Calculation sheet number: 09160001C-01-CAL-0001
Caculation sheet description: Surface flood retention and peak discharge
Caculation type (if applicable): SCS, Rational and SDF
Date of calculations: 24-03-2025
Calculations done by: Des Fourie

Calculation summary:

Surface flood retention and peak discharge

Calculation method	Flood Retention (m^3) - V	Peak Discharge (m^3/s) - Q
SCS	13495	2.5
Rational	8355.00	1.51
SDF	8083	2.1

Conclusion:

The flood retention volume for the purpose of design will be based on the rational method. Peak discharge for the purpose of design will also be based on the Rational method. The design may improve on this minimum storage requirement as subsequent revisions to the design may be effected.

In order to calculate flood retention volume and peak discharge, the following will be utilized for the SCS method:

Abbreviation	Item description	Unit of measure	Source	Input value
Q_p	Peak discharge	m^3/s	Calculated	
V	Catchment volume	m^3	Calculated	
A	Catchment area	km^2	Measured	0.114366
Q	Stormflow depth	mm	Calculated	
Event	Storm event	years		01:50
T_L	Catchment lag time	hours	Calculated	
L	Hydraulic length of catchment along main channel	km	Measured	0.539
S	Potential Maximum Soil Water Retention/Infiltration	mm	Calculated	
CN	Curve number	N/A	Chart	91.7
y	Average catchment slope	%	Calculated	
ARF	Areal reduction factor	%	Calculated	
T_c	Time of concentration	hours	Calculated	
r	Roughness coefficient	N/A	Tabulated with recommended values	0.3
P_d	Runoff potential	mm	Chart	140
I_a	Initial abstraction	mm	Calculated from S, based on curve number	23
S (Slope)	Based on Invert levels set for the design	m/m	Measured	N/A
N	Contour interval	m	Measured	10

Supporting info:

Surface description	Recommended value of r
Paved areas	0,02
Clean compacted soil, no stones	0,1
Sparse grass over fairly rough surface	0,3
Medium grass cover	0,4
Thick grass cover	0,8

SCS (Soil Conservation Service) - SA Method

The United States Department of Agriculture's Soil Conservation Service based techniques for the estimation of design flood volume and peak discharge from relatively small catchments with slopes of less than 30 % has been adapted for South African conditions by the Water Research Commission

Average catchment slope is calculated to be:

y 0.3 % Invert levels set out in drawing - Reference 09160001E-C.9.20-01-001-01

Potential Maximum Soil Water Retention is calculated to be:

S 23 mm

$$S = \frac{25400}{CN} - 254$$

Stormflow depth is calculated to be:

Q 118 mm

$$Q = \frac{(P_D - I_A)^2}{P_D - I_A + S}$$

P reduced to PD

Aereal reduction factor is calculated to be:

ARF 120.2 %

$$ARF = (90\,000 - 12\,800 \ln A + 9\,830 \ln t)^{0.4}$$

Where:
ARF = Areal reduction factor (%)
A= Catchment area (km^2)
t = Time of concentration (min)

May not exceed 100

Time of Concentration is calculated to be:

T_c 1 hr

$$T_c = 0.604 \left(\frac{rL}{S^{0.5}}\right)^{0.467}$$

Catchment volume

V 13495 m^3 V = Q x A

Catchment lag time is calculated to be:

T_L 0.61 hrs

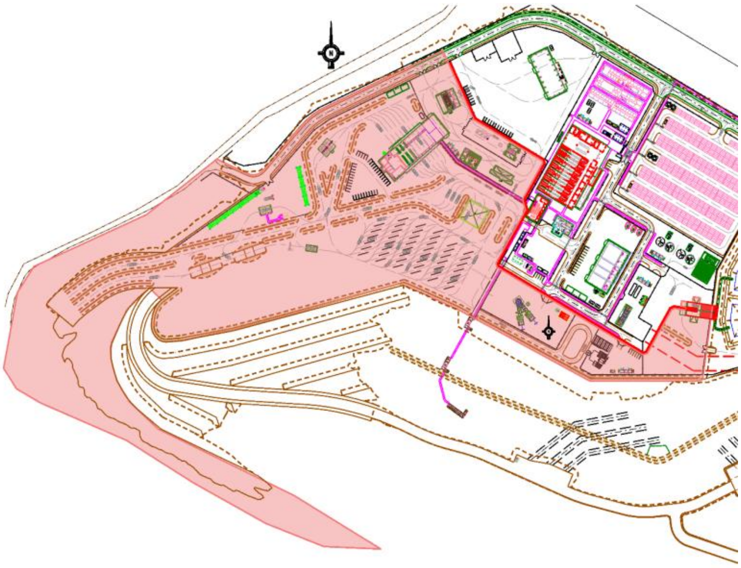
$$TL = \frac{L^{0.8}(S + 25.4)^{0.7}}{7069(y^{0.5})}$$

Peak discharge is calculated to be:

Q_p 2.5 m^3/s

$$Q_P = \frac{0.2083(A)(Q)}{1.83 T_L}$$

The stormwater/dirty water drain and catchment area information is as follows:



Catchment area	114366 m^2		
Drain length	539.5 m		
Drain invert start	1193.376		
Drain invert end	1191.911		
Drain fall	**1.465 m**	**0.3%**	**1:368**
Drain cross section	1.5m wide and 0.75m deep at start		
Terrace fall to drain	1 in 100		

In order to calculate flood retention volume and peak discharge, the following will be utilized for the rational method:				
Abbreviation	**Item description**	**Unit of measure**	**Source**	**Input value**
Qp	Peak discharge	m^3/s	Calculated	
V	Catchment volume	m^3	Calculated	
A	Catchment area	km^2	Measured	0.114366
L	Hydraulic length of catchment along main channel	km	Measured	0.539
Event	Storm event	years		01:50
I	Rainfall Intensity	mm/hour	SAICE Chart 2	50
Tc	Time of concentraction	minutes	Calculated	
r	Roughness coefficient	N/A	Tabulated with recommended values	0.3
C	Runoff factor	N/A	Chart	0.95
S (SANRAL)	Average slope of the overland path	m/m	Measured	0.003
Time of Concentration is calculated to be:				
Tc	61	minutes	$T_c = 0.604\left(\frac{rL}{S^{0.5}}\right)^{0.467}$	
Catchment volume				
V	8355.00	m^3	V = Q x 3Tc x 60/2	
Peak discharge is calculated to be:				
Q_p	1.51	m^3/s	Q = CIA/3.6	

In order to calculate flood retention volume and peak discharge, the following will be utilized for the SDF method:

