WASTE STABILISATION PONDS MANAGEMENT, OPERATIONS AND MAINTENANCE TOOLS

U. Jack[+], P. de Souza[+], G. Mackintosh[+] and H. Snyman*

[+]Emanti Management (Pty) Ltd, P.O. Box 1264, Stellenbosch, 7599, South Africa
(E-mail: *unathij@emanti.co.za; philipds@emanti.co.za; grantm@emanti.co.za*)
* Water Research Commission, Private Bag X 3, Gezina, 0031, South Africa
(E-mail: *heidis@wrc.org.za*)

Abstract An investigation of the current status of municipal waste stabilisation pond systems in South Africa was undertaken. The main purpose of the study was to determine the major risk factors and provide the local government (i.e. municipalities) with a risk assessment tool for waste stabilisation pond systems and practical guidelines for management, operations and maintenance. The tool would be used to evaluate the current status of the waste stabilisation pond systems to have base line information clearly indicating where actions should be taken. This will also contribute to environmental sustainability by ensuring that strategic environmental issues associated with wastewater treatment systems are identified and that potential strategies for impact minimisation and prevention are implemented. This paper provides a tool and guidelines developed from issues identified and field experiences. These tools must be seen as an evaluation to ensure good management, maintenance and operation of waste stabilisation pond systems to promote a sustainable environment.
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BACKGROUND

Waste stabilisation pond systems comprise a series of ponds, all of which are relatively shallow bodies of wastewater contained in an earthen basin. Waste stabilisation ponds are used extensively for treatment of domestic wastewater and mixtures of industrial and domestic wastewater where amenable to biological treatment by natural processes involving the use of algae and bacteria (Metcalf and Eddy, 1991).

Waste stabilisation ponds have some critical advantages compared to other forms of wastewater treatment include the following (Mara, 1976; Environmental Protection Agency (EPA), 2002; Mara, 2005; Ramadan and Ponce, 2005):

- Ponds can achieve the required degree of purification at lowest cost and with minimum maintenance by unskilled process controllers.
- The removal of pathogens is considerably greater.
- They are well able to withstand both organic and hydraulic shock loads
- They can effectively treat a wide variety of industrial and agricultural wastes.
- They can easily be designed so that the degree of treatment is readily altered.
- The method of construction is such that, should at some future date the land be required for some other purpose, it is easily reclaimed.

Disadvantages of waste stabilisation ponds include the following: (EPA, 2002; Mara, 2005; Ramadan and Ponce, 2005):

- The need to clean out accumulated solids
- May produce undesirable odours
- The inability of the ponds to remove small-sized particles.

- They require a large piece of land

Design, Operation and Performance, Maintenance, Safety and Final effluent quality are the key success areas mentioned by many authors (Marais, 1966; Metcalf and Eddy, 1991; WISA, 2002; Mara, 2005) in the literature to be of important consideration in dealing with pond systems:

Inadequate and ineffective management of drinking water and wastewater treatment systems can contribute to water quality deterioration. The negative impact of providing sanitation services without adequate wastewater treatment on nearby water resources can not be ignored. A large number of waste stabilisation ponds exist across South Africa, and are popular as they are meant to be low maintenance with zero discharge. However, the perception exists that low maintenance constitutes no attention and for this reason the monitoring, maintenance and management of waste stabilisation ponds is very poor and unfortunately many have deteriorated. Department of Water Affairs and Forestry (DWAF) in the Free State province in SA initiated a risk management based tool for managing the status of waste stabilisation ponds in their region. Subsequent to that Water Research Commission (WRC) extended the project to other regions with the purpose of developing guidelines for management, operations and maintenance personnel. This paper shows how the management, operations and maintenance tools could make significant difference to practical performance at a local government level.

The studies were conducted after an indication that problems exist within pond systems including:

- Complaints relating to the failure and/or poor condition of waste stabilisation ponds;
- Indications of intent to take legal action against local authorities because of the poor conditions that exist at pond systems and the associated environmental and health impacts; and,
- Insufficient information regarding the operational status of waste stabilisation ponds, and the effectiveness of the management thereof by local municipalities.

The main objectives of the study were to:

- Determine and document the current status of waste stabilisation ponds in South Africa in three provinces (i.e. Free State, Northern Cape and Eastern Cape);
- Develop a simple strategic decision support tool to guide interventions as may be required; and,
- Develop a guideline document highlighting required operation and maintenance procedures for waste stabilisation pond systems (where the waste stabilisation pond is the main treatment process), common issues of concern, best practice techniques, criteria for selection of treated effluent for reuse purposes and criteria for selection of alternative technologies (if applicable).

Experiences gained and best practices guidelines from the study are presented in this paper. This paper is aimed at providing information about the outputs of the study that should assist water services authorities in developing countries to effectively manage waste stabilisation pond systems.

