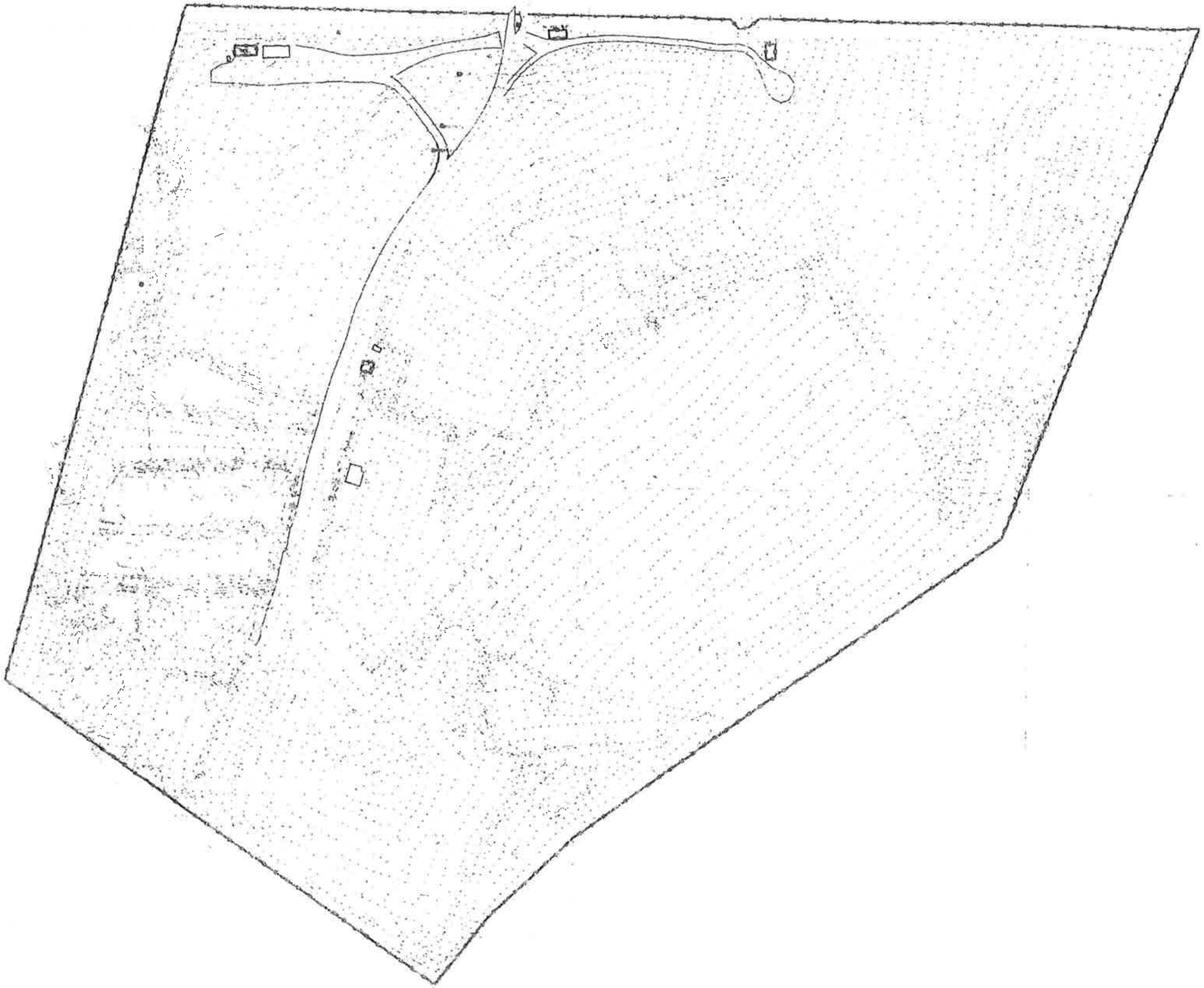

ENVIRO SERV

Project / Projek

SSF CHARLIE 1 LANDFILL SITE

EXISTING CONTOUR SURVEY BEFORE OPERATIONS

FIG 1

[illegible]	W.A. OPMETINGS TEL. (011) [illegible]5-2340 CELL 082 [illegible]
[illegible] JUNE [illegible]	1 : 3000

APPENDIX D

Fence Amendment

DEPARTMENT OF WATER AFFAIRS AND FORESTRY

Eloffgebou
Paul Krugerstraat 339

HOëVELDSTREEK
HIGHVELD REGION

Eloff Building
339 Paul Kruger Street

Navrae: / Enquiries: J. Goosen
U verwysing: / Your reference:
Ons verwysing: / Our reference: B33/2/310/28-S

Privaatsak / Private Bag X206
Pretoria
0001
hk/jg/20

Telefoon: / Telephone: 299-2542
Fax: / Faks: (012) 3242369
Telegramme: / Telegrams:

1993-02-01

Sasdiens
P.O. Box 1
SECUNDA
2320

ATTENTION: MR. GERT ERASMUS

SOLID WASTE SITE PERMIT B33/2/310/28/P51 : CHARLIE 1 SASOL SECUNDA

Enclosed please find the permit for your Charlie 1 site.

Yours faithfully

ANDRÉ DU TOIT

M van [signature]
REGIONAL DIRECTOR

VERTAAL IN ENGELS ASB.

