higher level technologies may not always be within reach of some of the municipalities.

Furthermore, it would appear that in terms of demand growth, the trend is not to extend the existing plant and maintain the technology level, but to upgrade to a higher technology level as shown in the graphs below. This is disconcerting as not all municipalities are necessarily equipped to sustainably manage such a change in circumstances, specifically with regard to skills and financial resource availability.



	Low to Medium	Medium	Medium to High	High
Current % Plants at Technology Level	29%	35%	18%	24%
Future % Plants at Technology Level	6%	35%	41%	24%

The table that follows indicates whether suitable technologies are employed for 1) wastewater treatment 2) sludge handling in each of the 18 test cases (15 plus 3 additional), based on the available information.



Aspects taken into account in identifying appropriateness were not only the technology level, but also aspects such as:

- Sensitivity of receiving natural resource
- Legal Requirements / license Requirements
- Capacity of municipality to operate system
- Availability of funding to construct and maintain

Table indicating whether suitable technologies are employed for 1) wastewater treatment 2) sludge handling in each of the 18 test cases

WWTP	MUNICIPALITY	Technology employed for effluent	Technology employed for sludge	Sensitivity of receiving natural resource	Legal Req / license Req	Capacity of municipality to operate system	Availability of funding to construct and maintain	General Comment on "appropriateness" of Technology (Current & Future)
Plant 1	A1	Medium	Low to Medium	Class C (Moderately modified)	General limits	Class 4 – Performing well, Financial constraints	Small Towns & Rural community – high indigents – funding constraints	**Appropriate**
Plant 2	A2	Medium to High (future)		Class C (Moderately modified)	Exemption (Historically) Special Limits (Future)	Class 4 – Performing well, some financial constraints	Small Towns & Rural community – high indigents – funding constraints	Possibly Appropriate
Plant 3	A3	Low to Medium (current), but Medium to High (future)		Class B (Largely Natural with few modifications)	General limits	Class 4 – Performing well, some financial constraints	Rural community – high indigents – funding constraints	Possibly Inappropriate
Plant 4	A4	Low to Medium (current), but Medium to High (future)	Low to Medium (current), but Medium to High (future)	Suspect Class C (Moderately modified)	Exemption (Historically)	Class 2 – Performing well financially, socio-economic constraints	Small Towns & Rural community – high indigents – funding constraints	Possibly Inappropriate

Plant 5	A5	Medium	Low to Medium	Suspect Class C (Moderately modified)	Specific Limits close to General Limits, but with IRQO	Class 4 – Performing well, some financial & operational constraints	Large town settlement	Possibly Inappropriate
Plant 6	A6	Medium to High	Low	Sea outfall	Slightly Stricter than General Limits ito Exemptions for sea Outfalls	Metro – Performing well	Urban area, little funding constraints	Possibly Appropriate
Plant 7	A7	Medium to High	Medium to High	Class B (Largely Natural with few modifications)	Fairly Similar to the General Standards for Irrigation at 2000 m^3/day	Metro – Performing well	Urban area, little funding constraints	Possibly Appropriate
Plant 8	A7	Medium	Low to Medium	suspect Class B (Largely Natural with few modifications)	General limits (assumed)	Class 3 – Performing fairly well, some financial constraints	Small Towns & Rural community – high indigents – funding constraints	**Appropriate**
Plant 9	A9	Medium	Medium	suspect Class B (Largely Natural with few modifications)	General Limits for discharges below 2 Ml/day	Class 2 – Performing weakly	Rural community – high indigents – funding constraints	Possibly Inappropriate

Plant 10	A10	Low to Medium (current), but Medium to High (future)	Medium	Suspect Class C (Moderately modified)	Unknown	Class 2 – Performing weakly	Small Towns & Rural community – high indigents – funding constraints	Possibly Inappropriate
Plant 11	A11	Medium	Low to Medium	Suspect Class C (Moderately modified)	Stricter than General Standards , IRQO	Class 4 – Performing well	Urban area, little funding constraints	Possibly Appropriate
Plant 12	A12	Medium to High	Low to Medium	Suspect Class B (Largely Natural with few modifications)	Unknown	Class 3 – Performing fairly well, definite financial constraints	Small Towns & Rural community – high indigents – funding constraints	Possibly Inappropriate
Plant 13	A13	High	Medium to High	Suspect Class C (Moderately modified)	Slightly stricter than General Standards (Vaal Barrage WQO)	Class 4 – Performing well	Urban area, little funding constraints	**Appropriate**
Plant 14	A14	High	High	Class B (Largely Natural with few modifications)	Stricter than General Standards & some aspects closer to Special Limits	Metro – Performing well	Urban area, little funding constraints	Possibly Inappropriate
Plant 15	A15	Low to Medium	Low	Suspect Class C (Moderately modified)	Exemption (Historically)	Class 4 – Performing well, some financial constraints	Large town settlement	**Appropriate**

