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CITY OF JOHANNESBURG ORGANIC WASTE TO BIOMETHANE FOR BUS FUEL PLANT

CIVIL WORKS

SEWER AND STORMWATER CONCEPT DESIGN REPORT

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UNIVERSITY OF JOHANNESBURG

ENERGiDROP
ACCELERATING ALTERNATIVES

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SYNOPSIS

The report focuses on the concept sewer and stormwater design for a 50 tonnes per day organic waste to bio-methane plant, for the university of Johannesburg (UJ), in collaboration with the City of Johannesburg Metropolitan Municipality. JG Afrika have been sub-contracted to EnergiDrop (Pty) Ltd.

KEY WORDS:

Civils, Stormwater, Sewer, Biogas, Bio-methane, UJ, CoJ

QUALITY VERIFICATION

This report has been prepared under the controls established by a quality management system that meets the requirements of ISO 9001: 2015 which has been independently certified by DEKRA Certification.

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CITY OF JOHANNESBURG ORGANIC WASTE TO BIOMETHANE FOR BUS FUEL PLANT

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1 INTRODUCTION

The University of Johannesburg (UJ), in collaboration with the City of Johannesburg (COJ) has launched the Biomethane project which aims to produce biomethane as bus fuel from clean organic waste produced by the Johannesburg Fresh Produce Market (JFPM). The facility will function as a commercially operated demonstration plant of organic waste processing, biogas production and biomethane filling into busses.

Energidrop (Pty) Ltd was appointed by UJ in April 2018 to undertake the professional services for the design and specification of a biomethane plant (reference number RFP UJ 01/2018). Energidrop appointed JG Afrika (Pty) Ltd as sub-consultants to assist with the civil and structural conceptual design for the facility.

This report focuses on the conceptual design for the civils works with a focus on storm water and sewer requirements.

2 BACKGROUND

The purpose of this report is to inform the City of Johannesburg and University of Johannesburg on the following:

a) Stormwater infrastructure requirements (conceptual design level);

b) Internal sewer requirements (conceptual design level);

c) Conceptual level cost estimate for a) and b) above.

3 LOCALITY AND DESCRIPTION OF PROPOSED DEVELOPMENT

3.1 LOCALITY

The site for the plant is located on the Robinson Deep Landfill ERF. Access to the facility is on Turffontein road and is shared with the main Robinson Deep landfill entrance as well as the entrance to the Pikitup offices on site. Figure 3-1 shows the location of the proposed biomethane plant in relation to the Robinson Deep Landfill Site.

Figure 3-1: Location of the Future Biomethane Plant

3.2 DESCRIPTION

The area allocated for the biomethane plant has a total land area of ± 1.1 hectare (including the weighbridge entrance area). The area was initially used as a brick quarry for the City which was subsequently converted into a hazardous waste incineration facility. The incinerator was later shut down as it did not meet the air emissions specifications within the CoJ. The tasks of removal of the old incineration plant and disposal thereof as well as the rehabilitation of the existing buildings for use in the biomethane production process, form part of this project. The stand is currently block paved with visible damage and ponding to the paving. Most of the existing buildings and infrastructure require repurposing for the operations of the biomethane plant.

4 SEWERAGE

4.1 DESIGN STANDARDS FOR SEWERAGE

The following standards are considered for this development:

Minimum Diameter	:	110 mm Ø
Pipe Location	:	1.0m in stand boundary
		2.0m in roads reserve
Minimum Cover	:	1.4m traffic areas
		1.0m other areas
Manhole Spacing	:	80m
Class Bedding	:	Class “B” bedding

Peak Factor	:	1.5 for Commercial stands
Maximum Flow Depth	:	67% of pipe diameter
Manhole Diameters	:	1.05m minimum (nominal) precast concrete
All Connections	:	110mm Ø uPVC
Minimum gradient to sewer	:	1:200 minimum gradient

4.2 PROPOSED BULK SEWERAGE

The internal sewer system servicing the Biomethane Plant will be connected into the existing bulk sewer pipe system servicing the Robinson Deep landfill site offices. There are existing sewer manholes in the project site, one situated at the eastern corner of the project site, behind the existing wash bay.

It is required that there are sewer connections for any catchment where there is potential for contamination of the stormwater as well as sewage discharge. New sewer connections are required for the new control room ablutions (7)[1], the new office ablutions (2), the digestors (9,10), the biogas upgrading plant (6), the metrobus fuelling area (23), the digestate liquor storage tank (8) and at the water treatment area (35).

It is proposed that the areas of potential contamination be built on raised platforms with inlets that are connected to the existing sewer system. A grease trap will be necessary at the fuelling area to ensure that any contaminated oil runoff (et al) is captured by the grease trap before entering into the sewer system.