Abbreviation	Item description	Unit of measure	Source	Input value
Q_t	Peak discharge	m^3/s	Calculated	
V	Catchment volume	m^3	Calculated	
A	Catchment area	km^2	Measured	0.114366
MAP	Mean annual precipitation	mm	Struan SAWS	550
Event	Storm event	years		01:50
L	Hydraulic length of catchment along main channel	km	Measured	0.539
Sav (SANRAL)	Average slope of the overland path	m/m	Measured	0.003
Pt.T	Point precipication depth	mm	Calculated	
It	Rainfall intensity	mm/hr	Calculated	
ARF	Areal reduction factor	%	Calculated	
T_c	Time of concentraction	hours	Calculated	
C_t	Runoff coefficient	N/A	Calculated	
r	Roughness coefficient	N/A	Tabulated with recommended values	0.3

Supporting info:

Table 3B.1: Information required for the calculation of the SDF

Basin	SAWS station number	SAWS site	M (mm)	R (days)	C_2 (%)	C_{100} (%)	MAP (mm)	MAE (mm)
1	546 204	Struan	56	30	10	40	550	1800

TABLE 8: RETURN PERIOD FACTORS

T =	2	5	10	20	50	100	200
Y_T =	0	0.84	1.28	1.64	2.05	2.33	2.58

Time of Concentration is calculated to be:

T_c 0.392 hrs

$$T_c = \left(\frac{0.87L^2}{1000S_{av}}\right)^{0.385}$$

Rainfall intensity is calculated to be (based on modified Herschfield equation):

$P_{t.T}$ 70.685 mm

$$P_{t,T} = 1.13(0.41 + 0.64lnT)(-0.11 + 0.27lnt)(0.79M^{0.69}R^{0.2})$$

Aereal reduction factor is calculated to be:

ARF 117 %

$$\mathbf{ARF = (90\,000 - 12\,800lnA + 9\,830lnt)^{0.4}}$$

Where:
ARF = Areal reduction factor (%) May not exceed 100
A= Catchment area (km^2)
t = Time of concentration (min)

Runoff coefficient is calculated to be:

C_t 0.364

$$C_T = \frac{C_2}{100} + \left(\frac{Y_T}{2,33}\right)\left(\frac{C_{100}}{100} - \frac{C_2}{100}\right)$$

Catchment volume is calculated to be:

V 8083 m^3

Rainfall intensity is calculated to be:

I_t 180 mm/hr

$$I_T = \frac{P_{t,T}}{T_c}$$

Peak discharge is calculated to be:

Q_t 2.1 m^3/s

$$Q_T = \frac{C_T I_T A}{3,6}$$

Calculation sheet number:	09160001C-01-CAL-0003
Caculation sheet description:	Slope Stability On Dams - Worst Case
Caculation type (if applicable):	
Date of calculations:	24-03-2025
Calculations done by:	Des Fourie

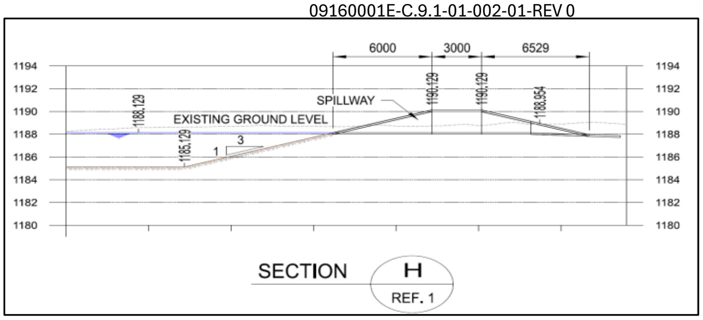
Conclusion/summary:

These calculations are applicable to settling-, return water- as well as pollution control dams. The slope stability analysis shows that an acceptable factor of safety have been achieved.
The planned geotechnical investigation is required to confirm these results.
The source of assumptions for c and Ø values is a report referenced in detail in the WULA design report (Reference 13.10).
It may also be noted the South African Pavement Engineering Manual prredicts much higher shear and friction angles for the slopes under investigation as the construction materials will be a G5 imported product as defined in TRH 14: 1986

In order to do a slope stability design check, the following will be utilized:

Abbreviation	Item description	Unit of measure	Source	Input value
F	Safety factor	N/A	Calculation	
c	Cohesive strength of construction material	kN/m^2	Assumed from Table 3	5
ϕ	Friction angle	degrees/º	Assumed	20
γ	Compacted density of construction material	kN/m^3	Assumed	19
N	Stability number	N/A	Read from chart (Fig 5.17)	
c_m	Cohesion value	kN/m^2	Calculation	
F_c	Factor of safety for cohesion only	N/A	Calculation	
H	Height of constructed embankment	m	Drawings	2

Reference drawing: 09160001E-C.9.1-01-002-01-REV 0



Reference table:

TABLE 3: PEAK STRENGTH PARAMETERS DERIVED FROM PREVIOUS TRIAXIAL AND SHEAR BOX TESTING, AND PARAMETERS FROM GEOTECHNICAL CHART

	Triaxial Testing on Similar Soils		Shear Box Testing on Similar Soils		Strength Parameters from Geotechnical Chart	
Soil Description	Cohesion c' (kPa)	Friction angle ϕ' (degrees)	Cohesion c' (kPa)	Friction angle ϕ' (degrees)	Cohesion c' (kPa)	Friction angle ϕ' (degrees)
Black slickensided clay (CH)	16 – 26	14 - 17	29 - 34.5	8.2 - 9	25 ± 10	22 ± 4
Highly weathered norite (SM)	-	-	4 - 5.5	38.4 - 38.9	0	34 ± 3

Reference chart:

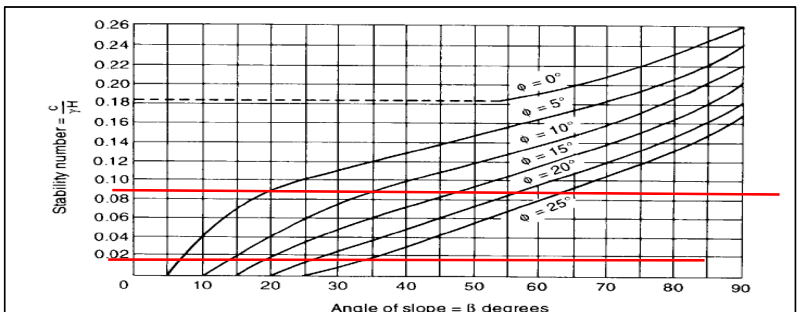
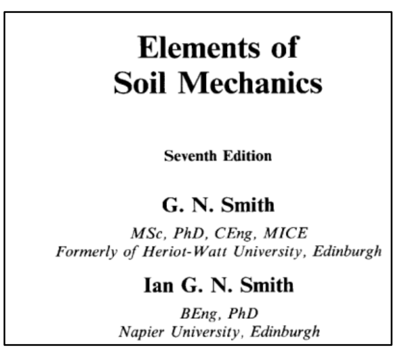


Fig. 5.17 Curves for total stress analysis (After Taylor (1948); for $\phi = 0°$ and $\beta < 53°$, use Fig. 5.18).