Plant 16	A16	High	High	Suspect Class C (Moderately modified)	Closer aligned to General Limits than for Special Limits (Schedule 1 areas)	Class 3 – Performing fairly well	Urban area, little funding constraints	**Appropriate**
Plant 17	A16	Medium	Low to Medium	Suspect Class C (Moderately modified)	Closer aligned to General Limits than for Special Limits (Schedule 1 areas)	Class 3 – Performing fairly well	Urban area, little funding constraints	**Appropriate**
Plant 18	A18	High	Medium	Class B (Largely Natural with few modifications)	Close to Special Limits (Schedule 1 areas)	Class 4 – Performing well, some financial constraints	Small Towns & Rural community – high indigents – funding constraints	Possibly Inappropriate

From the information received for the various WWTP and from the literature reviewed, the following assessment observations can be made:

- Few of the supporting documents refer to or even define what alternative technology options were investigated when selecting/ deciding upon the technology choice for a WWTP and or an upgrade to the works.
- No information was provided as to cost comparisons between options and it is appears as if cost-benefit analysis are not a standard practice when informing technology options.
- Motivation/proof as to the municipality skills and resource availability to effectively and sustainably operate the WWTP and or selected technology choice, forms part of the supporting documentation. More often, it is merely (incorrectly) assumed that the municipality have or will acquire the resources (e.g. the Free State – Plant 10 case)
- When "upgrading a works" it usually would imply that a more specialist / complex technology option is selected, which often may be more costly from a capital, operational and resource perspective.
- Few municipalities prioritise green economics in their decision making process, i.e. the beneficial use of their waste products or water, other than using it for irrigation and in some cases re-used by industry (some of the best efforts found were in KZN and Western Cape).
- In terms of the licence, there would not appear to be a section where DWA comment on the appropriateness of the type of technology used or suggested by the applicant in terms of:
    - The applicant's current ability to manage their existing works and technology. (Green Drop Status is suitably positioned to assist on this aspects);
    - Other potential options or suggestions of potential investigative options more suited to the applicant's situation.
- The most fundamental parameters, when selecting the technology choices are those of flow/strength of wastewater, compliance, capital costs and land availability, insufficient attention to long term sustainability aspects such as operation and maintenance costing over the design lifespan of the infrastructure, skill/resource requirements and constraints, tariff / cost recovery and alternative cost recovery options, i.e. re-use and other green technology options such as gas, ability of community to pay, energy requirements, etc.
- From the above tables, 33% have appropriate technology in place, 22% technologies are suspect but perhaps defendable if a more extensive assessment is done, and 44% have potentially inappropriate technology in place which possibly may not be sustainable in the long term. Examples of the latter would be Plant 10 (Free State) and Plant 6 (Eastern Cape), both municipalities are struggling and little financial resource base for cost recovery, yet have chosen technology levels ranging from medium to high (future), technology potentially more appropriate to financially and skills strong municipalities.

8 CONCLUSIONS

From the high level assessment results, it would appear that licence applications are strongly driven by support consultants in the case of smaller/low-capacity municipalities. It is apparent that in a number of cases, the project decision is driven from the consultant and is not always the product of a joint investigative team of municipal officers and consultants that undertake the technology choice investigations. In some cases, such investigations are not done at all. A number of possible reasons can be suggested:

- technically qualified and competent municipal officials are overcommitted, specifically considering the real extent and impact of all the various local government functions undertaken by municipalities,
- municipal officials are not sufficiently conversant or experienced to engage with their consulting engineers on the critical issues,
- pre-set concepts may be held by either the official and or the consultant as to technological choices with which they are familiar and prefer, although these may not necessarily be the most viable choice,
- such investigations are time consuming and costly and often there is not adequate budget,
- DWA does not provide sufficient guidance via its licensing process to guide and ensure that appropriate technology options are taken. Some municipal officials express concern that the same technical capacity constraints evident in municipalities may also prevail in DWA, thereby compounding the problem,
- key aspects / parameters (that would ensure sustainability in long term) such as energy and receiving natural resource vulnerability and climate change (floods, droughts) and agricultural value of sludge and effluent) are not considered at all. The main attention is given to baseline engineering decision drivers such as flow, growth, strength, population size.... whilst neglecting the longer term drivers,
- sufficient guidance is not available in the SA water sector to guide municipalities as to the options available and their applications under varying circumstances.

Although not stated directly in any of the documents, it is suspected that socio-environmental requirements, as reflected by the licence limits, place municipalities in situations where they are under pressure to select technological options which are not financially or operationally sustainable. It is not clear what resolutions or remedies are available in the event where a municipality is wholly unable to achieve compliance and sustainability, as most support facilities relate to capital grants, etc., but not ongoing physical and financial support.

