PAPER 11

TRANSFORMING WASTE: SUSTAINABLE SEWAGE SLUDGE MANAGEMENT IN GEORGE MUNICIPALITY

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George Municipality

ABSTRACT

South Africa produced 55 million tonnes of general waste in 2017, as noted in the 2018 South Africa State of Waste Report (Report No. 1), with only 6.05 million tonnes diverted from landfill sites. Diverting organic waste from landfills is a critical focus of the National Waste Management Strategy 2020 as published by the Department of Environment, Forestry and Fisheries, which emphasizes treating organic biodegradable materials such as sewage sludge.

The 2020 National Waste Management Strategy outlines five key principles aimed at increasing landfill waste diversion rates to 40% by 2025, 55% by 2030, and 70% by 2035. Similarly, the Western Cape Integrated Waste Management Plan (4th Generation) published by the Western Cape Government in 2017 highlights the need to improve sewage sludge management within the province, targeting a diversion rate of 50% by 2022 and full diversion by 2027. A feasibility study commissioned by DEDAT for the Sludge Beneficiation for the Western Cape revealed that the Western Cape generated 295,000 tonnes of sewage sludge in 2016, with only 33% being beneficially utilized — 22% for land farming and 11% for composting or agricultural purposes. The Garden Route District contributed approximately 10% (28,400 tonnes), making it the third-largest contributor.

The George Municipality recognizes the environmental and socioeconomic value of treating sewage sludge for beneficial use. In 2023, the municipality produced 41 tonnes of dewatered sludge/day (15% dry solids), with projections indicating an increase of approximately 14 tonnes/day by 2033 at an annual growth rate of 3–3.3%. However, current practices by the municipality involve stockpiling at wastewater treatment works, with no beneficial and environmentally acceptable take-off agreements. As a turnaround strategy for its current sludge handling practices, the municipality initiated an Expression of Interest for the beneficial utilisation of sewage sludge, incorporating sustainable engineering practices aligned with national and provincial strategies and processes to explore options for beneficial sludge treatment.

To address this challenge, the Expression of Interest explored sustainable sludge utilization options available in the market that are aligned with national and provincial strategies. This process advanced to a tender stage inviting financial proposals. Following evaluations, the municipality opted for a long-term agreement under the Municipal Asset Transfer Regulations: Municipal Finance Management Act, 2003 (Act No. 56 of 2003). By December 2025, it aims to finalize a partnership to establish a facility using solar drying technology to treat sewage sludge. This technology will achieve a dry solids content of 65–95%, reduce pathogens and faecal coliforms, and assist in the production of A1a-classified sludge. This initiative enables the municipality to comply with legislation while securing economically viable and sustainable agreements for treated sewage sludge, ensuring responsible management from production to final use.

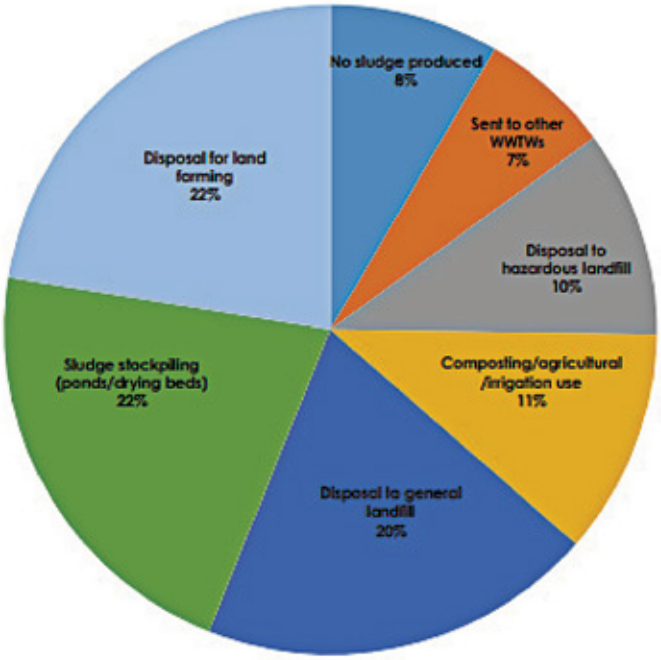

FIGURE 1: *Sewage sludge management method (Western Cape Status Quo Report: 2020/21)*