GROETE
CHARLOTTE
Tel. 610 3443

DEPARTMENT OF WATER AFFAIRS
REPUBLIEK VAN SUID-AFRIKA / REPUBLIC OF SOUTH AFRICA

RESIDENSIEGEBOU / BUILDING, SCHOEMANSTRAAT 185 SCHOEMAN STREET

Fax: (012) 326-1780
(012) 323-4472

Privaatsak / Private Bag X313
Pretoria
0001

Navrae: / Enquiries: G. le Roux
☎ 299-2773
Verwysing: / Reference: B33/2/310/P51

glr/lk/0001D/49

26 JUL 1993

Omgewingsbestuurder: SASDIENS
Sasol Nywerhede (Edms.) Beperk
Posbus 1
SECUNDA
2303

AANDAG: MNR. P.S. JANSE VAN RENSBURG

Meneer

WYSIGING AAN PERMIT B33/2/310/P51 KRAGTENS ARTIKEL 20(1) VAN DIE WET OP OMGEWINGSBEWARING, 1989 (WET 73 VAN 1989) VIR DIE SASOL SECUNDA'S CHARLIE 1 AFVALSTORTTERREIN

Verwys asseblief na u versoek om bogenoemde terrein se omheining te verlaag vanaf 1,8 meter na 1,2 meter in hoogte.

Voorwaarde 4.2 van Permit B33/2/310/P51 gedateer 13 Januarie 1993 word hiermee soos volg gewysig:

4.2 Die Terrein moet doeltreffend omhein word met 'n heining van ten minste 1,2 meter hoog en hekke by toegangspunte met dieselfde hoogte ten einde ongemagtigde toegang redelikerwys te voorkom en die rondwaai van papiere en plastiek te beperk.

Bogenoemde Permit moet beskou word as gewysig in die voorafgaande mate.

Indien u enige navrae het, kan hierdie kantoor gerus geskakel word.

Die uwe

BESTUURDER: WETENSKAPLIKE DIENSTE
p.p. MINISTER VAN WATERWESE

APPENDIX E

Ponds Location Memorandum

TECHNICAL MEMORANDUM

DATE 27 February 2015 **REFERENCE No.** 1418079_TechMem_005

TO Mr J Toporski
Sasol Synfuels

CC SAP Brown

FROM A Botes and G Dode **EMAIL** GDode@golder.co.za

POLLUTION CONTROL DAM SITE SELECTION AND LOCATION

1.0 INTRODUCTION

Sasol Synfuels commissioned Golder Associates Africa (Pty) Ltd. (Golder) to conduct the feasibility of the extension of the existing Charlie1 land fill site. As the extension requires a dedicated pollution control dam (PCD), Golder was requested to substantiate the position of the PCD.

This technical memorandum covers the basic considerations for site selection with associated advantages and disadvantages for the various sites considered.

1.1 Background

Golder report (12614891-12400-1 Pre-feasibility Assessment for Site Extension and Storm Water Management for Charlie 1 Landfill) dated October 2013, stipulated that the PCD be situated immediately north west of Charlie 1. The inflow to the PCD will mainly comprise of contaminated runoff from the active landfill cells as well as contaminated shallow seepage from the overall landfill footprint area. This will be controlled within the PCD by means of enhanced evaporation. The quality of this water will most likely be very poor from the onset, and is likely to become poorer over time, due to the effect of evaporation. Hence, it is highly unlikely that the water accumulated in the dam will at any stage, even after prolonged rainfall events, be of acceptable quality to be released to the receiving environment.

The PCD will have a separate cell which will house the leachate from the leachate system, ensuring that the contaminated storm water and the leachate remain separate in the PCD.

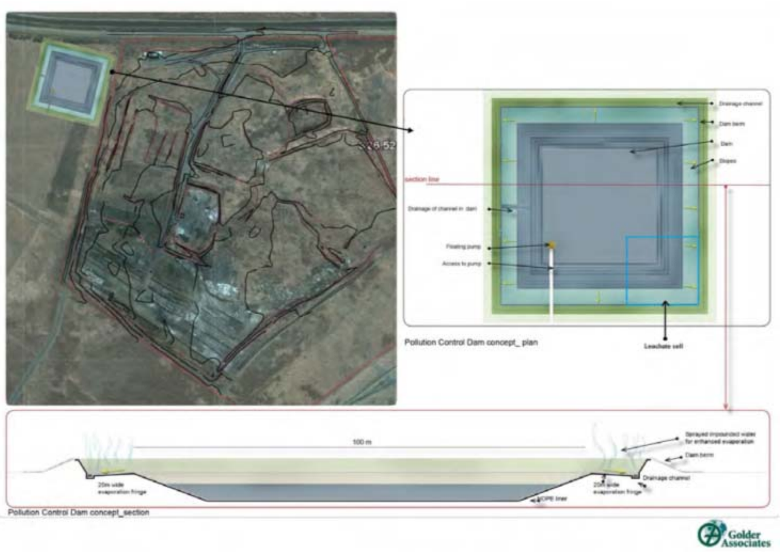

Figure 1: Proposed PCD Charlie 1 landfill

Reg. No. 2002/007104/07 Directors: SA Eckstein, RGM Heath, SC Naidoo, GYW Ngoma
Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

1.2 Objective of memorandum

The memorandum presents and analyses possible locations for the PCD at the Charlie 1 Landfill. While the pre-feasibility design (Golder, October 2013) placed the PCD in the location discussed above (also refer to Option 1), Sasol has requested that Golder provide reasoning for this decision based on a site selection analysis. Further to this, going forward into the feasibility stage of the project, a final decision needs to be made on the location of the PCD, taking the relevant technical and likely regulatory considerations into account.

2.0 REGULATORY ASPECTS

The following is Golder's viewpoint on the regulatory aspects regarding the positioning of the PCD for the Charlie 1 Landfill Site:

- A **full EIA** is required for the project regardless of the locality of the facility (i.e. within the current permitted/licensed area or not), since the construction of hazardous lagoon triggers a Full EIA (to our knowledge, this aspect was confirmed with the DEA in 2014);
- Since the dam is associated with the existing dump, the addition of the dam regardless of the locality of the facility will be considered an **expansion** to the current facility, and hence an "addition" to the current permitted/licensed area (again, this aspect was confirmed with the DEA in 2014). Therefore, the addition of the dam will be of no consequence to the current permit/licence for the dump; the current authorisation will still remain valid for the disposal activities (provided that disposal of general waste still takes place within the licensed area/footprint and not beyond); and
- With regard to the zoning of the property, it is understood that if the PCD is placed outside of the current permit/licence area, a process of rezoning will be required, whereas any location within the area will not.