It is encouraging to see the role of the Regulatory shaping much more prominently in addressing the more urgent cases of non-compliers. It is further encouraging to note the impact of the Green Drop incentive based regulation to raise awareness and encourage planning towards sustainable technology choices in order to meet compliance objectives. However, the Green Drop criteria are as yet not suitably structured to address this particular issue.

It is also encouraging to see Win-SA initiatives to identify and document good practices in wastewater treatment with bold discussion of the same issues addressed in this report (e.g. Bitou and Tlokwe examples).

It is understood that what is often perceived as being the more simplistic technology options (i.e. ponds, etc.), also require substantial space / land and that such options may thus not be realistic in an urban environment where land is at a premium. However in many of the rural areas, with smaller and often more vulnerable municipalities, space/land is more readily available, making such technologies potentially more viable and sustainable.

It is understood that the green technology options are not fully investigated or utilised as they are still being viewed with scepticism, often due to a lack of current knowledge. Linked to this is the fact that this concept is considered to be unknown/unreliable/ untested and require more development and application on municipal ground. This uncertainty is often strengthened by the fact that green technologies are applied without fully understanding or considering the factors that affect their suitability, as green solutions are not always suitable for all situations.

In February 2003, DWA brought out a guideline document, being: "Aide Mémoire For The Preparation Of A Water Quality Management Report To Support The Application For Licences For Sewage Treatment Works In Terms Of The Requirements Of The National Water Act, 1998 (Act 36 of 1998), to assist licence applicants in completing and providing a comprehensive water quality management report with their licence application. The guide is very comprehensive, but focuses mainly on the situation where the applicant has already decided on a technology choice. Some of the support documentation made limited reference to the use of the aide memoire, however, the extent to which these guidelines are followed by municipalities is uncertain. The guideline does not comment on the need to provide a motivation as to which options were investigated and why the final selection was made in the event of new works or upgraded works.

Although there appear to be a plethora of research into the field of wastewater treatment and specific technology options, there would not appear to be a readily accessible manner in which municipalities and/or consultants, specifically in South Africa, can by means of a multi-criteria selection basis access a model which can assist in them in their initial identification of potentially appropriate technological options. Such a model would assist in identifying which technologies need further feasibility investigation. Once done the feasibilities can then be compared to identify which technology would be the most appropriate in terms of the legislative, environmental, financial and operational management and sustainability requirements and resources.

A further positive development would be the development of standards and specifications for technologies that can be used by municipalities to spec and scope their projects with improved confidence.

It needs to be stated that the comment above does not discount existing guideline documents such as "The South African Oxidation And Disinfection Manual" (WRC Report TT 406/09 - July 2009) and similar others, which assists the reader in making a logical selection in matching the water treatment challenges with appropriate treatment processes and technology. Such manuals are the first steps in providing effective assistance. If such a guideline were to be developed into a computer based package, it may provide a more accessible mechanism.

9 RECOMMENDATIONS

A number of the conclusions do not necessarily allow for implementable recommendations, for example:

- How to ensure that it is a joint investigative team of municipal officers and consultants who undertake technology choice investigations.
- How to effectively expose municipal officials and consultants to alternative/green technology and solicit buy-in.
- How to ensure that effective and sustainable options are included in the feasibility studies on a comparative base which considers the full host of 'technology drivers' (Ref: listed as part of the assessment framework).

There are however some generic and specific recommendations that can be made in relation to the central roles played by the various sector partners:

- Department of Water Affairs' role as regulator is vital a way forward if the sector is to take responsible decisions pertaining to technology choices:
    - The licensing process is currently reactive whereas it need to be proactive in the decision making process