The detailed design should consider screeding of existing building floors to ensure adequate drainage slope for drains within the building towards a floor drain outlet connection to the external sewer system. Careful consideration of outlet levels during detail design will be necessary.[2]

Proposed connection points to existing pipe systems are shown on the Sewer Layout Plan.

Please refer to the *Annexure A* for the Conceptual Sewer Layout Plan (DWG 4798/09/SEWLP/01).

5 STORM WATER DRAINAGE MANAGEMENT

It is proposed that stormwater be managed using on-surface flow, as far as practically possible, thus promoting sheet flow. Diversion by means of kerbing and shaping of ground levels leading to pipe culverts, swales (which will promote further cleaning of stormwater, lowering of the flow rate (SUDS)) and an on-site attenuation.

[1] The numbers reference EnergiDrop Drawing: "*Bio-methane Plant Gas Plant- Site Plan"* Legend
[2] Refer to Section 7 DETAIL DESIGN CONSIDERATIONS.

The conceptual stormwater layout plans show proposed conceptual routing of the stormwater, the detailed design should ensure that earthworks and shaping of ground levels can achieve this routing, interface with building floor levels to ensure sufficient freeboard, drainage slope, et al. Note that it is recommended that the location of the fuelling station be reconsidered to suit stormwater drainage (Minimise inflow of stormwater into the fuelling station) . Refer to Annexure *A* for the Conceptual Stormwater Layout Plan.

The detail design must comply with the design guidelines and standards of the JRA in accordance with the JRA stormwater management policy, it will be required that a detailed stormwater management plan be submitted with the detail designs and approved by the JRA prior to construction.

Policy of Johannesburg Roads Agency considered in the design:

- The stormwater runoff associated with the development is to be attenuated such that the predevelopment flows for the 1:5 as well as the 1:25 year storm events are not exceeded.
- The attenuation structure must be able to withstand the 1:50 year storm event.
- Discharge from the attenuation facility is subject to approval by the landowner downstream.
- Site Development Plans will only be approved if supported by an acceptable stormwater management strategy (not part of this scope).
- Clearance for the issue of Section 82 or Regulation 38 certificate will only be given once the stormwater management system is in place.
- The attenuation facility must have adequate erosion protection
- Provision for an emergency overflow must be accommodated
- The entire route from the attenuation facility to the ultimate destination must be designed - i.e. from A to B (or a tie-in point acceptable to the JRA), in accordance with the approved SWMP.

5.1 Determination of the stormwater run-off

The storm water run-off for this proposed development, has been calculated by means of the Rational Method and as set out below:

Q	=	CIA / 3.6
Q	=	Storm water runoff (m^3/s)
C	=	Runoff coefficient
I	=	Average rainfall intensity over catchment (mm /h) (750 mm /year)
A	=	Effective area of catchment (km^2)
3.6	=	Conversion factor

- Minor storm water pipes (no attenuation) : 1 : 5 years
- Major storm water pipes (for attenuation) : 1 : 25 years
- Attenuation ponds : 1 : 5, 1 : 25 years
- Pre-development with run-off coefficient (C) : 0.28 for 1 : 5 years

- Pre-development roughness coefficient : 0.02 for 1 : 5 years
  (Existing paved areas)
- The time of concentration : 15 minutes (min)

5.2 Minimum storm water drainage specification.

- Minimum pipe diameter : 450 mm
- Minimum pipe class : 100D
- Maximum velocity of storm water runoff : Pipes 5 m/s
  : Roads 3 m/s
  : Discharge points 1m/s
- Minimum slopes in pipes : 1%
- Maximum spacing of manholes : 100 m
- Kerb inlets : As per JRA standards
- Outlet Structures : As per JRA standards

It should be noted that the pipe and inlet sizes are indicative and the sizes of the pipe culverts as well as the hydraulic design will need to be modelled and calculated during the detailed design stage. Existing levels within the site boundary will be required to be reworked in order to achieve minimum drainage slopes.

➢ Please refer to the *Annexure A* for the Conceptual Stormwater Layout Plan

5.3 Attenuation Facility

One attenuation facility forms an integral part of the concept stormwater design and proposes to reduce the peak flow.

It is envisaged that the pond will be positioned at the lowest portion of the development site (or on the positions indicated on the drawings), so that the whole development can benefit from the stormwater attenuation facility. The concept design ensures that the stormwater flows into a bioswale before entering the attenuation facility. A bioswale is a type of sustainable drainage system (SUDS) typically designed to concentrate and convey stormwater runoff while removing debris and pollution. Bioswales are typically vegetated and consist of drainage layers, erosion protection and gentle side slopes. Vegetated bioswales can be planted with ornamental grasses, shrubs, perennials, or a combination of these. Larger stone can also be used to break up concentrated flows of water and reduce velocity.