Reference literature:



Elements of Soil Mechanics

Seventh Edition

G. N. Smith

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Ian G. N. Smith

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Formulae:

$$F = \frac{Shear\ Strength}{Disturbing\ Shear}\ i.e.F = \frac{c + \sigma tan\emptyset}{\tau}$$

$$\frac{tan\emptyset}{F}$$

$$N = \frac{c}{\gamma H}$$

$$\tau = \frac{c}{F} + \frac{\sigma tan\emptyset}{F}$$

For an assumed F = 1.5, the following:

From formula, Ø has been calculated to be 13.6°. When utilizing Figure 5.17, a stability number of 0.017 is derived. From here c_m is calculated and by calculating F_c, 7.74 is obtained, which is too high.

Formulas used: $\frac{tan\emptyset}{F}$ $c_m = N\gamma H$ $F_c = \frac{c}{c_m}$

For an assumed F = 2, the following:

By using the same methodology as for F = 1.5, but with F = 2, Ø has been calculated to be 10.3°. A stability number of 0.082 is obtained from Figure 5.17. This results in F_c being calculated as 1.6 which is indicating the factor of safety cannot be 2.

For an assumed F = 1.52, the following:

Taking into account F = 1.5 and F = 2, a value of F = 1.52 was selected. A stability number of 0.084 is obtained from Figure 5.17. This results in F_c being calculated as 1.57. With F = 1.52 and F_c being 1.57, the safety factor is satisfactory.

This will result in a factor of safety for the slope, being 1.5.

Calculation sheet number:	09160001C-01-CAL-0004
Caculation sheet description:	In-pit flood retention and peak discharge
Caculation type (if applicable):	SCS, Rational and SDF
Date of calculations:	24-03-2025
Calculations done by:	Des Fourie

Calculation summary:

Surface flood retention and peak discharge

Calculation method	Flood Retention (m³) - V	Peak Discharge (m³/s) - Q
SCS	40878	712
Rational	35114.31	11.55
SDF	13655	10.1

Conclusion:

The flood retention volume and peak discharge for the purpose of design will be based on the rational method. The SCS method is disregarded for peak discharge and flood retention.

Space is available in-pit to accommodate the flood retention predicted in the North East corner.

In order to calculate in-pit flood retention volume and peak discharge, the following will be utilized for the SCS method:

Abbreviation	Item description	Unit of measure	Source	Input value
Q_p	Peak discharge	m^3/s	Calculated	
V	Catchment volume	m^3	Calculated	
A	Catchment area	km^2	Measured	0.297
Q	Stormflow depth	mm	Calculated	
T_L	Catchment lag time	hours	Calculated	
Event	Storm event	years		1:100
L Eastern Path	Hydraulic length of catchment in-pit	km	Measured	0.75
L Western Path	Hydraulic length of catchment in-pit	km	Measured	0.498
S	Potential Maximum Soil Water Retention/Infiltration	mm	Calculated	
CN	Curve number	N/A	Chart	91.7
y	Average catchment slope	%	Calculated	
ARF	Areal reduction factor	%	Calculated	
T_c	Time of concentraction	hours	Calculated	
r	Roughness coefficient	N/A	Tabulated with recommended values	0.3
P_d	Runoff potential	mm	Chart, Marikana for a 1:100-year storm	160
I_a	Initial abstraction	mm	Calculated from S, based on curve number	23
S (Slope - Eastern Path)	Based on Invert levels set for the design	m/m	Measured	0.0676
S (Slope - Western Path)	Based on Invert levels set for the design	m/m	Measured	0.0723
N	Contour interval	m	Measured	10

Supporting info:

Surface description	Recommended value of r
Paved areas	0,02
Clean compacted soil, no stones	0,1
Sparse grass over fairly rough surface	0,3
Medium grass cover	0,4
Thick grass cover	0,8

SCS (Soil Conservation Service) - SA Method

The United States Department of Agriculture's Soil Conservation Service based techniques for the estimation of design flood volume and peak discharge from relatively small catchments with slopes of less than 30 % has been adapted for South African conditions by the Water Research Commission

Average catchment slope

The average slope value cannot be applied to a flow path length of 500 m, as the actual slope is much flatter and pit path length is longer (see contour and lengths measurements below):

Average catchment slope for entire catchment area, y(%), may be determined from the following equation:

$$y(\%) = \frac{(\mathbf{M})(\mathbf{N})(\mathbf{10})^{-4}}{\mathbf{A}}$$

Where:

M = Total length of all contour lines (m) within the catchment, according to the scale of the map

M	11945	m
N = Contour interval (m)	10	m
A = catchment area (km^2)	0.297	km^2
y	40.2	%

The relevant slopes and path lengths for the Eastern and Western paths will be used for the purpose of calculations.

Note that the catchment is largely in rock with thin soil cover, hence runoff can be assumed to be 100%, particularly as design for a 100 year return interval storm should assume days of light rain, sufficient to saturate the soil layer, before the 100 year storm hits. Ref: Prof Alexander article in SAICE journal ~ 2001. SEE ALSO Sanral Drainage Manual Table 3.8 and the note below it that recommends using C = 100% for 100 year return interval.

Average catchment slope is calculated to be:

y, Eastern path	0.0676	m/m	Invert levels set out in drawing - Reference 09160001E-C.9.20-01-001-01
y, Western path	0.0723	m/m	

Potential Maximum Soil Water Retention is calculated to be:

S 23 mm

$$S = \frac{25400}{CN} - 254$$

Stormflow depth is calculated to be:

Q 137.5 mm

$$Q = \frac{(P_D - I_A)^2}{P_D - I_A + S}$$

P reduced to PD

Aereal reduction factor is calculated to be:

ARF 114.5 %

$$\mathrm{ARF} = (90\,000 - 12\,800 \ln A + 9\,830 \ln t)^{0.4}$$

Where:

ARF = Areal reduction factor (%)

A= Catchment area (km^2)

t = Time of concentration (min)

May not exceed 100

Time of Concentration is calculated to be:

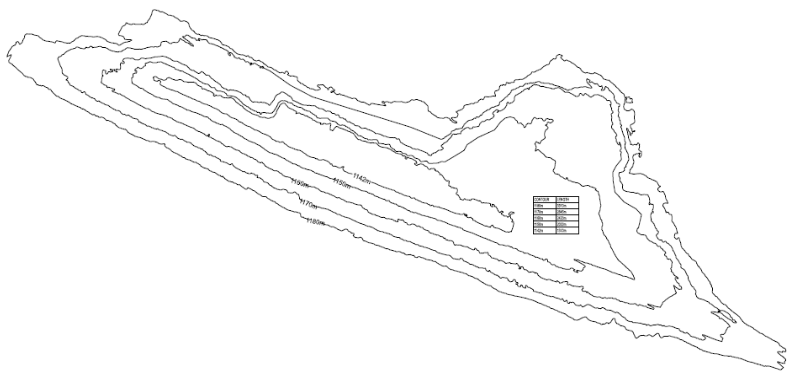
T_c Eastern Path	0.563	hrs
T_c Western Path	0.5	hrs

$$T_c = 0.604\left(\frac{rL}{S^{0.5}}\right)^{0.467}$$

Catchment volume			
V Eastern Path	40878 m^3	V = Q x A	Highest T_c so only Eastern Path considered.
Catchment lag time is calculated to be:			
T_L Eastern Path	0.01 hrs	$TL = \frac{L^{0.8}(S+25.4)^{0.7}}{7069(y^{0.5})}$	Highest L so only Eastern Path considered.