- The consultation process prior to the technology decision making process does not provide sufficient guidance as to the expected effluent quality objectives or the river water quality objectives
  - As result, decisions are taken in the absence of one decisive factor – effluent quality compliance objectives
  - Quality control in terms of the content of water use licenses is crucial, as many licenses are issued with unreasonable or irrational requirements
  - As part of the licence appraisal process, there may be a potential for DWA to provide initial feedback on their perception of the appropriateness of the selected technology and where necessary and possible provide alternative options to be investigated, prior to the granting of the licence.
- Department of Environmental Affairs role in the application of Waste License (National Environmental Management: Waste Act No. 59 of 2008) is also relevant, and close coordination with DWA is required to ensure that municipalities understand the different roles and requirement of the national departments.
- SALGA as an institute dedicated to advising municipalities and representing their best interests, has a key role to play in:
  - Consulting with municipalities on the findings and concerns raised in this report and ensure that they apply care and method when making technology choices
  - Consult with DWA to address concerns regarding the i) requirements as contained in licenses and ii) the regulation thereof.
  - Confer with the relevant Professional Bodies to ensure that the apparent tendency (by some consulting members) to recommend technologies not fitting to the municipal client's circumstances is addressed.
- Financial institutions (including National Treasury) have a crucial role to play to ensure that:
  - Applications consist of relevant proof that technology alternatives have been evaluated in the context of affordability and sustainability, with clear rational why they were discarded
  - Comment and calculations on the municipality's ability to sustainably operate and maintain the selected technology
  - Cost recovery options investigated and decided upon (linked to tariffs)
  - Mechanisms may need to be created (including DWA & Local Government – MIG) to assist and allow for municipalities in undertaking more detailed type of feasibility studies, as it is suspected that current grant funding for this component would be inadequate.
  - A way forward needs to be investigated for the situations where a municipality is unable to comply with a required high technology level due to financial and skills resourcing. Possibilities could include ongoing grant systems, which will need to be motivated on an ongoing basis and review on a regular basis – this is however open to abuse and deepens the dependency syndrome.
- Professional bodies have a vital role to play to ensure that vulnerable municipalities are not disadvantaged by support providers who do not comprehend the fragile longer term situation of local government:
  - More robust mechanisms would be the use of performance based PSPs arrangements, whereby assistance is rendered to the municipality to management the contract and to build capacity via this arrangement.

- Knowledge transfer and research institutions carry a very specific role and mandate, i.e.:
    - Mechanisms need to be investigated to facilitate the effective expose of municipal officials and consultants to alternative/green technologies. The current development of ISO standards for reuse and reclamation of effluents will elevate these aspects and improve awareness.
    - Development of a computer based model / programme, which will allow for multi-criteria to be populated to assist users in making a logical selection in matching the water treatment challenges with appropriate treatment processes and technology.

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APPENDIX: A

List of selected Licence/ Licence application, based on DWA database October 2010

Province	No of licences to be selected	WWTP	REGION	MUNICIPALITY	TYPE OF AUTHORISATION	LICENCE/PERMIT NO.	DATE EXPIRED	DESIGN CAPACITY (Ml/day)	OPERATIONAL CAPACITY (Ml/day)	CLASS OF WORKS	IMPACT ON WATER RESOURCES	Type of discharge	WATER MANAGEMENT AREA	TYPE OF AUTHORISATION REQUIRED / COMMENTS	River Classification WSAM: Present Ecological State (on the PESC straight mean of imp score)
Western Cape	2	Plant 1	Western Cape	A1	P	987B		3	2.5	C	Irrigation	ir	Olifants/ Doorn	License pending	Unable to determine, from information provided
		Plant 2	Western Cape	A2	P	1685B	31/08/2001	0.701	0.39	E	Irrigation	ir	Olifants/ Doorn	License application in process. Upgraded to WWTP's	Unable to determine, from information provided
		Plant 3	Western Cape	A3				0.156		C	Groot River	r	Fish to Tsitsikamma	Exemption	
Eastern Cape	2	Plant 4	Eastern Cape	A4	Exemption	495B		0.5	Unknown	E	No discharge	e	Fish to Tsitsikamma	According to Green Drop process documentation has been submitted, but this information has not been confirmed	Unknown – suspect Class C
		Plant 5	Eastern Cape	A5	None			2.5	1.8	D	Botha's River	r	Fish to Tsitsikamma	Applied during 2008	Unable to determine, from information provided

KZN	2	Plant 6	KwaZulu-Natal	A6	Exemption	1747B; (21030402/1 – WU reg. no.)	22/10/2002	230	193.58	B	Indian Ocean (sea outfall)	o	Mvoti-Umzimkulu	License being processed – awaiting additional info. from client	Unable to determine, from information provided
		Plant 7	KwaZulu-Natal	A6	None	21030448/1 WU reg. no.		10 (13)	6.02	B	Umdloti River	r	Mvoti-Umzimkulu	License application submitted November 2003	CLASS C
Northern Cape	1	Plant 8	Northern Cape	A8	None			4	1.25	C	Vlei	v	Lower Vaal	License application has been submitted to DWA	Unknown – suspect Class B
Free State	1	Plant 9	Free State	A9	None			Unknown	Unknown	B	Unknown		Upper Orange	License application received	Unknown – suspect Class B
		Plant 10	Free State	A10				1.2		C			Lower Vaal		Unknown
North West	2	Plant 11	North West	A11	Exemption	2126B	01/06/2004	8	7.9	C	Hex River	r	Crocodile West	IWUL application at HO	Suspect Class C
		Plant 12	North West	A12	None /P	286B		3.585	3.585	D	Portion sold to Khumba and rest to Rooikuilspruit	re & r	Crocodile West and Marico	IWUL	Unable to determine, from information provided
Gauteng	2	Plant 13	Gauteng	A13	L	20030182	10/2005	24	13	A	Vaal River	r	Upper Vaal	WULA (2005) Draft license – awaiting info from applicant	Unable to determine, from information provided
		Plant 14	Gauteng-North	A14	Exemption	1961B		45	55	A	Hennops River	r	Crocodile-Marico	License application at HO	CLASS B