3.0 SITE SELECTION OPTIONS

The following Section analyses each potential site location, weighing up potential advantages and disadvantages. All options are analysed at a high level with potential for optimisation during the design stage. It should be noted that no formal geotechnical investigations at these locations have been performed with regard to constructability of the PCD, and therefore this factor has not been included in the analysis.

3.1 Option 1

The location of the PCD in Option 1 is outside the property of the landfill site, immediately adjacent to the north western boundary. The pre-feasibility designs (Golder, October 2013) were based on this location, as shown in Figure 2.

Figure 2: Location of PCD in Option 1 (north-west of Charlie 1 Landfill)

3.1.1 Advantages and disadvantages Option 1

Table 1: Option 1 advantages and disadvantages

Advantages	Disadvantages
Situated at the closest low point to the Charlie 1 landfill.	Possibility of wetland in this area (Sasol has indicated that this is unlikely).
Site capacity is maximised for landfilling (no airspace loss).	Rezoning could be required (potentially a 2 year process). It is noted that no zoning was done for the two process water dams "recently" constructed within the Synfuels Secondary Area.
All surface water drainage can gravitate to this point, therefore no pumping is needed (making construction and operation more feasible).	
The dam is positioned in the corner of the adjacent property. Therefore the space is used optimally by utilising the minimal footprint (no dead space).	
Easy access from the gravel road to the north of Charlie 1. New roads will not have to be developed.	
Ground is relatively level and clear, making construction economical and simpler.	
There is no undermining at this proposed location that may influence geotechnical stability.	

3.2 Option 2

The location of the PCD in Option 2 is within the property boundary of the Charlie 1 Landfill. The PCD is located in the north western corner of the landfill area, as presented in Figure 3. A large part of this location has already been landfilled, with some small structures also existing.

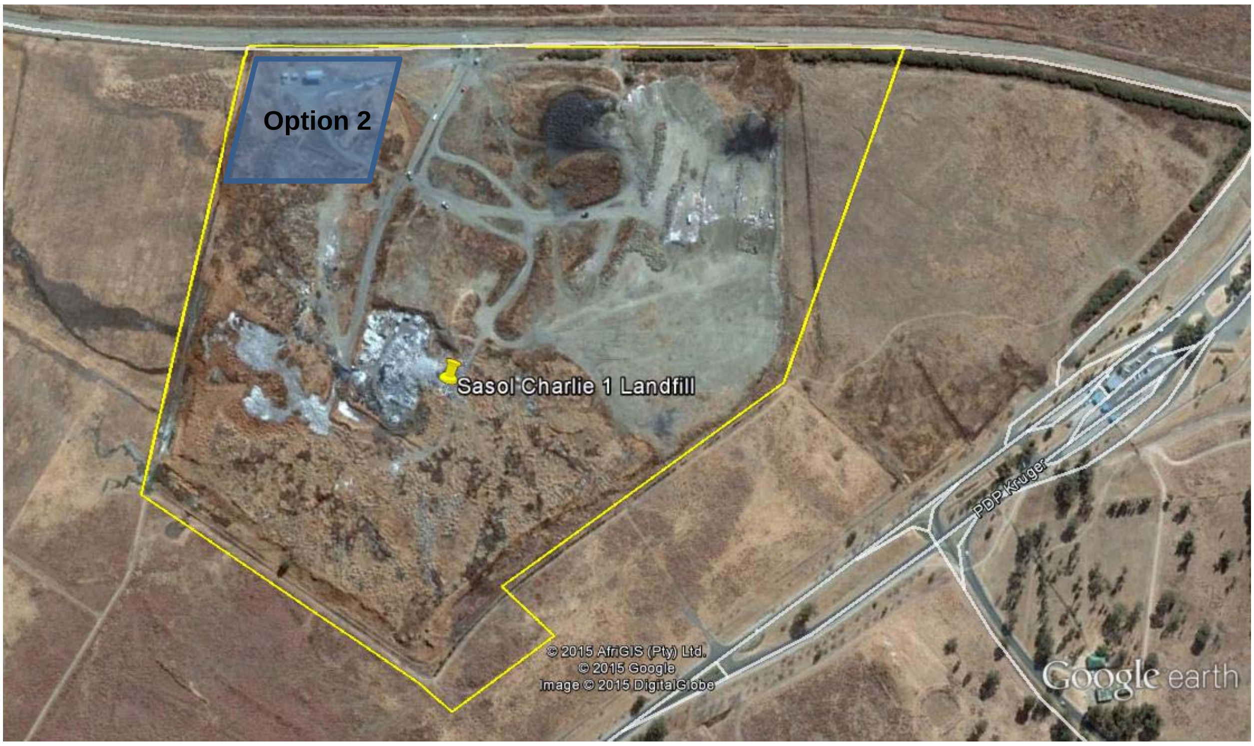

Figure 3: Location of PCD in Option 2 (north-west corner, within Charlie 1 Landfill boundary)

3.2.1 Advantages and disadvantages Option 2

Table 2: Option 2 advantages and disadvantages

Advantages	Disadvantages
No rezoning required purely on the basis that it is located within the bounds of the existing Charlie 1 permit that is still zoned as agriculture. If rezoning could be obviated, authorisation could be obtained "faster". It is noted that due to the nature of the liquid to be impounded in the PCD a full EIA is anyway required.	PCD is located on higher ground than the collection systems. This means that the stormwater will need to be collected and pumped upstream into the dam, which will have cost implications. Pumping of stormwater runoff invariably poses challenges.
Possible wetland will be avoided.	The area is not level and will require additional earthworks. The process of levelling and clearing will also involve the moving and "re-landfilling" of waste. Thereby reducing the landfill capacity of Charlie 1.
	Estimated airspace loss of landfill is: ■ 6.8% or 175 000 m^3 (15 m height at 1:4 side slopes); and ■ 8% or 275 000 m^3 (20 m height at 1:4 side slopes). Lifespan estimates are not given at this stage as the latest landfill disposal rates are unconfirmed.
	Although not expected to be of concern, the geotechnical stability will need to be confirmed due to undermining at the proposed location.
	Limited surface infrastructure e.g. shed will have to be removed and relocated to other portions of the landfill site which will have an influence on cost.