As a guideline to determine the amount of storage required at the planning stage, a volume of 350m^3 /ha of storage for a pond subjected to 1:25 year storm event will be used. The required volume results in the attenuation facility being larger than the existing swale area and allocated space for the facility. The area required for the facility is approximately 210m^2 with a depth of

1.8m. Ponds are deliberately kept shallow to allow them to be incorporated into the site landscaping and for easier accessibility and maintenance, while also considering safety related requirements and risk mitigations. A rectangular basin shape with 1:3 (V:H) side slopes are recommended.

Note: The geotechnical investigation undertaken in May 2019 (JG Afrika, 2019) indicates groundwater water seepage at 1.5m at certain areas of the site. Further geotechnical investigation at the proposed attenuation facility would need to be undertaken to determine the exact depth of the water table in the vicinity. Possible mitigation measures to lower the water table include construction of subsoil interception drains (See Figure 5-1).

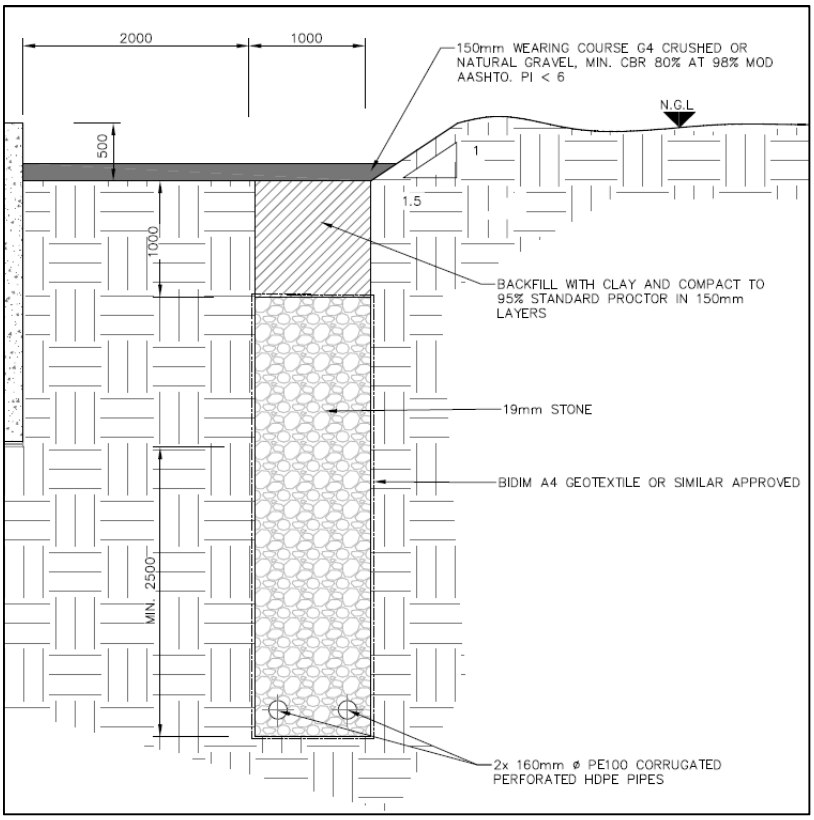

Figure 5-1: Typical Interception Drain Detail

The Department of Water and Sanitation (DWAS) requires that stormwater should be managed in such a way that contaminated and un-contaminated flow is separated from each other. Currently on the Robinson Deep landfill site, the contaminated stormwater is directed through a stormwater system into an evaporation pond to the north east of the Waste Disposal Facility (WDF). The attenuation facility is situated next to this evaporation pond (See Figure 5-2). The spillway (sized to 1:50 year flood) for the attenuation pond should be positioned to ensure that any overflow through the spillway would flow into the existing evaporation pond.

Figure 5-2: Location of proposed Attenuation Facility

Note: Although currently all stormwater from the site runs into the WDF evaporation pond, consultations with Department of Environmental Affairs and Department of Water Affairs and Sanitation would need to be undertaken to determine if this system is still acceptable.
The authorities may require testing or investigations to be undertaken. If the runoff into the evaporation pond is accepted by the authorities, then the capacity of the evaporation pond may need to be investigated to ensure there is sufficient capacity in the evaporation pond to accommodate the additional runoff from the plant. If the authorities agree that the stormwater runoff from the site is of a suitable quality and that it must enter directly into the municipal system, then it may connect, via concrete channels, to the Robinson Deep stormwater system which currently directs all stormwater from the roads into the existing municipal system.

Legislative and environmental approval may be required and should be investigated and resolved prior to construction. A stormwater management plan would need to be undertaken to address these design aspects.