Mpumalanga	3	Plant 15	Mpumalanga	A15	None			1.5	1	E	No discharge	e	Olifants	Licensing in process	Unable to determine, from information provided
		Plant 16	Mpumalanga	A16	L	24009662	20/05/2030	1.1	0.8	D	Gladdespruit	r	Inkomati	Issued 20/05/2010 at Letsema	Unable to determine, from information provided
		Plant 17	Mpumalanga	A16	L	2.4E+08	25/08/2029	12	5.3	C	Crocodile River	r	Inkomati	Issued 25/08/2009	Unable to determine, from information provided
Limpopo	1	Plant 18	Limpopo	A18	L	27086965	25/08/2029	3	1.75	C	Irrigation	ir	Limpopo	Issued on 25/08/2009	Unable to determine, from information provided

APPENDIX: B

A critical factor is identifying the type and level of technology being used and or envisaged for future use. Due to the numerous types of technology options available and in order to gain some comparative perspective, a simplistic comparative table was generated for the various types of treatment technologies. The table includes the various technology types for the different levels of treatment, i.e. Preliminary, Primary, Secondary, Tertiary and Sludge treatment with comments as to their expected effluent quality results, as well as comparative comments regarding the level of capital cost, operational cost, power consumption, level of technology and maintenance required. These individual aspects were identified as being "low", "medium" or "high" and which were the summated for each specific section.

This table is by no means considered to fully comprehensive, but developed mainly to assist in the comparative analysis of the selected applications for this study. The table indicate typical effluent quality expected with various treatment technologies.

Technology type	Expected Result	Comment about suitability / application of technology	Summative / General Comment on Technology
PRELIMINARY TREATMENT			
Screens	Removal of screenings. Hand raked screens: Small sized works.	**1. Hand raked screen** Low capital cost. Low operational cost. No power consumption. Low level technology. Low maintenance reqd. 25 mm bar spacing. < 4 ML/d treatment works.	**Low**
	Mechanical screens: Medium to large sized works.	**2. Mechanical screen** Medium capital cost. Low operational cost. Low power consumption. Medium level technology. Medium maintenance reqd. 12 mm bar spacing. Single bank. >= 4 ML/d.	**Low to medium**
Degritting	Removal of grit Manually cleaned	**1. Manually cleaned channel** Low capital cost.	

	channels: Small sized works Vortex degritters: Medium to large sized works.	Low operational cost. No power consumption. Low level technology. Low maintenance. < 10 ML/d treatment works. **2. Vortex degritter** Medium capital cost. Low operational cost. Medium power consumption. High level technology. Medium maintenance reqd. >= 10 ML/d.	**Low** **Medium**
PRIMARY TREATMENT			
Primary settling	Separation of solid and liquid fractions. Reduction of TSS and COD. Biofilter and activated sludge works	Medium capital cost. Low operational cost. Low power consumption. Circular tank preferred. Medium level technology. Low maintenance reqd.	Low to Medium
Flow balancing	Flow and load equalization Activated sludge works	Medium capital cost. Low operational cost. Low power consumption. Medium level technology. Low maintenance reqd.	Low to Medium
SECONDARY TREATMENT			
Trickling filters	General Limits** *(Appendix C)* Rural areas and for producing effluents of General Limits.	Medium capital cost. Low operational cost. Low power consumption. Medium level technology. High effluent nitrate and phosphate.	Low to Medium

Rotating biological filters	General Limits Limited to package plants	Medium capital cost. Medium operational cost. Medium power consumption. Medium level technology. High effluent nitrate and phosphate.	Medium
Pasveer ditch	General Limits Medium sized works producing effluent for General limits	Medium capital cost. Medium operational cost. Medium power consumption. Medium level technology. High effluent nitrate and phosphate.	Medium
Oxidation ponds	General Limits Small to Medium sized works producing effluent for General Limits	Medium capital cost. Medium operational cost. Low power consumption. Medium level technology. High effluent nitrate and phosphate.	Low to Medium
Wetlands	General Limits Small sized works producing effluent for General Limits	Medium capital cost. Low operational cost. No power consumption. Medium level technology. High effluent nitrate and phosphate.	Low to Medium
Extended aeration	General Limits Medium sized works producing effluent for General Limits	High capital cost. High operational cost. High power consumption. Medium level technology. High effluent nitrate and phosphate.	Medium to High
Biological nutrient removal / Activated Sludge	Special Limits** *(Appendix D)* Only for skilled labour	High capital cost. High operational cost. High power consumption.	