Peak discharge is calculated to be:			
Q_p	712 m^3/s	$Q_P = \frac{0.2083(A)(Q)}{1.83T_L}$	Highest TL so only Eastern path considered.

The stormwater and catchment area information is as follows:



M

	Contour interval (AMSL) m	**Length (m)**
	1180	3310
	1170	2845
	1160	2420
	1150	2000
	1142	1370
38	**m Elevation M Σ =**	**11945**

Reference email from Wayne Howroyd dated 21/05/2024

In order to calculate in-pit flood retention volume and peak discharge, the following will be utilized for the rational method:				
Abbreviation	**Item description**	**Unit of measure**	**Source**	**Input value**
Q_p	Peak discharge	m^3/s	Calculated	
V	Catchment volume	m^3	Calculated	
A	Catchment area	km^2	Measured	0.297
Event	Storm event	years		1:100
L Eastern Path	Hydraulic length of catchment along main channel	km	Measured	0.75
L Western Path	Hydraulic length of catchment along main channel	km	Measured	0.498
I Eastern Path	Rainfall Intensity	mm/hour	SAICE Chart 2	140
I Western Path	Rainfall Intensity	mm/hour	SAICE Chart 2	142
T_c	Time of concentraction	minutes	Calculated	
r	Roughness coefficient	N/A	Tabulated with recommended values	0.3
C	Runoff factor	N/A	Chart	1
S (Slope - Eastern Path)	Based on Invert levels set for the design	m/m	Measured	0.0676
S (Slope - Western Path	Based on Invert levels set for the design	m/m	Measured	0.0723

Time of Concentration is calculated to be:			
T_c Eastern Path	33.78	minutes	$T_c = 0.604\left(\frac{rL}{S^{0.5}}\right)^{0.467}$
T_c Western Path	25	minutes	
Catchment volume			
Volume Eastern path	35114.31	m^3	V = Q x $3T_c$ x 60/2
Volume Western path	26358.75	m^3	Worst case scenario (Eastern path) will be used.
Peak discharge is calculated to be:			
Q_p Eastern path	11.55	m^3/s	Q = CIA/3.6
Q_p Western path	11.72	m^3/s	Worst case scenario (Eastern path) will be used.

In order to calculate in-pit flood retention volume and peak discharge, the following will be utilized for the SDF method:

Abbreviation	Item description	Unit of measure	Source	Input value
Q_t	Peak discharge	m^3/s	Calculated	
V	Catchment volume	m^3	Calculated	
A	Catchment area	km^2	Measured	0.297
MAP	Mean annual precipitation (noting the reported value for the site of 655 mm)	mm	Struan SAWS	550
Event	Storm event	years		1:100
L Eastern Path	Hydraulic length of catchment along main channel	km	Measured	0.75
L Western Path	Hydraulic length of catchment along main channel	km	Measured	0.498
$S_{Eastern\ Path}$ (SANRAL)	Average slope of the overland path	m/m	Measured	0.0676
$P_{t,T}$	Point precipication depth	mm	Calculated	
It	Rainfall intensity	mm/hr	Calculated	
ARF	Areal reduction factor	%	Calculated	
T_c	Time of concentraction	hours	Calculated	
C_t	Runoff coefficient	N/A	Calculated	
r	Roughness coefficient	N/A	Tabulated with recommended values	0.3

Supporting info:

Table 3B.1: Information required for the calculation of the SDF

Basin	SAWS station number	SAWS site	M (mm)	R (days)	C_2 (%)	C_{100} (%)	MAP (mm)	MAE (mm)
1	546 204	Struan	56	30	10	40	550	1800

TABLE 8: RETURN PERIOD FACTORS

T =	2	5	10	20	50	100	200
Y_T =	0	0.84	1.28	1.64	2.05	2.33	2.58

Time of Concentration is calculated to be:

T_c 0.15 hrs

$$T_c = \left(\frac{0.87L^2}{1000S_{av}}\right)^{0.385}$$

Only Eastern path considered as this is worst case.

Rainfall intensity is calculated to be (based on modified Herschfield equation):

$P_{t,T}$ 45.977 mm

$$P_{t,T} = 1.13(0.41 + 0.64lnT)(-0.11 + 0.27lnt)(0.79M^{0.69}R^{0.2})$$

Only Eastern path considered as this is worst case.

Aereal reduction factor is calculated to be:

ARF 110 %

$$ARF = (90\,000 - 12\,800lnA + 9\,830lnt)^{0.4}$$

Where:
ARF = Areal reduction factor (%) May not exceed 100
A= Catchment area (km^2)
t = Time of concentration (min)

Runoff coefficient is calculated to be:

C_t 0.4

$$C_T = \frac{C_2}{100} + \left(\frac{Y_T}{2,33}\right)\left(\frac{C_{100}}{100} - \frac{C_2}{100}\right)$$

Catchment volume is calculated to be:

V 13655 m^3

Only Eastern path considered as this is worst case.

Rainfall intensity is calculated to be:

I_t 307 mm/hr

$$I_T = \frac{P_{t,T}}{T_c}$$

Peak discharge is calculated to be:

Q_t 10.1 m^3/s

$$Q_T = \frac{C_T I_T A}{3,6}$$

Only Eastern path considered as this is worst case.