APPROACH

The following aspects would provide guidance to evaluate and optimize waste stabilisation pond systems. For developing countries the following are recommended for waste stabilisation pond systems (Golder Associates Africa and Zitholele Consulting, 2006):

- Community size and discharge standards - i.e. there are < 10 000 people and the final effluent discharged meets the country's discharge standards.
- Land availability - i.e. there is 30 000 m^2 area of land available and potential to groundwater contamination is minimal
- Operational support and resources - i.e. access to operations and maintenance personnel is limited and there are no trained personnel for process control
- Maintenance support and resources - i.e. access to electrical and maintenance people is minimal and/or the area is rural therefore supply of electricity is limited.
- Existing treatment infrastructure - i.e. where waste stabilisation ponds already exist, upgrading options could include constructing more pond basins and/or wetlands, integrating ponds with trickling filter system or activated sludge system.

The aspects presented above were used to develop WRC guideline documents (2008): Guide for Management of waste stabilisation ponds and Guide for Operations and Maintenance of waste stabilisation ponds.

METHODOLOGY

In order to identify and highlight the operating and maintenance conditions of these pond systems with identification of issues of concern and best practice techniques it was deemed necessary to interact with the people responsible in the three provinces. People at the management positions were targeted for the interactions followed by site visits. The field observations were loaded onto the waste stabilisation ponds risk profiling tool presented in the section below.

GPS co-ordinates, layout of the system and all observations were noted from each site. The systems that discharge to the environment were monitored. Reports indicating all issues identified on-site were sent and communicated with the people interviewed. On the second year of the project, waste stabilisation ponds in the Free State province were assessed again to identify if there are any improvements.

KEY ELEMENTS AND RESULTS

Management interviews

The interviews were conducted using the following categories:

- Source of influent
- Operations and maintenance of the system
- Public safety
- Supervision and Management of the system
- Final effluent monitoring (where necessary)
- Staff requirements

In terms of management interviews, similar situations occur in the three provinces. Considering the findings from the interactions, the following key issues are noted:

- Lack of design records and information about the existing pond systems may lead to poor planning and management of pond systems. WISA (2002) states that problems have been experienced in cases where incomplete information was gathered when the ponds were designed. The issue result in improper planning and therefore poor operation of the pond system.

- Guidelines as to how to maintain the pond systems are not made available to the maintenance staff. Logbooks to keep records on-site are not made available by the management to the maintenance staff. Therefore management does not become aware of issues on time to take corrective measures. Many authors including (Mara, 2005; Ramadan and Ponce, 2005; Qasm, 1998) have indicated that though waste stabilisation ponds are easily operated, maintenance remains an issue resulting in nuisance conditions. Poor communication between the operational staff and the superiors has been mentioned by Mara, 2005.
- Some pond systems are not surrounded by a fence and/or gates are not kept closed. In most cases warning notices in English and appropriate local language(s) are not attached to the fence. For security reasons, the community has to be made aware of safety around the pond systems.
- Process controllers were observed as on the whole being very poorly resourced in terms of operational equipment and the necessary protective clothing etc.
- It was identified that the final effluent of the ponds that are discharging to the environment is not monitored in most of these systems to verify if they comply with the general authorisation related to discharge standards. Mara (2005) states that monitoring reveals that the effluent from waste stabilisation ponds in many countries fail to meet regulatory standards.

Following management interviews, investigations through site visits of the status of pond systems in the three provinces were conducted. The following risk assessment tool was then developed to identify the status of these systems.

Development of a risk assessment tool

In order to determine waste stabilisation pond risk, elements utilised in performing evaluations for Environmental Impact Assessments (EIAs) and ISO 14001 Environmental Management Systems (EMS) were adapted and utilised. In summary, the following convention for the assessment of impact significance was used:

Extent - This indicates whether the impact is or will be local and limited to the immediate area surrounding the pond system (< 200 m); limited to within 500 m of the ponds; or whether the impact may be realised regionally or even nationally.
Duration - This indicates the lifetime of the impact, as being short term (0 – 1 year), medium (2 – 5 years), long term (>5 years but where the impacts would cease if the pond system was not utilised), or permanent.
Intensity - This gives an indication of whether the impact is destructive or mild and is described as low (e.g. no environmental or human functions and processes are affected), medium (e.g. the environment and human activities continue to function but in a modified manner) or high (e.g. environmental and human functions and processes are altered such that they are temporarily or permanently impaired).
Probability - This considers the likelihood of the impact occurring and should be described as improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of prevention measures).
Degree of confidence in predictions - The degree of confidence in the predictions, based on the availability of information and specialist knowledge.