	force and effluent compliant with Special limits.	High level technology.	High
AERATION			
Surface aeration	Satisfy oxygen demand	High installation cost. High operational cost. High power consumption. Medium maintenance cost. Medium oxygen transfer rate.	Medium to High
Fine bubble aeration	Satisfy oxygen demand	High installation cost. Medium operational cost. Medium power consumption. High maintenance cost. High oxygen transfer rate. Spare treatment capacity reqd.	Medium to High
Jet aeration	Only for very small treatment works. Not recommended.	High installation cost. Medium operational cost. Medium power consumption. Medium maintenance cost. Low oxygen transfer rate.	Medium to High
Coarse bubble aeration	Satisfy oxygen demand Not recommended.	High installation cost. Medium operational cost. Medium power consumption. High maintenance cost. Medium oxygen transfer rate. Spare treatment capacity reqd.	Medium to High
Sludge fermentation	Special Limits Required for BNR process	Medium capital cost. Medium operational cost. Low power consumption. High level technology. Medium maintenance reqd.	Medium to High

Clarification	Final separation of solid from liquid phase before wasting or recycling.	Medium capital cost. Low operational cost. Low power consumption. Circular tank. Medium level technology. Low maintenance reqd.	Low to Medium
TERTIARY TREATMENT			
Chlorine gas disinfection	Low *E. Coli* but high residual chlorine	Medium capital cost. High operational cost. Low power consumption. Medium level technology. Medium maintenance reqd.	Medium
Calcium or Sodium hypochloride	Low *E. Coli* – short shelf life	Low capital cost. Medium operational cost. Low power consumption. Medium level technology. Medium maintenance reqd.	Low to Medium
Ozonation	Low *E. Coli*	High capital cost. High operational cost. Medium power consumption. High level technology. High maintenance reqd.	High
Ultra-violet	Low *E. Coli*	High capital cost. High operational cost. Medium power consumption. High level technology. High maintenance reqd.	High
Chlorine dioxide	Low *E. Coli* – produced on site.	Medium capital cost. High operational cost. Medium power consumption. High level technology. High maintenance reqd.	Medium to High

Maturation pond	Low *E. Coli* Recommended where land is available.	Medium capital cost. Low operational cost. No power consumption. Low level technology. Low maintenance reqd.	Low
Chlorine / ammonium bromide	Low *E. Coli* – difficult to control mixture Not recommended	Medium capital cost. High operational cost. Low power consumption. Medium level technology. High maintenance reqd.	Medium to High
Membranes, nano technologies, etc. for drinking water (Namibia, etc.)	Advanced technologies that could improve the quality of treated effluent to drinking water standard or any standard required.	High capital and operational cost. High skills requirements.	High
SLUDGE TREATMENT			
Gravity Thickening	Reduce water content of sludge.	High capital cost. Medium operational cost. Medium power consumption. Medium level technology. Medium maintenance reqd.	Medium
Thickening by dissolved air flotation	Reduce water content of sludge.	High capital cost. Medium operational cost. High power consumption. Medium level technology. High maintenance reqd.	Medium to High
Lime stabilisation of sludge	Sludge stabilization – remove odour and fly breeding potential. Disposal only on soils with low pH.	Medium capital cost. Medium operational cost. Medium power consumption. Low level technology. Medium maintenance reqd.	Medium

		High chemical consumption. (pH > 12 reqd)	
Aerobic digestion	Sludge stabilization – remove odour and fly breeding potential.	High capital cost. High operational cost. High power consumption. Medium level technology. High maintenance reqd.	Medium to High
Anaerobic digestion	Sludge stabilization – remove odour and fly breeding potential. **Produces biogas for energy production.**	High capital cost. Medium operational cost. Medium power consumption. Medium level technology. High maintenance reqd.	Medium
Belt press dewatering	Reduce volume of sludge to be disposed.	High capital cost. Medium operational cost. Low power consumption. Medium level technology. Medium maintenance reqd.	Medium
Solar drying beds	Reduce volume of sludge to be disposed	High capital cost. Low operational cost. Low power consumption. Low level technology. Low maintenance reqd.	Low
Centrifuge dewatering	Reduce volume of sludge to be disposed	High capital cost. High operational cost. Medium power consumption. Medium level technology. High maintenance reqd.	Medium to High
Plate filter press dewatering	Reduce volume of sludge to be disposed	High capital cost. High operational cost. Medium power consumption. Medium level technology.	Medium to High