3.3 Option 3

The location of the PCD in Option 3 is in the south east corner of the Charlie 1 Landfill Site, inside the landfill property. The location proposed for Option 3 is shown in Figure 4. A large part of this location has already been landfilled, although a section of the eastern extent is currently open.

Figure 4: Location of PCD in Option 3 (south-east corner of the Charlie 1 Landfill, inside the property boundary)

3.3.1 Advantages and disadvantages Option 3

Table 3: Option 3 advantages and disadvantages

Advantages	Disadvantages
No rezoning required purely on the basis that it is located within the bounds of the existing Charlie 1 permit that is still zoned as agriculture. If rezoning could be obviated, authorisation could be obtained "faster". It is noted that due to the nature of the liquid to be impounded in the PCD a full EIA is anyway required.	Surface water will not gravitate to the dam location. Pumping, along with the construction of a collection sump will be required at a cost. The pumping requirements in this case, will be somewhat greater than those of Option 2.
Possible wetland will be avoided.	The process of levelling and clearing a small section of this location will involve the moving and "re-landfilling" of waste. Thereby reducing the landfill capacity of Charlie 1.
A large section of the proposed location is relatively level.	Estimated airspace loss of landfill is: ■ 1.9% or 49 000 m^3 (15 m height at 1:4 side slopes); and ■ 2.9% or 99 000 m^3 (20 m height at 1:4 side slopes). Lifespan estimates are not given at this stage as the latest landfill disposal rates are unconfirmed.
This option presents the lowest loss of landfill capacity while keeping the PCD on the landfill property	New service roads would have to be constructed to the dam.
	Although not expected to be of concern, the geotechnical stability will need to be confirmed due to undermining at the proposed location.

3.4 Option 4

The location of the PCD in Option 4 is in the north east corner of the site, within the boundary of the landfill property. A section of the PCD covers a currently landfilled area; however the extent of this cannot currently be confirmed (updated site surveys and/or imagery are required).

Figure 5: Location of PCD in Option 4 (north-east corner of the Charlie 1 Landfill, inside the property boundary)

3.4.1 Advantages and disadvantages Option 4

Table 4: Option 4 advantages and disadvantages

Advantages	Disadvantages
No rezoning required purely on the basis that it is located within the bounds of the existing Charlie 1 permit that is stilled zoned as agriculture. If rezoning could be obviated, authorisation could be obtained “faster”. It is noted that due to the nature of the liquid to be impounded in the PCD a full EIA is anyway required.	Surface water will not gravitate to the dam location. Pumping, along with the construction of a collection sump will be required at a cost. The pumping requirements in this case, will be somewhat greater than those of Option 2.
Possible wetland will be avoided.	The process of levelling and clearing a small section of this location will involve the moving and “re-landfilling” of waste. Thereby reducing the landfill capacity of Charlie 1.
A large section of the proposed location is relatively level.	Estimated airspace loss of landfill is: ■ 10.4% or 267 000 m^3 (15 m height at 1:4 side slopes); and ■ 10.4% or 350 000 m^3 (20 m height at 1:4 side slopes) Lifespan estimates are not given at this stage as the latest landfill disposal rates are unconfirmed.
There is no undermining at this proposed location that may influence geotechnical stability.	

3.5 Option 5

Option 5 involves the pumping of surface water and leachate to Sasol’s sewage treatment plant. This is located approximately 2.5 km south west of the facility and would include a pipeline with a minimum of two road crossings and a river crossing.

Figure 6: Option 5 involves pumping surface water and leachate to the sewage treatment plant

3.5.1 Advantages and disadvantages Option 5

Table 5: Option 5 advantages and disadvantages

Advantages	Disadvantages
No rezoning required, (allowing for a quicker approval process).	Pipeline with large pumps would need to be constructed at a cost.
EIA and other relevant licensing for PCD is not required.	Relevant licensing would be required for the pipeline (which includes at least two road crossings and a river crossing). This could be mitigated by using a pipeline not exceeding 360 mm, constructed within the road servitude.
Site capacity is maximised for landfilling (no airspace loss).	Mixing of contaminated surface runoff with potentially highly contaminated waste water could result.
All surface water drainage can gravitate to this point.	Confirmation that the treatment plant would be able to accept the leachate and stormwater must still be obtained.
Cost saving by not constructing a new PCD.	

3.6 Option 6

Option 6 is essentially a combination of Options 1 and 5. It includes a leachate sump, located at an appropriate location along the lower western boundary of the site, which will collect leachate. The leachate will then be pumped from this sump to the sewage treatment plant as in Option 5. The leachate will add a small additional waste load to the large sewage stream at the sewage treatment plant. A dedicated stormwater dam will collect the relatively clean run-off from the site, which will be located outside the property boundary, in the north-western corner, as in Option 1.