FIGURE 2: *Waste management hierarchy (DWAF & WRC, 2009)*

INTRODUCTION

The Western Cape, like other provinces, is struggling with the availability of landfill capacity to accommodate the disposal of waste, with the sighting of new landfills being a challenge (Western Cape Government 2017). The 2022 Waste Market Intelligence Report by GreenCape estimates that the municipal landfill lifespan for each local municipality in the province is less than 5 years, apart from Swartland (more than 15 years), City of Cape Town and Overstrand (both more than 5 years but less than 10 years).

However, more than 50% of sewage sludge in the Western Cape Province is not being utilised as a resource, as the sludge is either disposed of at landfill

FIGURE 3: *George Municipal Jurisdictional Area*

(general and hazardous) sites (30%) or stockpiled on site (22%). Refer to Figure 1.

From the above statistics, it is evident that disposal is still seen by the majority of local authorities as the default option to dispose of sludge. This practice is contrary to both the waste management hierarchy, see figure 2, which prioritizes waste diversion measures such as waste prevention, re-use, recovery, and recycling over disposal as well as the provincial and national waste diversion targets set to reduce in the next 5 – 10 years.

Currently, there is general consensus that sludge is a potential source of valuable resources and energy (WRC report; no. TT 756/18). Treated sewage sludge can be beneficially utilised in the agricultural sector through land application, recovering energy, producing compost or fertiliser, use in construction industry such as brick making and others.

To ensure alignment with provincial and national strategies, sustainable and compliant practices are implemented, more beneficiation projects must be considered and implemented by local government/municipalities to make use of this valuable resource, however the environmental legislative environment is complex and regulation by more than once government department must be considered for on-site and off-site disposal.

THE GEORGE MUNICIPALITY

The George Municipality is the third largest municipality, in terms of population, in the Western Cape Province of South Africa and is situated in the Garden Route District of the province. Refer to Figure 3.

The municipality serves 294 929 people from 85 931 households (Statistics SA 2023) across 28 wards including Uniondale and Wilderness – with service hinterlands geographically separated from the main city area George. Small rural or tourism settlements include Haarlem, Waboomskraal, Uniondale, Touwsranten, Hoekwil – and various hamlets and rural places like Avontuur, De Vlugt, Herold and Noll. Coastal areas include Herold's Bay, Victoria Bay, Wilderness, Kleinkrantz, and Gwaing.

84% of the municipal area's population is located within George. Wilderness, Uniondale and Haarlem respectively host the bulk of the remaining urban population, and 9% of the municipal area's population is rural.

The municipality administers a vast and diverse geographic area of 5191km^2 that extends from the dry and climatically extreme Little Karoo in the north, to the wetter more temperate Garden Route in the south. The area administered by the municipality forms part of the larger Garden Route District Municipality's jurisdictional area.

The Municipal area is served by six (6) wastewater treatment works (excluding privately owned WWTW's) with capacities and locations indicated in Table 1.

TABLE 1: *George municipal wastewater treatment works*

No	WWTW	Current Design Capacity (Ml/day)	Service/Drainage Area
1	Gwaing	11	Eastern Parts of George
2	Outeniqua	25	Western Parts of George
3	Kleinkrantz	2.5	Wilderness, Kleinkrantz, Touwsranten and Hoekwil
4	Uniondale	1	Uniondale
5	Haarlem	0.1	Haarlem
6	Herold's Bay	0.3	Herold's Bay

STATUS QUO

Western Cape Government

The outcome of the Western Cape Government Status Quo report 2020/21 echoed the results of the 2016 DEDAT study, and from the 107 Wastewater Treatment Works (WWTW's) reviewed/surveyed, only 33% (22% land farming/application and 11% composting/agricultural/irrigation use) of the WWTW's beneficially utilise sewage sludge.