		High maintenance reqd.	
Thermal drying (heat)	Reduce volume of sludge to be disposed	High capital cost. High operational cost. High power consumption. High level technology. High maintenance reqd.	High
Composting	Increase stabilisation of sludge. Enhances beneficial use.	Medium capital cost. Medium operational cost. Low power consumption. Low level technology. Medium maintenance reqd.	Low to Medium
Thermo-chemical treatment	Increase stabilisation of sludge. Enhances beneficial use.	Medium capital cost. Medium operational cost. Low power consumption. Medium level technology. Medium maintenance reqd, depending on chemical requirements	Medium
Pelletisation	Increase stabilisation of sludge. Enhances beneficial use.	High capital cost. High operational cost. High power consumption. High level technology. Medium maintenance reqd.	High
Disposal by land application (agriculture)	Beneficial use – compliance with 2006 sludge guidelines.	Low capital cost. High cost of transport. Low operational cost. No power consumption. Low level technology. No maintenance reqd.	Low
Marine outfall/treatment* **	Vary from region to region and different standards for deep sea and for surfer zone.	Pipe and pumping cost Relaxed treatment requirements and cost Increased attention from	

		environmental perspective, ministerial focus point	Low to Medium
Lagoons	Poor method of sludge storage – not considered as disposal option but only temporary solution. Not recommended	High capital cost – lining dam. Low operational cost. No power consumption. Low level technology. No maintenance reqd. High cost to empty	Low to Medium
Incineration	Reduce volume of sludge to be disposed – no beneficial use of final product. Air pollution problem. Not recommended	High capital cost. High operational cost. High consumption. High level technology. High maintenance reqd.	High

APPENDIX: C

Following on from identifying the technology options of the WWTP was to identify some of the environmental aspects relevant to the plant in terms of: location of (name of river) and manner of effluent discharged (e.g. river, irrigation, other) and which water management area the plant falls within. This information together with the existing DWA information base identifying the Present Ecological State and Condition (PESC), will assist in gaining an understanding of the potential vulnerability of the receiving environment. Through the Present Ecological State and Condition (PESC) the various catchments are represented by 6 categories, based on how effected the catchment is by development, these are.

Category /Classification	Description
F = Present Ecological State and Condition (PESC)	
Class A (Near natural)	Unmodified, natural.
Class B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
Class C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
Class D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
Class E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
Class F (Critically modified)	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

APPENDIX: D

Part of this investigation include being aware of the situation of the municipality in terms of overall skills and ability. To assist in obtaining such an insight, use was made of the CoGTA spatial analysis framework (2010).

The Local Government Turn-Around Strategy (TAS): Municipal Guidelines (January 2010) indicated that the 2009 State of Local Government Report has informed the Department of Cooperative Governance and Traditional Affairs (CoGTA) of issues that have a negative impact on local government. In their approach for the development of a municipal turn-around strategy CoGTA has devised a methodology to determine the critical intervention areas in municipalities for national and provincial support: Support must be prioritised in areas where it is most needed. The main building block of the approach for the National TAS is also the key principle of the guideline; the principle of a differentiated approach. The CoGTA spatial analysis framework of the municipalities in this guideline provides a basic insight into the aspects such as:

- Municipal size,
- Social-economic vulnerability,
- National Treasury (NT) classification,
- Audit outcomes, and
- The extent to which the municipality is undertaking all of their possible local government functions (as a %).

This information can be used for the purpose of this study to provide a basic indication of the potential of a municipality with regard to undertaking, operating and maintaining complex technological options in terms of WWTP. As the % of municipal function undertaken does not indicate which functions are undertaken, one of the criteria of the 18 selected WWTPs was that the municipality is the responsible WSA which may undertake the WSP function directly or outsource it. The manner in which the analysis will be is used for example as follows:

- Municipality A is a large municipality (Metro / Class A) performing well in terms of socio-economic vulnerability (Class 4) and a high NT classification and a positive audit outcome (unqualified) undertaking a high percentage of municipal functions
- Municipality B is a small municipality (Class C) performing poorly in terms of socio-economic vulnerability (Class 1) and a low NT classification and a negative audit outcome (qualified/ outstanding) undertaking a low percentage of municipal functions.

From the above one could conclude that Mun A should be able to select and effectively utilise a much higher/complex technological option as compared to Mun B, who may either not have the finances and skills to undertake or manage a highly complex technological option. Very strict licence limits, requiring a complex technology, could place such a vulnerable municipality in dire straits and will in all probability lead to failures unless alternative measures are put in place, i.e. guidance regarding a simpler technological options (if possible), relaxation in quality limits (if possible) and or direct ongoing support or assistance.