Figure 7: Option 6 involves pumping leachate to sewage treatment plant while stormwater run-off is collected in a new dam

3.6.1 Advantages and disadvantages Option 6

Table 6: Option 6 advantages and disadvantages

Advantages	Disadvantages
Potentially no rezoning required, allowing for a quicker approval process.	Pipeline with pumps would need to be constructed at a cost for leachate routing, however much less than pumping stormwater.
EIA may not be required, if General Authorisation route may be taken for the dam. Sump does not constitute a “hazardous lagoon”. It is noted that Golder has conducted an initial regulatory requirement assessment related to this option.	Relevant licensing would be required for the pipeline (which includes at least two road crossings and a river crossing). This could be mitigated by using a pipeline not exceeding 360 mm, constructed within the road servitude. In all likelihood the pipeline will be less than 100mm in diameter.
Site capacity is maximised for landfilling (minimal airspace loss).	Confirmation that the treatment plant would be able to accept the leachate must still be obtained.
Situated at the closest low point to the Charlie 1 landfill, therefore all surface water drainage can gravitate to this point.	
Liner requirements for the new stormwater dam are likely to be significantly reduced since no leachate will enter the dam.	
Easy access from the gravel road to the north of Charlie 1. New roads will not have to be developed.	
Ground is relatively level and clear, making construction economical and simpler.	
There is no undermining at this proposed location that may influence geotechnical stability.	

4.0 CONCLUSION

Having assessed all five of the proposed PCD locations and one option related to a stormwater dam, Option 1 is the favoured location from an engineering perspective. Option 1 provides the most feasible option largely due to the fact that it is located at the lowest point topographically, allowing for simpler and cost effective implementation of the PCD by minimising pumping and earthworks requirements. This option also affords the opportunity to develop the landfill to its footprint potential as authorised, notably increasing the available airspace and hence remaining operational life.

The only potentially significant disadvantage concerning this option is the rezoning which could be required, adding to the authorisation period. Given the timing constraints that this provides, Options 2 to 4 were analysed to provide alternatives within the current landfill boundary. Of these options, Option 2 has a topographical advantage which would result in less pumping requirements when compared to Options 3 and 4. It should however also be noted that Option 3 results in the least amount of airspace loss for the facility, largely because of its location in a “protruding” corner of the site, although this Option would require the construction of an access road and significant pumping. All of the options within the landfill boundary have additional cost implications relating to construction and operation as well as a reduction in the site capacity.

Option 5 provides a solution which does not require the construction of a PCD. The feasibility of this option is however questionable due to the quantity and mixing of surface run-off and leachate, as well as the licensing requirements that may be triggered.

Option 6 has potential to provide a solution with a faster authorisation process, though various aspects from a regulatory point of view will need to be confirmed with the authorities. This Option also provides a favourable solution from an engineering perspective, thus combining Options 1 and 5 into a single feasible option, without having to pump stormwater run-off. This option obviates a PCD as this could be replaced with a routine stormwater dam.

However, a small diameter pipeline for leachate routing from the landfill site to the existing sewage works would be required as well as confirmation that the leachate could be accepted.

 

A Botes/G Dode
Waste Rehabilitation and Closure

SAP Brown
Waste Rehabilitation and Closure

AB&GD/SAPB/abgd

APPENDIX F

Leachate Sampling Test Results

Results retrieved Sample criteria Result criteria Start date/time Start date/time	10-MAR-2015 11:50 Customer All results 3-MAR-2015 00:00 3-MAR-2015 16:00	003_S	Group: WL Final results only

Sample point/name	Date sampled	Component	Result	Units	Final
003TESTPIT1B	3-MAR-2015 12:00	pH	6.90		Yes
003TESTPIT1B	3-MAR-2015 12:00	Uncertainty of pH (p	0.02		Yes
003TESTPIT1B	3-MAR-2015 12:00	Temperature	21	deg_C	Yes
003TESTPIT1B	3-MAR-2015 12:00	Conductivity	3730	uS/cm	Yes
003TESTPIT1B	3-MAR-2015 12:00	Uncertainty of condu	79	uS/cm	Yes
003TESTPIT1B	3-MAR-2015 12:00	Total dissolved soli	2526	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Fluoride	0.380	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Uncertainty of Fluor	0.003	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	COD	340	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Sulfate	742.3	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Ammonia	2.0	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Nitrate + Nitrite as	0.95	mg N/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Phosphate	0.25	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Phosphorous	<0.20	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Chloride	726.5	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	P Alkalinity	0	mg/l as CaCO3	Yes
003TESTPIT1B	3-MAR-2015 12:00	Uncertainty of P alk	0	mg/l as CaCO3	Yes
003TESTPIT1B	3-MAR-2015 12:00	M Alkalinity	811	mg/l as CaCO3	Yes
003TESTPIT1B	3-MAR-2015 12:00	Uncertainty of M alk	17	mg/l as CaCO3	Yes

Sample point/name	Date sampled	Component	Result	Units	Final
003TESTPIT1B	3-MAR-2015 12:00	Calcium	288.10	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Cadmium	<0.10	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Chromium	<0.100	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Cobalt	<0.10	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Copper	<0.100	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Mercury	<0.10	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Potassium	19.73	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Sodium	456.10	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Nickel	0.10	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Lead	<0.10	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Zinc	<0.100	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Selenium	<0.10	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Arsenic	<0.10	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Manganese	2.07	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Aluminium	0.71	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Iron	0.54	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Boron	0.28	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Vanadium	<0.10	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Lithium	<0.100	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	TOC	25.892	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Magnesium	163.70	mg/l	Yes
003TESTPIT1B	3-MAR-2015 12:00	Silica	32.98	mg/l as SiO2	Yes
003TESTPIT4	3-MAR-2015 12:00	pH	6.95		Yes
003TESTPIT4	3-MAR-2015 12:00	Uncertainty of pH (p	0.02		Yes
003TESTPIT4	3-MAR-2015 12:00	Temperature	21	deg_C	Yes
003TESTPIT4	3-MAR-2015 12:00	Conductivity	5380	uS/cm	Yes
003TESTPIT4	3-MAR-2015 12:00	Uncertainty of condu	114	uS/cm	Yes
003TESTPIT4	3-MAR-2015 12:00	Total dissolved soli	4226	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Fluoride	0.538	mg/l	Yes