An extract of data performed as part of the development of the status quo report from the Western Cape Provincial Integrated pollutant and waste information system for the 2019 calendar year revealed that only two (2) municipalities report on the disposal of their sewage sludge at three waste management facilities. The report stated, "*there is a severe lack of reporting for this waste type and is an area that needs improvement in order to gain an idea of what the potential for beneficiation is in terms of quantity.*"

Figure 4 shows the distribution of organic waste in the Western Cape in 2015. According to the DEDAT 2016 study 45% of the total waste generated in the Western Cape is organic, with sewage sludge contributing 4%.

The Status Quo report confirmed that the Municipalities are facing various infrastructural and operational challenges which could have a direct or indirect impact on how the Municipalities manage sewage sludge. However, there were some encouraging examples where 11% of the WWTW's surveyed were already diverting sewage sludge for beneficial use.

In conclusion, the report stated the need to stimulate business interest in sewage sludge and encouraged municipalities to get their sludge classified and tested to guide the way forward in managing the sludge beneficially.

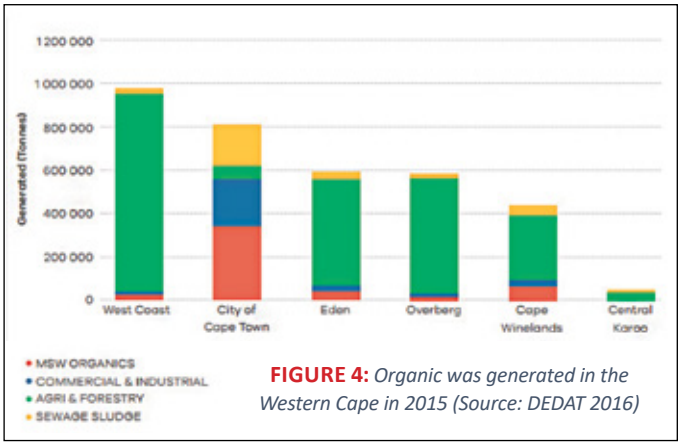

FIGURE 4: *Organic was generated in the Western Cape in 2015 (Source: DEDAT 2016)*

TABLE 2: *George municipal wastewater treatment works*

No	Wastewater Treatment Works (WWTW)	Sludge drying method	Disposal Route
1	Gwaing	Mechanical dewatering	Stockpiling
2	Outeniqua		
3	Kleinkrantz	Drying beds. Upgrade to mechanical dewatering in planning for implementation	
4	Herold's Bay	Mechanical dewatering at Gwaing WWTW (tanks are emptied and transported to Gwaing WWTW)	
5	Uniondale	Drying beds	Land application
6	Haarlem	Drying beds (tanks are emptied and sludge transported to Uniondale for drying)	

The George Municipality

The current sludge drying method(s) and disposal route of the six (6) WWTWs that service the entire Municipal area are indicated in Table 2.

Figure 5 below indicates the sludge volume projections for the George Municipal WWTW's (Gwaing, Outeniqua, Kleinkrantz and Uniondale). The projected sludge production by these WWTW's post mechanical dewatering amounts to ±40 000kg/day in 2023 and is projected to increase up to ±138 000kg/day in 2063 at a medium growth rate of 3 to 3.3%.

Currently, the sludge produced is classified as class B1a according to a report by Herselman Consulting Services compiled in October 2021. The 'B' designation refers to microbiological class with the presence of faecal coliforms above 1000CFU/gdry and Helminth ova above 0.25 viable ova/gdry preventing the sludge from achieving an 'A' designation for microbiological class. This places restrictions on how the sludge can be utilised. The designation '1' refers to the stability class while the 'a' refers to the pollutant class (metals).