Calculation sheet number:	09160001C-01-CAL-0005
Caculation sheet description:	Spillway Design Check - Worst Case
Caculation type (if applicable):	
Date of calculations:	24-03-2025
Calculations done by:	Des Fourie

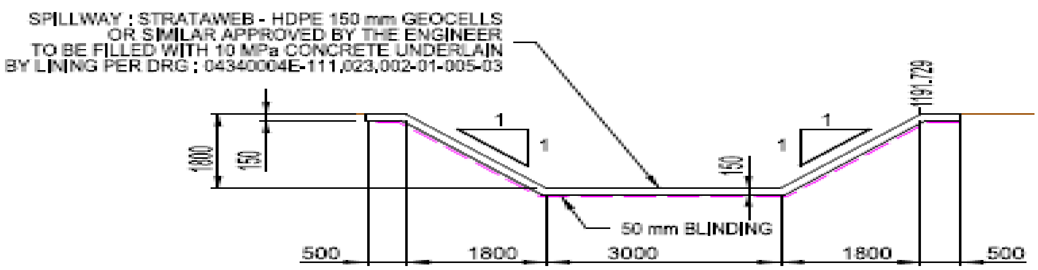
Conclusion:

The spillway from the settling dams to the return water dam is the smallest of all spillways and subsequently has been utilized as worst case scenario. The spillway design shows that the spillway sizing for all spillways is thus adequate and that the discharge side of the spillway will accommodate a flow of less than 3m/s, which is adequate. The velocity on the downstream side of the spillway has been reviewed and is less than 3m/s, on condition a minimum slope of 1:55 is maintained. The drawings indicate a slope of less than 1:55 so the velocity will not present a degradation attack to the lining.

In order to do a spillway design check, the following will be utilized:

Abbreviation	Item description	Unit of measure	Source	Input value
L_e	Effective length/width of spillway	m	Drawings	3
h	Flood level above TOC	m	Drawings	1
C_d	Coefficient of discharge	N/A	Calculated	
h_e	Effective height of flow above spillway	m	Calculated	
Q	Peak discharge from 1:50 year storm event	m^3/s	Calculated from 0916000C-01-CAL-0001	2.1
Q_A	Maximum allowable flow from spillway	m^3/s	Calculate	
P	Height from invert level on dam to top of spillway	m	Drawings	3
d_n	Normal depth of flow	m	Calculated	
B	Width of the spillway/channel	m	Drawings	3
s	Slope	N/A	Drawings	01:55
V_n	Normal velocity	m/s	Calculated	
g	Gravitational acceleration	m/s^2	N/A	9.81

Reference drawing: 09160001E-C.9.1-01-002-01-REV 0



SECTION - SPILLWAY - SETTLING DAMS

SCALE 1: 100

Assumption:

Spillway is 3000mm wide and 1000mm high (vertically) in trapezoidal shape however rectangular shape has been used for calculations.

P = 3000mm Reference 09160001E-C.9.1-01-002-01-REV 0 Section C

Coefficient of discharge, C_d, is calculated to be:

C_d 0.63

$$C_d = 0.602 + \frac{0.083h}{P}$$

Rhebock formula in BS3680 Part 4A:1965

Reference Fluid Mechanics for Civil Engineers by N.B. Webber 1971

Effective height of flow ,h_e, is calculated to be:

h_e 1.0012 m

h_e = h + 0.0012

Maximum allowable flow, Q_A, is calculated to be:

Q_A 5.6 m^3/s

$$Q_A = \frac{2}{3}\sqrt{2gC_d}L_e h_e^{\frac{3}{2}}$$

Manning d_n value on spillway exit is calculated to be:

d_n 0.158 m

$$Q_A = \frac{Bd_n}{n}\left[\frac{Bd_n}{B+2d_n}\right]^{\frac{2}{3}}\sqrt{s}$$

Reference 0916000C-01-CAL-0001 Surface flood and peak

V_n is calculated to be:

V_n 2.95 m/s

$$V_n = \frac{Q_A}{Bd_n}$$

Velocity <3m/s acceptable

Froude no is calculated to be:

Froude no 2.37

$$Froude\ No = \frac{V_n}{\sqrt{g}d_n}$$

Reference Fluid Mechanics for Civil Engineers by N.B. Webber 1971

Section 7.7 Scouring and silting p164

Supercritical flow maintained due to Froude no > 1

Calculation sheet number:	09160001C-01-CAL-0006
Caculation sheet description:	Subsoil Drain Loading
Caculation type (if applicable):	
Date of calculations:	24-03-2025
Calculations done by:	Des Fourie

Conclusion:

HDPE flexible slotted drainage pipe with smooth bore

Source https://tinyurl.com/3eh3x845

Loading, pipe and liner information

Liner	
Width	110mm HDPE slotted pipe buried
Trench	750mm wide x 750mm deep

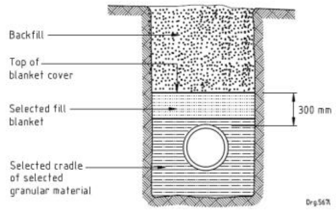
Loading	Density	Depth/thickness	Width	Loading/m
Liner weight	2400kg/m^3	0.2m	0.75m	3.5kN/m
Weight of water	1000kg/m^3	4m	0.75m	29.4kN/m
Front End Loader Axle Loading	-	-	-	87kN/m
Soil pressure	1900kg/m^3	0.75m	0.75m	10.5kN/m
Total loading (worst case excl water)				**101kN/m**

The loading is specified for worst case scenario when a Front End Loader (FEL) will be cleaning out a dam. In this instance there will be no water loading. The total loading is well below the design resistance load of 150kN/m provided the bedding and filler material are correctly constructed as per CQA. A typical FEL such as a Bell 2606E has been used for the purpose of calculations.
Axle loading = (25576)(9.81)/2 = 125.9kN spread across axle width of 2.877m = 87kN/m.

Reference Buried Pipe Design by A.P. Moser and Steven Folkman, Third Edition McGraw Hill, 2008

Pipe Strength Calculation based on the Moser and Spangler procedure

Subsoil Drain	110	mm Diameter
Fill Conditions	200 thick concrete liner plus water surcharge or Vehicle Loading	
Negative Project Codition	SANS 10102-1: 2013	
Bedding Class	d	Figure 5 SANS 2001-DP1: 2011



b) Backfilling over flexible pipeline

Filtration Geotextile to encase the the pipe line

Table 1 - Loads on buried pipes	SANS 10102-1: 2013	
Liner	Static Load	
Water Surcharge	Static Load	
Fill Load	Static Load	
Vehicle Load	Live	
Fluid Pressure due to transient flow	Live	ignored as nominal

From Table 2 Property of soil SANS 10102-1

γ	20	kN/m^3	
E_s	11	MPa	Proctor Density 97%

Area Moment of Inertia Section Properties = I $\frac{\pi(D^4 - d^4)}{64}$

D	110	mm	
d	100	mm	
I	2.3E+06	mm^4	
r	52.5	mm	
Stiffness Factor	EI	25.1E+06	MPa

Ring stiffness $= \frac{EI}{r^3}$ 173.2 N/mm

Pipe stiffness $= \frac{F}{\Delta y} = 6.7\frac{EI}{r^3}$ 1160.3 kN/m

Pipe stiffness = $\frac{}{\Delta y}$ = 0.? $\frac{}{r^3}$

K	0.083	Bedding angle 180° or 0.1
D_L	1.5	After RK Watkins

L

$$\Delta X = \frac{D_L K W_c r^3}{EI + 0.061 e r^4} \qquad (3.4)$$

where D_L = deflection lag factor
K = bedding constant
W_c = Marston's load per unit length of pipe, lb/in
r = mean radius of pipe, in
E = modulus of elasticity of pipe material, lb/in²
I = moment of inertia of pipe wall per unit length, in⁴/in = in³
e = modulus of passive resistance of sidefill, lb/(in²) (in)
ΔX = horizontal deflection or change in diameter, in

E' is recommended in SANS 10201-1 as 11 MPa refer reference above

The CQA will ensure that tis density is achieved Proctor Density 97%

W_c 101 kN/m Refer loading above

Spangler's modified equation or the Iowa formula

$$\Delta X = \frac{D_L K W_c r^3}{EI + 0.061 E' r^3} \qquad (3.5)$$

ΔX 0.087

The theory is defined in emprical units however the calculation has been carried out in metric units.