Sample point/name	Date sampled	Component	Result	Units	Final
003TESTPIT4	3-MAR-2015 12:00	Uncertainty of Fluor	0.004	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	COD	317	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Sulfate	731.0	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Ammonia	41.0	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Nitrate + Nitrite as	73.00	mg N/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Phosphate	<0.20	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Phosphorous	<0.20	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Chloride	825.6	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	P Alkalinity	0	mg/l as CaCO3	Yes
003TESTPIT4	3-MAR-2015 12:00	Uncertainty of P alk	0	mg/l as CaCO3	Yes
003TESTPIT4	3-MAR-2015 12:00	M Alkalinity	803	mg/l as CaCO3	Yes
003TESTPIT4	3-MAR-2015 12:00	Uncertainty of M alk	17	mg/l as CaCO3	Yes
003TESTPIT4	3-MAR-2015 12:00	Calcium	313.50	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Cadmium	<0.10	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Chromium	<0.100	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Cobalt	<0.10	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Copper	<0.100	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Mercury	<0.10	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Potassium	4.80	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Sodium	394.40	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Nickel	0.14	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Lead	<0.10	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Zinc	<0.100	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Selenium	<0.10	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Arsenic	<0.10	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Manganese	0.60	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Aluminium	0.30	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Iron	0.27	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Boron	0.13	mg/l	Yes

_

Sample point/name	Date sampled	Component	Result	Units	Final
003TESTPIT4	3-MAR-2015 12:00	Vanadium	0.10	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Lithium	<0.100	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	TOC	24.378	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Magnesium	240.20	mg/l	Yes
003TESTPIT4	3-MAR-2015 12:00	Silica	37.45	mg/l as SiO2	Yes
003TESTPIT6	3-MAR-2015 12:00	pH	7.08		Yes
003TESTPIT6	3-MAR-2015 12:00	Uncertainty of pH (p	0.02		Yes
003TESTPIT6	3-MAR-2015 12:00	Temperature	21	deg_C	Yes
003TESTPIT6	3-MAR-2015 12:00	Conductivity	2930	uS/cm	Yes
003TESTPIT6	3-MAR-2015 12:00	Uncertainty of condu	62	uS/cm	Yes
003TESTPIT6	3-MAR-2015 12:00	Total dissolved soli	2305	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Fluoride	0.666	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Uncertainty of Fluor	0.005	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	COD	401	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Sulfate	264.0	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Ammonia	1.8	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Nitrate + Nitrite as	0.31	mg N/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Phosphate	<0.20	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Phosphorous	<0.20	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Chloride	536.2	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	P Alkalinity	0	mg/l as CaCO3	Yes
003TESTPIT6	3-MAR-2015 12:00	Uncertainty of P alk	0	mg/l as CaCO3	Yes
003TESTPIT6	3-MAR-2015 12:00	M Alkalinity	535	mg/l as CaCO3	Yes
003TESTPIT6	3-MAR-2015 12:00	Uncertainty of M alk	11	mg/l as CaCO3	Yes
003TESTPIT6	3-MAR-2015 12:00	Calcium	166.30	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Cadmium	<0.10	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Chromium	<0.100	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Cobalt	<0.10	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Copper	<0.100	mg/l	Yes

Sample point/name	Date sampled	Component	Result	Units	Final
003TESTPIT6	3-MAR-2015 12:00	Mercury	<0.10	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Potassium	6.13	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Sodium	405.40	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Nickel	0.21	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Lead	<0.10	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Zinc	<0.100	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Selenium	<0.10	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Arsenic	<0.10	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Manganese	14.79	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Aluminium	1.19	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Iron	1.43	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Boron	5.67	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Vanadium	<0.10	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Lithium	<0.100	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	TOC	19.810	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Magnesium	111.70	mg/l	Yes
003TESTPIT6	3-MAR-2015 12:00	Silica	25.89	mg/l as SiO2	Yes

* - offspec result

APPENDIX G

Leachate Assessment Memorandum

TECHNICAL MEMORANDUM

DATE 10 April 2015

PROJECT No. 1418079_TechMem_007

TO Gregory Dode
Golder Associates

CC

FROM Elize Herselman

EMAIL eherselman@golder.co.za

CHARACTERISATION AND CLASSIFICATION OF STORM WATER AND SEDIMENT

1.0 INTRODUCTION

Golder Associates Arica (Pty) Ltd. (Golder) is designing a storm water and leachate management for the Charlie 1 Landfill at Sasol. As part hereof, legal requirements for the barrier design/liner design for the leachate and storm water interception system need to be determined.

This Technical Memorandum details the approach, methodology and findings of this investigation.

2.0 SAMPLING AND ANALYSES

Three test pits were excavated at the downstream toe of the waste body and leachate were collected from these test pits and analysed. The analytical results as supplied by Sasol were used as received. No verification on the quality of the analytical data was done.

3.0 ANALYTICAL RESULTS

The leachate from the test pits was assessed according to the Waste Classification and Management Regulations (WCMR) which was promulgated on 23 August 2013 (GN R.634 of 2013). In terms of Regulation 8 of the WCMR, waste must be assessed in accordance with the Norms and Standards for Assessment of Waste for Landfill Disposal prior to the disposal of waste to landfill (GN R.635 promulgated on 23 August 2013). The analytical results (total and leachable) must be assessed against the four levels of thresholds for leachable and total concentrations, which in combination, determines the waste type and associated barrier design/liner requirements. The terminology is as follows:

- LC - means the leachable concentration of a particular contaminant in a waste, expressed as mg/l;
- TC - means the total concentration of a particular contaminant in a waste, expressed as mg/kg;
- LCT - means the leachable concentration thresholds for particular contaminants in a waste (LCT0, LCT1, LCT2, LCT3); and
- TCT - means the total concentration thresholds for particular contaminants in a waste (TCT0, TCT1, TCT2).

Figure 1 shows the flow diagram of the process to be followed to determine the waste type for disposal. According to this process, the waste needs to be analysed to determine total and leachable concentrations of potential constituents of concern (CoCs). The results are then compared to the threshold values to determine the waste type.