The current methods of sewage sludge disposal are neither satisfactory nor sustainable to the municipality, and do not align with the provincial and national strategies. In addition, the sludge produced has potential commercial value for use in saleable products, and the municipality is interested in exploring the available options. This value provides opportunities for alternative means of disposal.

To make the sludge a more attractive commodity for beneficial use the sludge needs to be processed further.

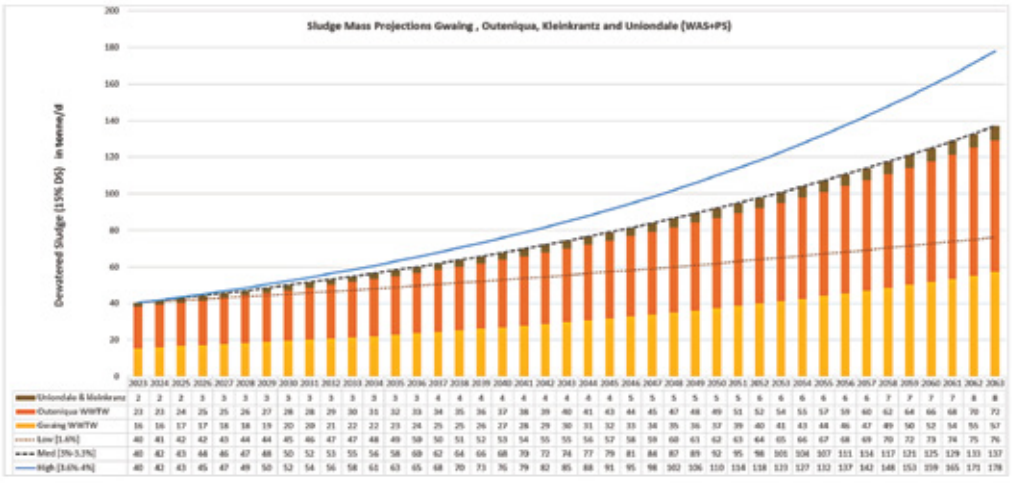

FIGURE 5: *40-year sludge volume projections (Gwaing WWTW Phase A & B Concept & Viability report)*

The waste management planning of the George Municipality aligns with the national and provincial targets to divert sewage sludge from landfills. The George Municipality has developed a suite of documents to effectively deal with waste. These include an integrated waste management plan (3rd generation 2020-2025, March 2020), waste minimisation plan (draft June 2021), and a home composting guideline.

The waste minimisation plan specifically addresses sewage sludge by prioritising its diversion from landfills through composting, anaerobic digestion and where appropriate, land application. These strategies are designed to comply with national regulations, reduce environmental impact, and promote resource recovery from waste streams.

OPTIONS ANALYSIS

The municipality investigated several options for sludge beneficiation as well as a diversified approach to be less dependent on a single solution, two of these solutions are discussed below.

Composting

Composting is a suitable method for treating sewage sludge. Composting not only reduces the volume of sludge but also eliminates most of the pathogens. Sewage sludge is considered a good material for composting practices, and it can be combined with other material sources such as garden refuse, wood chips etc. to create a compost for land application, selling compost to consumers etc. Composting could be employed to sterilize the sludge to class A1a. If this is achieved, the sludge can be sold as compost for agriculture or horticulture use, reducing the need for sludge storage or landfill application.

Delta Built Environment Consultants (Pty) Ltd (Delta BEC) was appointed by the George Municipality in 2015/16 to provide professional services for their solid waste management. Delta BEC's appointment included compiling a feasibility report and applying for a waste management licence for a new composting facility and builders' rubble processing plant in George. In 2019 Delta BEC conducted a study to investigate whether the proposed composting facility should be developed by the municipality, in partnership with a private company or solely by a private company. In 2021, a detail design report of the proposed facility was issued, and the facility was constructed. The feasibility study and detail design excluded the use of sewage sludge as part of the composting process, as the use of compost containing sewage sludge by end users was not well received. This is due to their target market being domestic end users and the possible health risks that are perceived with sewage sludge.