Therefore this deflection is acceptable

Calculation sheet number:	09160001C-01-CAL-0007
Caculation sheet description:	Channel Flow on Surface
Caculation type (if applicable):	
Date of calculations:	24-03-2025
Calculations done by:	Des Fourie

Conclusion:

The Rational method was used to size the channel. The cross section and fall is adequate to carry the peak discharge. This will inherently apply to the silt trap entry and exit channels.

In order to do a channel flow design check, the following will be utilized:

Abbreviation	Item description	Unit of measure	Source	Input value
L	Length of channel	m	Drawings	539
$H_{0.10}$	10% of average slope	m	Calculated as 10% of fall of channel	
$H_{0.85}$	85% of average slope	m	Calculated as 85% of fall of channel	
$L_{0.10}$	10% of channel length	m	Calculated as 10% of length of channel	
$L_{0.85}$	85% of channel length	m	Calculated as 85% of length of channel	
S_{av}	Slope	m/m	SDF worksheet	0.003
A	Cross sectional area of channel	m^2	Calculated from drawing	0.863
P	Wetted perimeter of channel	m	Calculated from drawing	2.96
n	Roughness factor (Manning)	N/A	SANRAL Drainage manual	0.014
v	Velocity	m/s	Calculated	
r	Ratio of area to perimeter	N/A	Calculated	

Reference drawing:		09160001E-C.9.20-01-001-01
From drawings:		
	Channel width:	1500mm
	Channel depth:	575 mm

Velocity is calculated as follows:

v	1.81	m/s	$v = \frac{1}{n} r^{\frac{2}{3}} . s^{\frac{1}{2}}$

Peak discharge is calculated as follows:

Q	1.56	m^3/s	Q = v x A

With Rational method, Peak discharge was calculated to be 1.51 m^3/s, thus the channel size is sufficient.

Calculation sheet number:	09160001C-01-CAL-0008
Caculation sheet description:	Silt Trap Sizing
Caculation type (if applicable):	
Date of calculations:	24-03-2025
Calculations done by:	Des Fourie

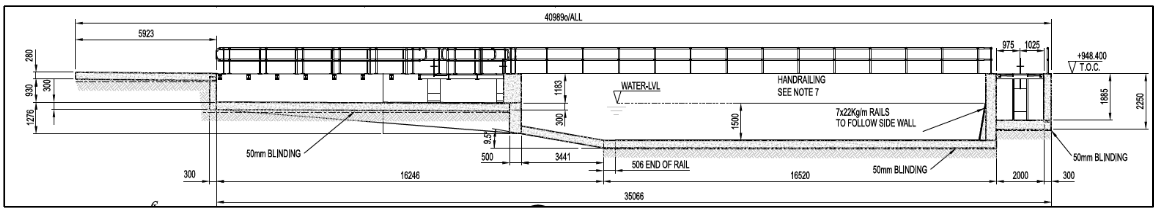
Conclusion:

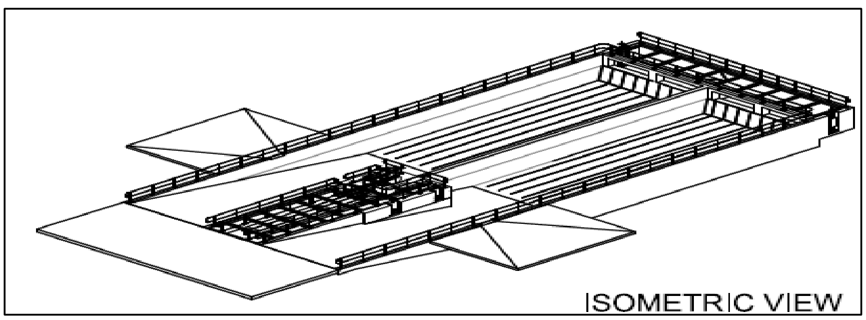
Two scenarios were run to confirm silt trap sizing; 1:50 year storm event as well as normal operations. In both instances it was confirmed that the silt trap capacity as per drawings is sufficient. One compartment would be sufficient herefor, however a second compartment is allowed to allow cleaning and simultaneous operation of silt trap with the associated drying pads which is discussed in the design report.
It may however be noted that in a Jones and Wagener report A SOUTH AFRICAN CASE STUDY ON SEDIMENT CONTROL MEASURES
WITH THE USE OF SILT TRAPS IN THE COAL MINING INDUSTRY

In order to do a silt trap sizing check, the following will be utilized:

Abbreviation	Item description	Unit of measure	Source	Input value
V	Silt trap compartment volume	m^3	Calculated from drawings	
Q_{storm}	Volume of sediment introduced in storm event	m^3/hr	Calculated from Fig 2 in report and CAL-0001	
Q_{normal}	Volume of sediment introduced in normal operation	m^3/hr	Calculated from Fig 2 in report and CAL-0001	
$Q_{silt, retained}$	Rate of silt retention in single compartment	m^3/hr	Calculated	
$V_{silt, retained}$	Volume of silt retained in single compartment	m^3/hr	Calculated	
$t_{silt, cleaning}$	Time interval between cleaning	hrs	Calculated	
V_L	Durand's limiting velocity	m/s	Calculated	
$V_{s, storm}$	Settling velocity in storm event	m/s	Calculated	
$V_{s, normal}$	Settling velocity in normal operation	m/s	Calculated	
Fl	Durand & Condolios Flow coefficient	N/A	Read off chart	0.6
g	Gravitational acceleration	m/s^2		9.81
D	Depth of flow	m		1.3
SG	Specific Gravity	N/A	Assumed	2.65
RD	Relative Density	t/m^3	Assumed	1.005
BD	Bulk Density	t/m^3	Assumed	1.65