Municipality	Category A, B1,B2,B3,B4 and C1 and C2	COGTA Research (socio-economic vulnerability) Class 1-4 Class 1 least performing	NT Capacity Classification (High Medium Low)	Audit Outcomes	MDB % of functions
A14	A		H	Qualified	
A7	A		H	Unqualified	
A13	B1	4	H	Disclaimer	73.68
A11	B1	4	H	Qualified	71.05
A16	B1	3	H	Qualified	44.74
A15	B2	4	M	Outstanding	47.37
A2	B3	4	M	Unqualified	78.95
A18	B3	4	M	Outstanding	52.63
A1	B3	4	L	Qualified	42.11
A9	B3	3	M	Disclaimer	65.79
A12	B3	3	L	Disclaimer	39.47
A10	B3	2	M	Outstanding	60.53
A3	C1	4	M	Unqualified	68.42
A6	C1	2	L	Disclaimer	7.89
A4	C2	2	H	Qualified	21.05

APPENDIX D:

General Authorisations in terms of Section 39 of the National Water Act

3. Discharge of waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit; and disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process

3.7 Discharging of domestic and industrial wastewater into water resources

1) A person who--

   i) owns or lawfully occupies property registered in the Deeds Office as at the date of this notice; or

   ii) lawfully occupies or uses land that is not registered or surveyed,

   outside of the areas as excluded in paragraph 3.4 above, may on that property or land--

   a) discharge up to 2 000 cubic meters of wastewater on any given day into a water resource that is not a listed water resource referred to in Table 3.4, provided--

      i) the discharge complies with the General Limit Values set out in Table 3.2;

      ii) the discharge does not alter the natural ambient water temperature of the receiving water resource by more than 3 degrees Celsius; and

      iii) the discharge is not a Complex Industrial Wastewater.

   b) discharge up to 2 000 cubic meters of wastewater on any given day into listed water resource referred to in Table 3.4, provided--

      i) the discharge complies with the Special Limit Values set out in Table 3.2;

      ii) the discharge does not alter the natural ambient water temperature of the receiving water resource by more than 2 degrees Celsius; and

      iii) the discharge is not a Complex Industrial Wastewater.

2) A person may discharge stormwater runoff from any premises, not containing waste or wastewater emanating from industrial activities and premises, into a water resource.

Table Wastewater limit values applicable to discharge of wastewater into a water resource

SUBSTANCE/PARAMETER	GENERAL LIMIT	SPECIAL LIMIT
Feacal Coliforms (per 100 ml)	1 000	0
Chemical Oxygen Demand (mg/l)	75 *	30 *
pH	5,5-9,5	5,5-7,5

Ammonia (ionised and un-ionised) as Nitrogen (mg/l)	3	2
Nitrate/Nitrite as Nitrogen (mg/l)	15	1,5
Chlorine as Free Chlorine (mg/l)	0,25	0
Suspended Solids (mg/l)	25	10
Electrical Conductivity (mS/m)	70 mS/m above intake to a maximum of 150 mS/m	50 mS/m above background receiving water, to a maximum of 100 mS/m
Ortho-Phosphate as phosphorous (mg/l)	10	1 (median) and 2,5 (maximum)
Fluoride (mg/l)	1	1
Soap, oil or grease (mg/l)	2,5	0
Dissolved Arsenic (mg/l)	0,02	0,01
Dissolved Cadmium (mg/l)	0,005	0,001
Dissolved Chromium (Vi) (mg/l)	0,05	0,02
Dissolved Copper (mg/l)	0,01	0,002
Dissolved Cyanide (mg/l)	0,02	0,01
Dissolved Iron (mg/l)	0,3	0,3
Dissolved Lead (mg/l)	0,01	0,006
Dissolved Manganese (mg/l)	0,1	0,1
Mercury and its compounds (mg/l)	0,005	0,001
Dissolved Selenium (mg/l)	0,02	0,02
Dissolved Zinc (mg/l)	0,1	0,04
Boron (mg/l)	1	0,5

** After removal of algae*

APPENDIX: E

Effluent Quality Limits in Exemption permits for sea outfall

Determinant/ Parameter	Limit
Arsenic as As	5.0 mg/l
Cadmium as Cd	1.5 mg/l
Chromium as Cr	3.0 mg/l
Copper as Cu	3.0 mg/l
Mercury as Hg	0.05 mg/l
Nickel as Ni	10.0 mg/l
Lead as Pb	5.0 mg/l
Zinc as Zn	10.0 mg/l
Cyanide as Cn	5.0 mg/l
Sulphides as S	20.0 mg/l
DDT and Derivates	0.5 ug/l
pH	5,5-9.5
Pesticide residue	< 0.01 ug/l
Soap, oil and grease	2.5 mg/l
Oxygen absorbed	
Suspended solids	25 mg/l
Chemical Oxygen Demand	75 mg/l
Electrical conductivity	75 mS/m above intake
Free and saline ammonia	3 mg/l