During 2023 to 2024, Delta BEC was once again engaged to investigate the feasibility of composting as a sludge beneficiation strategy for George Municipality at the newly implemented Municipal Composting Facility. Their Report titled: Sludge Utilisation Within George Municipality Compost Facilities Recommendations stated:

"Municipal sewage sludge is generated in large quantities and contains high organic loads. To reduce its environmental risk, composting is a common treatment technique. Key parameters include moisture content

and C/N ratio. Sludge variability makes it challenging to establish treatment protocols, but minimum requirements are necessary for proper composting."

A review of the Gwaing Compost Facility found that combining two platform would provide sufficient capacity for about 84% of the sewage sludge from the Gwaing and Outeniqua WWTWs. Although a significant portion of the daily sludge mass can be treated, further aspects must be considered to consider this treatment process a viable option:

- Construction of additional platforms to ensure adequate space is available for the addition of the sewage sludge as a material source (current and future).
- Co-operation and co-ordination between internal directorates in terms of construction and operation of the facility, provision of funding, resources etc.
- Continuous testing of the compost to ensure compliance and no harm to the public and the environment.
- Obtain public/community buy-in to ensure a saleable product, by perhaps creating a pilot/trial site to demonstrate to the community that the compost will remain a suitable product and there will be no harm to the public and the environment.
- Continuous compliance with Sludge Management Guidelines, NEMA, NWA and Waste Management Act.

In conclusion, presently the decision is not to pursue composting as a direct and sole option for the beneficiation of the sewage sludge. To bridge the gap and obtain public/community buy in will take time, requiring the municipality to investigate other alternatives that will prove equally suitable, beneficial and compliant. The municipality will however continue with the investigations and processes required to utilise the composting facility as far as possible and would ideally wish to implement this in the near future which will also allow two (2) avenues for beneficially disposing of sewage sludge.

Call for Proposals to Open Market: Solar drying and Fertilizer Production

Call for proposals process:

The municipality prepared a two-stage call for proposals tender requesting proposal from the open market to assess practical and beneficial disposal options available for the handling, management and disposal of sewage sludge & residuals from all municipal Wastewater Treatment Works (WWTW) and Water Treatment Works (WTW).

The municipality encouraged Tenderers to submit proposals that are comprehensive, competitive, robust, innovative, practical, functional, sustainable, each with attractive yet functional design solutions.

The overall objective of the municipality was to upon the conclusion of the tender process to:

- To appoint a service provider or multiple service providers that can sustainably, practically, and efficiently treat (if further treatment is required), manage and dispose of sludge from the six (6) municipal wastewater treatment works and residuals of five (5) water treatment works.
- The George Municipality's preferred outcome will be to enter a long-term contract with a financially stable, technically experienced, and well-resourced organization in sludge handling and management.
- To beneficially and sustainably dispose of residuals and sludge through a contracted third party
- To enter into an agreement that will minimize the municipality's administrative requirements, free the municipality of legal obligations and other risks associated with residual and sludge disposal while providing environmental acceptable solutions that are sustainable.

Stage 1 of 2 considered sustainable solutions proposed by service providers that required compliance with the tender conditions, and only responsive stage 1 tenders were then invited to submit their financial proposal as part of stage 2.

The stage 1 tender was advertised during February to March 2024, and twenty (20) service providers registered their interest, however only two (2) proposals were received, and only one (1) Tenderer was considered responsive and was invited to submit a financial proposal. The stage 2 process commenced in October 2024 and will be concluded by November 2025.

Upon conclusion of the procurement process, the municipality will enter into a long-term agreement (10 years) with an external party to operate and use the George BBF to produce fertiliser.

LEGISLATIVE REQUIREMENTS

Sewage Sludge Disposal

The South African environmental legislative environment is complex and regulation by more than one Government Department needs to be considered for on-site and off-site disposal of sewage sludge. The Department of Water and Sanitation (DWS), Department of Environmental, Forestry and Fisheries (DFFE) are the lead regulatory authorities for sewage sludge disposal.