Reference drawing: 09160001E-C.1-01-003-01





Assumptions & parameters:	In the event of a storm, all normal inflows of water into silt trap will remain in place.		
	Storm: Sediment load relative density (RD)	1.005	t/m^3
	Storm: Sediment loading rate in a storm event	38.57	t/hr
	Storm: Sediment loading rate in a storm event	23.38	m^3/hr with bulk density of $1.65t/m^3$
	Normal: Sediment load relative density (RD)	1.005	t/m^3
	Normal: Sediment loading under normal operation	0.77	t/hr
	Normal: Sediment loading under normal operation	0.47	m^3/hr with bulk density of $1.65t/m^3$
	80% of silt is retained in the silt trap (storm & normal operation)		
	20% of silt is carried over into settling dams (storm & normal operation)		
	Bulk density (BD)	1.65	t/m^3
	Specific gravity (SG)	2.65	

Silt trap single compartment capacity is calculated as follows:

Sloped area	68.04	m^3	16.2mL x 1.5mH x 5.6mW (50%)
Flat area	138.60	m^3	16.5mL x 1.5mH x5.6mW
Total V	**206.64**	**m^3**	

Total inflow in event of a storm is calculated as follows:

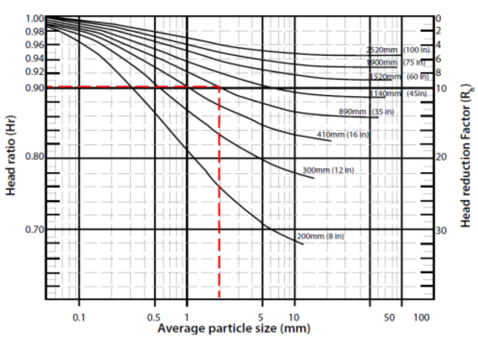
Storm event	7560	m^3/hr
Service water tank	0.007	m^3/hr
Potable water tank	0.007	m^3/hr
Fire water tank	0.007	m^3/hr
MG2 RWD	130	m^3/hr
Fissure water	10	m^3/hr

Oil separator	14.4 m^3/hr	
Total Q_{storm}	**7714.42 m^3/hr**	2.14 m^3/s

Total inflow under normal operating conditions is calculated as follows:			
Service water tank	0.007 m^3/hr		
Potable water tank	0.007 m^3/hr		
Fire water tank	0.007 m^3/hr		
MG2 RWD	130 m^3/hr		
Fissure water	10 m^3/hr		
Oil separator	14.4 m^3/hr		
Total Q_{normal}	**154.42 m^3/hr**		0.04 m^3/s
Volume of silt retained in silt trap in event of a storm is calculated as follows:			
At 80% retention			
$Q_{silt, retained}$	18.70 m^3/hr	80% of sediment loading	
$V_{silt, retained}$	56.10 m^3	For 3hr ($3T_c$) storm event, $V_{silt, retained}$	
Volume of silt retained is less than volume of silt trap, so sufficient capacity is available in silt trap.			
Cleaning intervals of silt trap under normal operations is calculated as follows:			
At 80% retention			
$Q_{silt, retained}$	0.37 m^3/hr	80% of sediment loading	
$t_{silt, cleaning}$	551.99 hrs	Intervals between cleaning	
Durand's limiting velocity for settlement is calculated as follows:			
V_L	4.16 m/s	$V_L = Fl\sqrt{\frac{2gD(SG-RD)}{RD}}$	
Actual settling velocity under storm event is calculated as follows:			
$V_{s, storm}$	0.29 m/s	This is lower than Durand's velocity, so settling will occur. Calculated on cross sectional area for silt trap of 5.8mW x 1.3mH.	
Actual settling velocity under normal operation is calculated as follows:			
$V_{s, normal}$	0.006 m/s	This is lower than Durand's velocity, so settling will occur. Calculated on cross sectional area for silt trap of 5.8mW x 1.3mH.	

Particle Sizing Assumptions

An example below being of a graph from the Hydraulic Institute Standard "12.1-12.6: Rotodynamic (Centrifugal) Slurry Pumps for Nomenclature, Definitions, Applications and Operation"

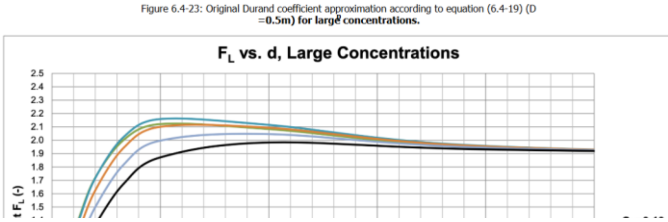


Information from HI Standards reproduced courtesy of Hydraulic Institute, Parsippany, NJ www.Pumps.org

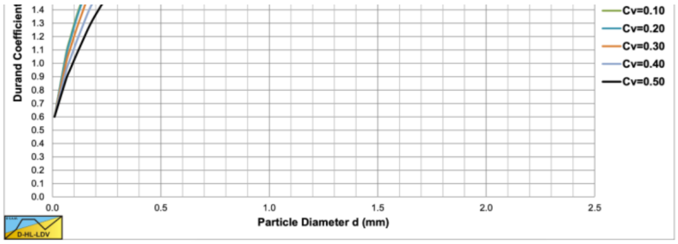
A d_{50} of 2 mm can be expected based on typical service water conditions as depicted in the chart shown in the Metso/Outotec slurry pumping manual
Samples will taken once silt deposition has taken place to validate this assumption which will also confirm % of silt retained

F_l Sourced from the Durand and Condolios chart for Limiting Factor vs Particle size

Figure 6.4-23: Original Durand coefficient approximation according to equation (6.4-19) (D =0.5m) for large concentrations.



https://tinyurl.com/2s3uxx9d


Durand Coefficient
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
0.5
1.0
1.5
2.0
2.5
Particle Diameter d (mm)
Cv=0.10
Cv=0.20
Cv=0.30
Cv=0.40
Cv=0.50
D-HL-LDV

Calculation sheet number: 09160001C-01-CAL-0009
Caculation sheet description: Settling Dam Sizing
Caculation type (if applicable):
Date of calculations: 24-03-2025
Calculations done by: Des Fourie

Conclusion:

Two scenarios were run to confirm settling dam sizing; 1:50 year storm event as well as normal operations. It is important to note that the inflow of water during a storm event would exceed the settling dams' capacity, however these dams are not designed for storm water catchment, only for the purpose of sediment settling. The PCD dam is sized to handle the volume of storm water required. Refer to 09160001C-01-CAL-0001.
The comments in the summary with respect to the sediment load in the sil trap calculations 09160001C-01-CAL-

In order to do a settling dam sizing check, the following will be utilized:

Abbreviation	Item description	Unit of measure	Source	Input value
V	Silt trap compartment volume	m^3	Calculated from drawings	
Q_{storm}	Volume of sediment introduced in storm event	m^3/hr	Calculated from Fig 2 in report and CAL-0001	
Q_{normal}	Volume of sediment introduced in normal operation	m^3/hr	Calculated from Fig 2 in report and CAL-0001	
$Q_{silt, retained}$	Rate of silt retention in single compartment	m^3/hr	Calculated	
$V_{silt, retained}$	Volume of silt retained in single compartment	m^3/hr	Calculated	
$t_{silt, cleaning}$	Time interval between cleaning	hrs	Calculated	
SG	Specific Gravity	N/A	Assumed	2.65
RD	Relative Density	t/m^3	Assumed	1.005
BD	Bulk Density	t/m^3	Assumed	1.65

Reference drawing: 09160001E-C.9.1-01-001-01

Assumptions & parameters:

In the event of a storm, all normal inflows of water into settling dams will remain in place.