The table below show the elements of the attenuation facility:

Attenuation Facility

Element	**Dimensions**
Catchment Area	0.9 ha
Actual Pond Capacity	315 m^3 (350 m^3/ha)
Basin area at embankment crest level	210 m^2
Dimensions shown on the drawing	32 m by 6 m (1.5m Deep with 1:3 side slopes) ***Note:*** This is **larger** than the original allocated space for the facility. Based on the current allocated area, the pond will need to **be ±2.5 m deep** Refer to Stormwater Layout Plan DWG

6 COST ESTIMATE

The table below lists the items and their estimated construction costs only. The cost does not include any possible bulk contribution fees.

The estimated construction cost also does not include the costs for the electrical, Telkom, mechanical etc. It also does not include any requirements that might become necessary during the detailed design phase (See Section 7 for Detail Design Considerations).

Table 6-1: Cost Estimate for Sewer and Stormwater Infrastructure

PROPOSED BULK INFRASTRUCTURE COST ESTIMATE						
Proposed Bulk Sewer	**Unit**	**Qty**	**Rate**		**Amounts**	
Sewer 110mmØ uPVC	m	220	R	1 350.00	R	297 000.00
Manhole	No	4	R	20 000.00	R	80 000.00
Floor Drain	Prov Sum	1	R	300 000.00	R	300 000.00
Grease Trap	No.	1	R	50 000.00	R	50 000.00
Sub- total (Bulk Sewer)					**R**	**727 000.00**
***Proposed Bulk Storm water**	**Unit**	**Qty**	**Rate**		**Amounts**	
Stormwater Pipelines	m	110	R	1 900.00	R	209 000.00
Grid Inlets	No.	4	R	15 000.00	R	60 000.00
Kerb Inlets	No.	8	R	15 000.00	R	120 000.00
Chutes	No.	4	R	10 000.00	R	40 000.00
Concrete Channels and Kerb	m	600	R	350.00	R	210 000.00
Sub- total (Bulk Stormwater)					**R**	**639 000.00**
General Items	**Unit**	**Qty**	**Rate**		**Amounts**	
1. Relocate, Connect to existing services	Prov Sum	1	R	100 000.00	R	100 000.00
2. Attenuation Facility	m^2	210	R	950.00	R	199 500.00
3. Bioswale	m^2	340	R	1 050.00	R	357 000.00
Sub-Total for General Items					**R**	**656 500.00**
Total (Construction Only)					**R**	**2 022 500.00**
Preliminary and General Costs				20%	R	404 500.00
Sub-Total					R	2 427 000.00
Add Contingencies (10%)				10%	R	242 700.00
Sub-Total					R	2 669 700.00
VAT (15%)				15%	R	400 455.00
TOTAL					R	3 070 155.00

Excludes cost for shaping of ground levels or any road pavement construction costs

7 DETAIL DESIGN CONSIDERATIONS

The conceptual design covers the basic principles for the sewer and stormwater management of the site. The following aspects will need to be further investigated and/or considered more comprehensively in the detailed design.

- The detailed design should consider screeding of existing building floors to ensure adequate drainage slope for drains within the building towards a floor drain outlet connection to the external sewer system. Careful consideration of outlet levels during detail design will be necessary.
- No existing underground services were verified for the concept design phase. Underground services should be identified, investigated and locations and invert levels verified prior to

finalising detailed design. Further it will be a worthwhile activity to undertake a CCTV investigation to confirm the existing condition assessment of underground pipe systems that may have been compromised by tree routes, et al.

- The detail design must comply with the design guidelines and standards of the Johannesburg Roads Agency (JRA) in accordance with the JRA stormwater management policy, it will be required that a detailed stormwater management plan be submitted with the detail designs and approved by the JRA prior to construction.
- It should be noted that the pipe and inlet sizes are indicative and the sizes of the pipe culverts as well as the hydraulic design will need to be modelled and calculated during the detailed design stage. Existing levels within the site boundary will be required to be reworked in order to achieve minimum drainage slopes.
- Further consideration will need to be given to the design of the bioswale. Consultation with a landscape architect to determine the plants/ vegetation best suited to the environment and function required.
- The geotechnical investigation undertaken in May 2019 (JG Afrika, 2019) indicates groundwater water seepage at 1.5m at certain areas of the site. Further geotechnical investigation at the proposed attenuation facility would need to be undertaken to determine the exact depth of the water table in the vicinity. Possible mitigation measures to lower the water table include construction of subsoil interception drains.
- Legislative and environmental approval may be required for approval of the stormwater management plan with particular focus on the runoff of the attention facility into the existing WDF evaporation pond. This should be investigated and resolved prior to construction.

Annexure A: DRAWINGS

DWG 4798/09/SEWLP/01- Conceptual Bulk Sewer Layout Plan
DWG 4798/09/SWLP/01- Conceptual Stormwater Layout Plan