The authorisations required for on-site and off-site disposal are defined in terms of the:

- National Water Act (Act 36 of 1998),
- Environmental Conservation Act (Act 73 of 1989),
- National Environmental Management: Waste Act (Act 59 of 2008)
- Waste Classification and Management Regulations GN 634 (August 2013)
- Water Services Act (Act 108 of 1997)
- National Health Act (Act 61 of 2003)

The processing and disposal of municipal sewage sludge has increased in importance since the establishment of stricter standards by the then Department of Water Affairs and Forestry (DWAF) and the publication of the updated Guidelines for the utilisation and disposal of wastewater sludge by DWAF and the Water Research Commission (WRC) in June 2009 (WRC Report no TT349/09).

In issuing the licenses of wastewater treatment plants and regulating wastewater sludge the Department of Water and Sanitation (DWS) stipulates that the Sludge Management Guidelines should be adhered to, and through this process the Guidelines become legally binding.

The South African guidelines comprise of a set of five volumes as indicated in Table 3.

Municipal Finance Management Act: Long Term Contracts

The MFMA *Section 33: Contracts having future budgetary implication*, applies when a municipality intends to enter into a contract or agreement that will have financial implications beyond the current three financial years.

TABLE 3: *Sludge Management Guidelines*

Volume	Description
1	Selection of Management Options
2	Requirements for the Agricultural Use of Sludge
3	Requirements for the on-site and off-site disposal of sludge
4	Requirements for the Beneficial Use of Sludge
5	Requirements for the Thermal Sludge Management Practices and for Commercial Products Containing Sludge

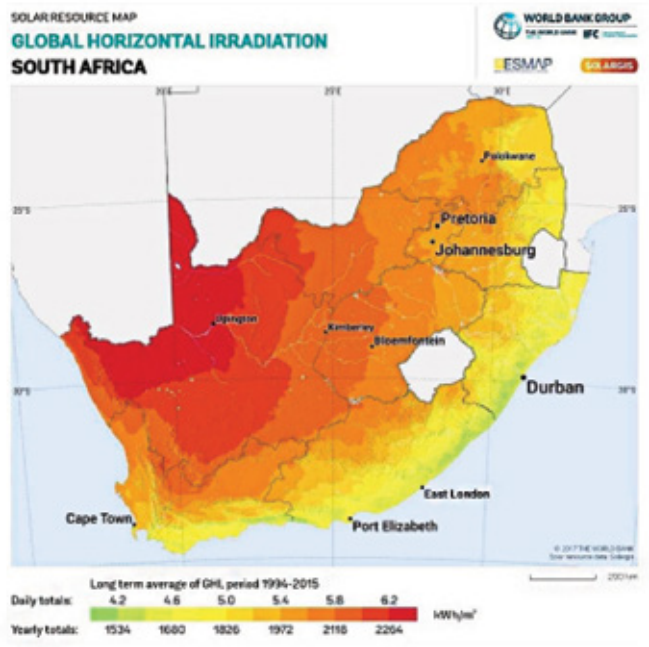

FIGURE 6: *Horizontal solar irradiation map of South Africa (Global Solar Atlas 2.0)*

The call for proposal tender document was advertised for a period of 3 years with the provision that proposals requiring longer periods shall be subject to compliance with the MFMA. Stage 1 proposals received required a longer-term contract to ensure a viable project. The municipality assessed the options prior to preparing the stage 2 tender document, and the tender documents were therefore prepared accordingly.

Through this process the municipality will ensure transparency, proper financial planning and conduct public participation by informing the public, interested and affected parties, provincial and national organs of state about the proposed contract and provide them an opportunity to comment over a 60-day period.

Municipal Asset Transfer Regulations (MATR): Granting long term right

The MATR govern how municipalities transfer or dispose of capital assets, including transfers to private parties, other municipalities, municipal entities, and national or provincial government organs. This includes permanent transfers (sales or other transactions) and temporary rights such as leasing.