<u>Note</u>: No TC results were available and only LC were evaluated.

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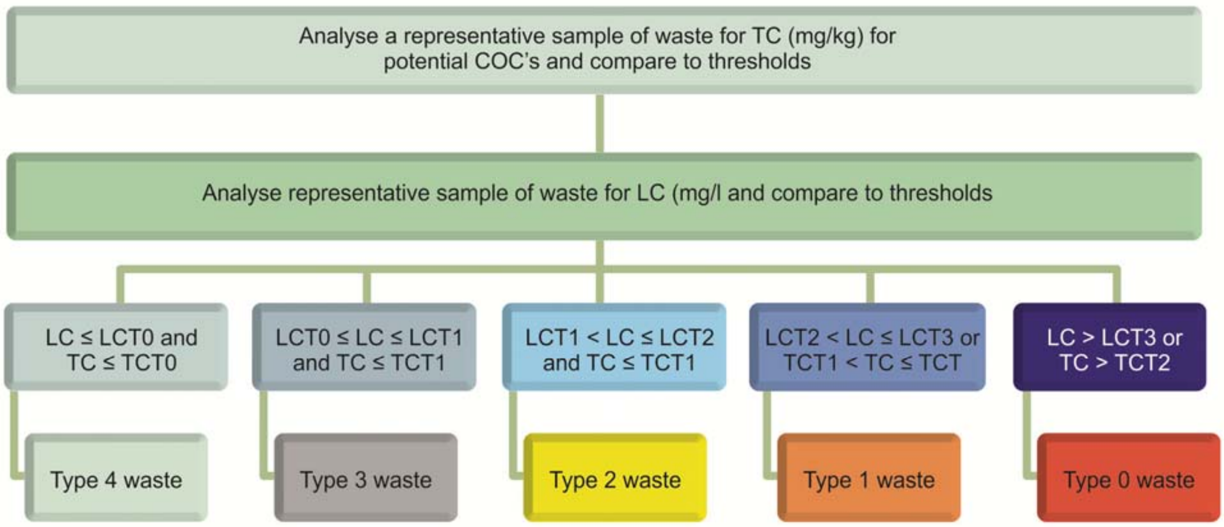

Figure 1: Flow diagram for waste assessment based on the WCMR

The analytical results of the leachate collected from the test pits (dissolved phase), compared to LCT levels are presented in

Table 1. These results indicate the following:

- Elevated Mn, Ni, TDS, Cl and SO_4 concentrations in all samples, exceeding LCT0 levels; and
- Elevated B (>LCT0) in leachate from Testpit 6.

This indicates that the CoCs in the sampled leach that have been collected in test pits at the downstream toe of the landfill, will migrate into the groundwater and will have to be intercepted.

Table 1: Analytical results of leachate samples from test pits compared to LCT levels

CoCs	LCT0	LCT1	LCT2	LCT3	TESTPIT 1B	TESTPIT 4	TESTPIT 6
pH	ng				6.9	6.95	7.08
EC µS/cm	ng				3730	5380	2930
Units	**mg/l**						
As, Arsenic	0.01	0.5	1	4	<0.1	<0.1	<0.1
B, Boron	0.5	25	50	200	0.28	0.13	5.67
Cd, Cadmium	0.003	0.15	0.3	1.2	<0.1	<0.1	<0.1
Co, Cobalt	0.5	25	50	200	<0.1	<0.1	<0.1
$Cr_{Total,}$ Chromium Total	0.1	5	10	40	<0.1	<0.1	<0.1
Cu, Copper	2	100	200	800	<0.1	<0.1	<0.1
Fe, Iron	ng				0.54	0.27	1.43
Hg, Mercury	0.006	0.3	0.6	2.4	<0.1	<0.1	<0.1
K, Potassium	ng				19.73	4.8	6.13
Li, Lithium	ng				<0.1	<0.1	<0.1
Mg, Magnesium	ng				163.7	240.2	111.7
Mn, Manganese	0.5	25	50	200	2.07	0.6	14.79

CoCs	LCT0	LCT1	LCT2	LCT3	TESTPIT 1B	TESTPIT 4	TESTPIT 6
Na, Sodium	ng				456.1	394.4	405.4
Ni, Nickel	0.07	3.5	7	28	0.1	0.14	0.21
Pb, Lead	0.01	0.5	1	4	<0.1	<0.1	<0.1
Se, Selenium	0.01	0.5	1	4	<0.1	<0.1	<0.1
V, Vanadium	0.2	10	20	80	<0.1	0.1	<0.1
Zn, Zinc	5	250	500	2000	<0.1	<0.1	<0.1
Total Dissolved Solids	1000	12500	25000	100000	2526	4226	2305
Chloride as $C\ell^-$	300	15000	30000	120000	726.5	825.6	536.2
Sulphate as SO_4^{2-}	250	12500	25000	100000	742.3	731	264
Nitrate as NO_3^-/NO_2^-	11	550	1100	4400	0.95	73	0.31
Fluoride as F^-	1.5	75	150	600	0.38	0.538	0.666

4.0 CONCLUSION

In concluding on the liner/barrier design the following served as basis:

- The assessment results of the leachate in Testpit 6, based on the risk averse principle in Section 2 of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA), are used in selecting the Class of barrier/liner design for the contaminated stormwater channels and the leachate pond;
- The leachate quality indicated potential contamination of the groundwater with Mn, Ni, Cl and SO_4;
- When assessed according to LCT levels of GN R.635, the leachate is a Type 3;
- Based on this assessment, a Class C/G:L:B$^+$ (GN R.636 of 23 August 2013) liner will be required; and
- Since GN R.636 prescribes landfill designs final endorsement will have to obtained from the Department of Water Affairs and Sanitation to confirm the acceptability of a Class C design for the leachate pond (in certain instances regarded as a hazardous lagoon by the DWS and not as a landfill in terms of its design).