In order to quantify the relative significance of the above potential risks, an ISO 14001 based scoring process was used. The seven categories are:

- Design
- Maintenance
- Operation and Performance
- Safety
- Supervision and Management
- Water Quality Monitoring
- General Authorisation

The field observations were then loaded onto the waste stabilisation pond risk assessment tool i.e. a web enabled tool utilising a scoring/weighting system and the outcomes thereof are critically considered. The tool contains the following main categories for which points were allocated to provide an overall score for a waste stabilisation pond system (WRC(a), 2008).

The following figure (Figure 1) illustrates how the environmental impacts associated with a pond system could be scored using the aforementioned methodology. A percentage score is calculated from the scores obtained for each category and plotted against that category.

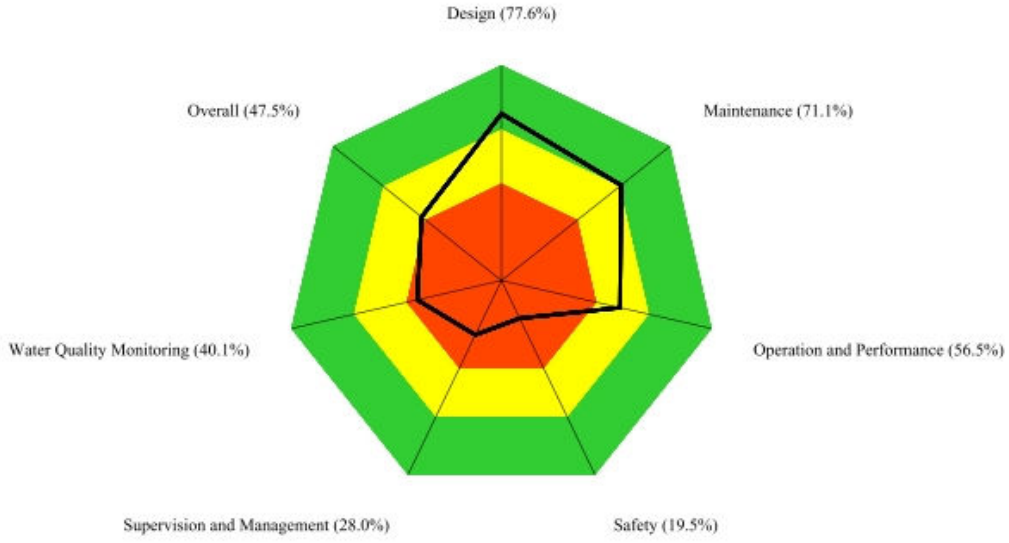

Figure 1. Risk assessment tool outputs example

Referring to the figure above, green indicates good, yellow indicates fair and red indicates poor performance in each category. The figure above then shows that according to the aspects considered in each category, the waste stabilisation ponds system represented above is well designed and properly maintained. The system is fairly operated therefore could result in the system performing fairly as well. This is as a result of the system being hydraulically overloaded. The system provides poor safety to the public as it in not enclosed. Supervision is provided for the site though the management does not prioritise on waste stabilisation ponds system needs. The system is discharging to the environment; however, there is no monitoring conducted.

In this particular case, considering one category as an example, the risks associated with public safety (scored at 19.5%) were allocated by considering factors, illustrated in Figure 2, such as:

- Whether the site is enclosed with a fence and closed gates;
- Whether the waste stabilisation ponds system is located at the recommended distance (i.e. >200m) from the dwellings;
- Whether "no entry" signs have been put up on site.

Figure 2. Indication of risks associated with safety

Management Guide

Observations from management interviews and site visits were used to develop the two guidelines. The management guide is developed in such a way that should there be any category that is performing poorly from the assessment output, practical considerations to improve the situation are provided. Upgrading options for waste stabilisation ponds are also presented. The guide includes the following aspects:

Ponds lining, inlet and outlet structures, receiving ponds, fencing, supervision, odour problem, measurement and removal of sludge, health of the people onsite consideration, monitoring of the final effluent (if necessary).

Operations and Maintenance guide

Guide for operations and maintenance has been developed in such a way that it will assist the operations and maintenance personnel of waste stabilisation ponds sites to understand:

Pump station maintenance, disposal of septage, proper handling of screenings, lining protection, proper operation of the system, final effluent monitoring, sludge handling, leak detection, process controllers and public safety.

This is shown in such a way that it indicates good and bad practices. It provides practical methods of maintaining waste stabilisation pond system.

CONCLUSION

Waste stabilisation pond systems are an appropriate technology for wastewater treatment. This study has shown that with municipal and community awareness, the situation has been observed to improve in most cases. Therefore profiling of the guideline documents presented above to every municipality could improve the current status of these systems in terms of management, operations and maintenance. This would also contribute to healthy environmental conditions. Having the tool at hand that could be used to assess the risk associated with waste stabilisation ponds allows municipalities to be able to identify areas of concern and plan accordingly, then take corrective measures as suggested in the guideline documents.

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