The intention of the municipality as part of the call for proposal process is to construct a solar drying and blending facility that will be operated and maintained by an external entity / service provider over a long-term period.

Granting a long-term right for the control, use or management of a high value capital asset (> R10 million) to an external entity for a long-term period (> 10 years), compliance in terms of the MFMA: Municipal Asset Transfer Regulations is required (National Treasury, 2008), specifically regulation 34 to 36.

The regulations would ensure that municipalities act as responsible custodians of public assets by prescribing procedures that protect the public interest and municipal financial health. Through this process the municipality will ensure transparency, asset management and conduct public participation by informing the public, interested and affected parties, provincial and national organs of state about the proposed contract and provide them an opportunity to comment over a 60-day period.

Once the two processes in terms of the MFMA (RSA, 2003), regulations 34 to 36 are successfully completed, and the council resolution(s) are passed, the contract can be signed.

PAVING THE WAY FORWARD

The current intention and preferred option for George Municipality is to construct a solar drying and granulation plant; this plant will be referred to as the George Biosolids Beneficiation Facility (BBF). George Municipality plans to construct the capital infrastructure and only outsource operation of the facility, including the selling of the granulated sludge as fertilizer.

The accepted solution in beneficially managing the sewage sludge of the municipality is to produce fertilizer. The solar dried sludge (>80% DS) granules are optionally mixed/blended with chemical fertilizers and sold to farmers for application to agricultural land. This option creates a high-value product that warrants the additional capital and operational expenditure required for a solar drying plant.

What is solar drying?

George experiences a horizontal solar irradiation of 1500-1850 kWh/m^2 per annum. This is low compared to other parts of South Africa, but relatively high when compared to central and northern Europe for example. George experiences a subtropical oceanic climate, characterized by mild winters and warm summers with monthly mean temperatures ranging from 12°C to 22°C. See figure 6.

The annual precipitation is about 715mm, spread quite evenly over the year so that monthly averages range from 45 to 70mm per month. See figure 7.

Solar drying of sewage sludge is typically done after initial dewatering to 14% - 17% dry solids (DS). Solar drying can be done to achieve between 65% and 90% DS. Above 65% DS the sludge forms granules or powder and is not lumpy or sticky any longer. The drying process reduces pathogens and faecal coliforms. A microbiological class of A could potentially be achieved to reach an overall sludge classification of A1a. However, it should be noted that temperature has been found to be the main parameter in the removal of helminth eggs and therefore the achievement of A1a may be dependent on the temperatures reached during the solar drying process. Stockpiling and curing of the sludge after drying has also been effective for pathogen reduction.

Another benefit of solar drying is the reduction of moisture content, leading to the reduction of mass and volume of the sludge. This reduces transport costs and simplifies sludge handling.