It should be noted that since leach samples have been taken in test pits at the toe of the Site these can be regarded as representative of actual leach quality potentially migrating into the water resource and hence defensible as a basis for the barrier design (in the absence of TC which is not available since the required *aqua regia* tests cannot be performed on a liquid sample).

JE Herselman
Senior Soil Scientist / Waste Classification Consultant

L Bredenhann
Strategic Advisor

EH/LB/jep

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APPENDIX H

View Shed Analysis Memorandum

TECHNICAL MEMORANDUM

DATE 7 April 2015

REFERENCE No. 1418079_TechMem_006_Rev 1

TO Jim Toporski
Sasol Synfuels

CC A Botes

FROM J Bothma

EMAIL jbothma@golder.co.za

SASOL SYNFULES CHARLIE 1 LANDFILL: VISUAL ASSESSMENT MODELLING TO DETERMINE POTENTIAL SCREENING EFFECTIVENESS OF VEGETATIVE BARRIERS

1.0 INTRODUCTION

Sasol Synfuels (Sasol) forms part of the Sasol Secunda Industrial Complex and is located on the Mpumalanga Highveld south of the town of Secunda. The Charlie 1 landfill site situated adjacent to Charlie 1 Gate has been developed and permitted (B33/2/310/28/P51, dated January 1993) to accept general waste from day to day operations at Sasol, and is classified as a Class 2 landfill – medium-sized general landfill, which does not produce significant leachate (GMB-).

The Charlie 1 waste permit states no height restriction for the landfill site and the landfill needs to be extended in order to cater for increased waste disposal needs of the Sasol operations. However, Sasol is concerned with the aesthetics of the landfill in general, but specifically for a number of key receptors, namely:

- Charlie 1 Gate;
- Graceland Casino & Hotel; and
- Secunda Mall.

Golder Associates Africa (Pty) Ltd. (Golder) was commissioned by Sasol to determine the most technically feasible option for extension of Charlie 1 landfill, by conducting initial air space modelling for various landfill design parameters and aesthetic considerations.

Golder conducted an initial GIS (Geographic Information System) based visibility/viewshed analysis of the various landfill configurations from the key receptors. The work reflected in this technical memorandum is a follow-up and refinement of this analysis.

2.0 FINDINGS OF PREVIOUS VIEWSHED ANALYSIS

Viewshed analysis modelling *(Sasol Charlie 1 Dump: Viewshed analysis to determine visibility of various dump heights and initial screening options*; number 12614891_Techmemo_002; Golder, 2013) was conducted for unscreened landfill heights of 5, 10, 15 and 20 m. The results for all the options were largely similar, with the landfill expected to be visible from more than 80% of the study area for all unscreened options, including from the casino, mall and most of the surrounding residential neighbourhoods.

Given the above, separate mitigation options were generated for the 5 m and 20 m landfill heights, i.e. with a line of trees placed along the:

- Northern and eastern boundaries of the landfill site; and
- Southern boundary of the casino golf course.

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For this modelling, the visual screening effect of trees were simulated by placing ellipses of 20 m x 12 m x 10 m high, spaced 6 m apart, as obstructions within the digital elevation model used for the viewshed analysis.

The results of the viewshed analysis indicated that by placing a tree screen along the eastern site boundary, the visual impact from the Charlie 1 Gate could be significantly mitigated for all landfill heights. Placing a similar tree screen along the northern site boundary would to some extent screen the landfill from view from the Secunda Mall and Graceland Casino golf course, for a landfill height of 5 m. However, the tree screen would not be effective at screening a landfill with a 15 m or 20 m height, especially when viewed from an elevated location.

It was therefore recommended that further visual assessment of various tree screen and landfill height combinations be conducted in order to verify and substantiate the results of the viewshed analysis.

3.0 FOLLOW-UP VISUAL ASSESSMENT

The follow-up visual assessment involved the taking of photographs of the landfill site from the above receptor locations on 5 February 2015; and then digitally superimposing textured three-dimensional models of the different landfill designs and graphically isolated photos of suitable tree and shrub specimens onto the photographs, creating a conceptual impression of what the various mitigated options will most likely look like.

3.1 View from Charlie 1 Gate

Charlie 1 Gate is arguably the most sensitive visual receptor location in terms of the planned expansion of the landfill, as it is located directly adjacent to the existing landfill site. Nevertheless the existing landfill is currently not highly visible, due to its relatively low height. However, the landfill becomes notably more visible as its height increases, especially at heights of 15 m and 20 m. It is therefore recommended that vegetative visual screening be implemented. Two options were assessed, namely a tree screen only (Figure 1) and combination of trees and shrubs (Figure 2).

From the visual modelling it can be seen that the tree-only screen provides a somewhat limited degree of screening regardless of the landfill height, due to the fact that the landfill is partially visible between the tree trunks and underneath the tree canopy. While the degree to which this will occur is partially dependant on the growth form and spacing of the specific tree species that is chosen, it is unlikely that the full screening of the landfill will be achieved using a tree screen only. Nevertheless, the trees tend to focus the attention of the viewer on the foreground of the view, thereby lessening the visual impact of the landfill itself. In addition, once profiled, capped and vegetated, the visual impact of the landfill in conjunction with the tree screen is expected to be significantly mitigated, regardless of its final height.

Conversely, the combination of trees and dense shrubs as a screen is expected to significantly screen the landfill from view, especially for the 5 m and 10 m landfill heights. While the top of the landfill will be partially visible at 15 m and 20 m the actual visual impact will be further reduced due to the appearance of the vegetative screen.

Existing scenario

Tree screen only, 5 m landfill height

Tree screen only, 10 m landfill height

Tree screen only, 15 m landfill height

Tree screen only, 20 m landfill height

Figure 1: View from Charlie 1 Gate - tree screen only

Tree and shrub screen, 5 m landfill height

Tree and shrub screen, 10 m landfill height