FIGURE 7: *Weather conditions for 2024 (gis.elsenburg.com/apps/wsp)*

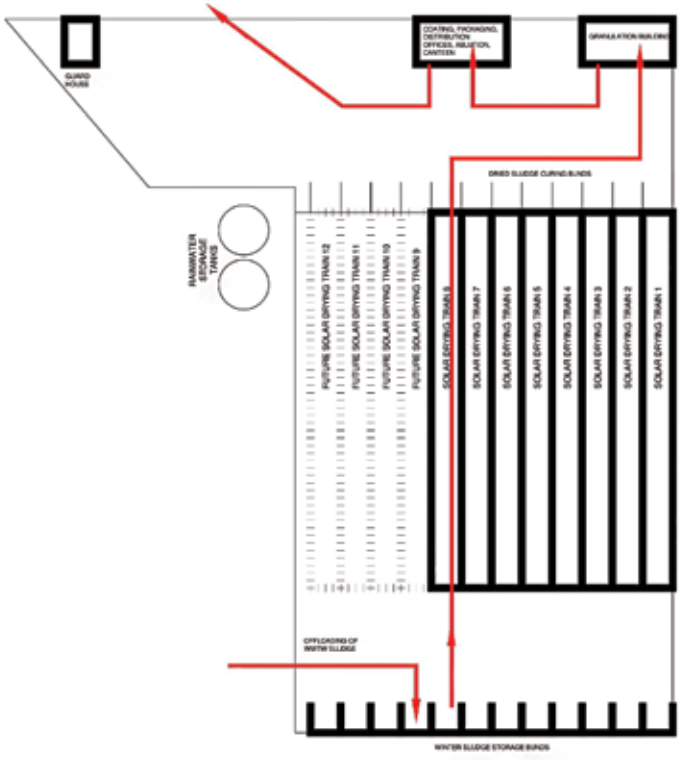

FIGURE 8: *Schematic layout and basic process flow diagram of proposed George BBF*

Concept

Solar drying can be done with or without roof coverings, this is however determined by the annual precipitation, evaporation rates and the solar irradiance.

Solar drying facilities can be simple consisting of concrete slabs with sufficient allowance for drainage and mechanical plant used to spread and turn the sludge periodically. In colder climate conditions, this same facility is generally equipped with translucent roof sheeting, forced ventilation and automated sludge spreading and turning equipment.

For the George BBF translucent roof sheeting may be required for the solar drying plant to limit the footprint required to within reasonable limits, ensure all year-round sludge treatment (high precipitation and low solar irradiation). Different options for sludge spreading and turning can be considered (continuous versus batch drying). This approach results in a drastic reduction of processing time or footprint and produces a better-quality sludge.

Batch solar sludge drying processes dries sludge in discrete batches, where each batch is dried separately before the next one begins. This method can be less efficient due to the downtime between batches and potential inconsistencies in drying conditions. However, batch drying allows for greater control over individual batches, which can be beneficial for handling varying sludge characteristics. For the George BBF this would typically entail that a greenhouse train is loaded to capacity with sludge with front-end loaders, and then the sludge is left to dry in that train for about 28 days while continuously being rotated by an electric mole.

The schematic layout and basic process flow diagram of the proposed George BBF is reflected in figure 8.

The facility is planned to be sized initially to receive approximately 50 tonne/d at 15% DS (see figure 5) which will result in a dried mass of about 8.3 tonne/d at 90% DS. The capacity of the BBF should be sufficient until at least 2030 based on a medium growth rate (3 – 3.3%). Additional drying trains can be added in future in line with the actual realized population rates.

The BBF will typically include perimeter fencing & access gates, ±30 000m² of concrete slabs for the various stages of sludge stockpiling, solar drying, composing and sludge handling, ±13 000m² (plan view) of translucent roof sheeting structures, 18m x 36m sludge granulation plant, 18 x 36m packaging & distribution depot which includes offices, ablution and a canteen for the operating staff of approximately 6 people, movable precast concrete walls placed on slabs to demarcate separated process areas and to prevent contamination, access roads, rainwater collection and storage from all roof structures, stormwater collection and drainage from concrete slabs with drainage back to the Gwaing WWTW inlet works.

CONCLUSION

The processing and disposal of municipal water residuals and wastewater sludge has increased in importance since the establishment of stricter standards by the then Department of Water Affairs and Forestry (DWAF) and the publication of the updated Guidelines for the utilisation and disposal of wastewater sludge by DWAF and the Water Research Commission (WRC) in June 2009 (WRC Report no TT349/09).

The current methods used by the George Municipality to dispose of sewage sludge are not satisfactory or beneficial and are not in terms of the Sludge Management Guidelines.

The sludge produced have potential commercial value for use in saleable products, and the municipality through a thorough planning process, rigorous and transparent legislative process will secure a long-term agreement with an external entity for the management and beneficial end use of sewage sludge.

Sustainable sludge management facilities are scarce in South Africa. If the municipality successfully implements this facility within the next few years, it will be a pioneering project for the Western Cape.

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