Storm: Sediment load relative density (RD)	1.005	t/m^3
Storm: Sediment loading rate in a storm event	38.57	t/hr
Storm: Sediment loading rate in a storm event	23.38	m^3/hr with bulk density of $1.65t/m^3$
Normal: Sediment load relative density (RD)	1.005	t/m^3
Normal: Sediment loading under normal operation	0.77	t/hr
Normal: Sediment loading under normal operation	0.47	m^3/hr with bulk density of $1.65t/m^3$

80% of silt is retained in the silt trap (storm & normal operation)

20% of silt is carried over into settling dams (storm & normal operation)

Bulk density (BD)	1.65	t/m^3
Specific gravity (SG)	2.65	

Volume of settling dams calculated as follows:

Settling dam North	1750.00	m^3
Settling dam South	1750.00	m^3
Total V	**3500.00**	$\mathbf{m^3}$

Total inflow in event of a storm is calculated as follows:

Storm event	7560	m^3/hr		
Service water tank	0.007	m^3/hr		
Potable water tank	0.007	m^3/hr		
Fire water tank	0.007	m^3/hr		
MG2 RWD	130	m^3/hr		
Fissure water	10	m^3/hr		
Oil separator	14.4	m^3/hr		
Total Q_{storm}	**7714.42**	$\mathbf{m^3/hr}$	2.14	m^3/s

Total inflow under normal operating conditions is calculated as follows:

Service water tank	0.007	m^3/hr		
Potable water tank	0.007	m^3/hr		
Fire water tank	0.007	m^3/hr		
MG2 RWD	130	m^3/hr		
Fissure water	10	m^3/hr		
Oil separator	14.4	m^3/hr		
Total Q_{normal}	**154.42**	$\mathbf{m^3/hr}$	0.04	m^3/s

Volume of silt retained in settling dams in event of a storm is calculated as follows:

At 20% carry over into silt traps

$Q_{silt, retained}$	4.68	m^3/hr	20% of sediment loading
$V_{silt, retained}$	14.03	m^3	For 3hr (3Tc) storm event, $V_{silt, retained}$

Volume of silt retained is less than volume of settling dam, so sufficient capacity is available in settling dam.

Cleaning intervals of settling dams under normal operations is calculated as follows:

At 20% carry over into silt traps

$Q_{silt, retained}$	0.09	m^3/hr	20% of sediment loading	
$t_{silt, cleaning}$	18698.88	hrs	Intervals between cleaning per dam	~779days

Calculation sheet number:	09160001C-01-CAL-0010
Caculation sheet description:	Return Water Dam Sizing
Caculation type (if applicable):	
Date of calculations:	24-03-2025
Calculations done by:	Des Fourie

Conclusion:

Two scenarios were run to confirm return water dam sizing; 1:50 year storm event as well as normal operations. It is important to note that the inflow of water during a storm event would exceed the return water dam's capacity, however this dam is not designed for storm water catchment, only for the purpose of service water storage. The PCD dam is sized to handle the volume of storm water required. Refer to 09160001C-01-CAL-0001.

In order to do a return water dam sizing check, the following will be utilized:

Abbreviation	Item description	Unit of measure	Source	Input value
V	Silt trap compartment volume	m^3	Calculated from drawings	
Q_{storm}	Volume of sediment introduced in storm event	m^3/hr	Calculated from Fig 2 in report and CAL-0001	
Q_{normal}	Volume of sediment introduced in normal operation	m^3/hr	Calculated from Fig 2 in report and CAL-0001	
SG	Specific Gravity	N/A	Assumed	2.65
RD	Relative Density	t/m^3	Assumed	1.005
BD	Bulk Density	t/m^3	Assumed	1.65

Reference drawing: 09160001E-C.9.1-01-001-01

Assumptions & parameters:
In the event of a storm, all normal inflows of water into return water dam will remain in place.
All settlement of sediment has occurred in the silt trap and settling dams with no carry over to the return water dam.

Volume of return water dam calculated as follows:

Total V	**4500.00**	**m^3**

Total inflow in event of a storm is calculated as follows:

Storm event	7560	m^3/hr
Service water tank	0.007	m^3/hr
Potable water tank	0.007	m^3/hr
Fire water tank	0.007	m^3/hr
MG2 RWD	130	m^3/hr
Fissure water	10	m^3/hr
Oil separator	14.4	m^3/hr
Total Q_{storm}	**7714.42**	**m^3/hr**

2.14 m^3/s

In the event of a storm the return water dam would fill within 0.583 hours or 35minutes, provided the dam was empty in the event of a flood event. All storm water overflow from the return water dam, would transfer directly into the PCD. Refer to Figure 2 of the WULA design report.

Total inflow under normal operating conditions is calculated as follows:

Service water tank	0.007	m^3/hr
Potable water tank	0.007	m^3/hr
Fire water tank	0.007	m^3/hr
MG2 RWD	130	m^3/hr
Fissure water	10	m^3/hr
Oil separator	14.4	m^3/hr
Total Q_{normal}	**154.42**	**m^3/hr**

0.04 m^3/s

At a rate of 154.4m^3/hr, the return water dam will fill within 29.2hours. This water is however returned as service water as per Figure 2 of WULA design report.

Calculation sheet number: 09160001C-01-CAL-0012
Caculation sheet description: Surface flood retention and peak discharge
Caculation type (if applicable): SCS, Rational and SDF
Date of calculations: 28-03-2025
Calculations done by: Des Fourie

Calculation summary:

Surface flood retention and peak discharge

Calculation method	Flood Retention (m³) - V	Peak Discharge (m³/s) - Q
SCS	Discharge to Sterkstroom River	2.1
Rational	Discharge to Sterkstroom River	1.54
SDF	Discharge to Sterkstroom River	1.6

Conclusion:

Peak discharge for the purpose of design is based on the Rational method which aligns closely with the SDF method.
In accordance with the SANRAL drainage manual the roads are considered class 3 , i.e. R3 Rural minor arterial or U3 Urban minor arterial.

In order to calculate flood retention volume and peak discharge, the following will be utilized for the SCS method:

Abbreviation	Item description	Unit of measure	Source	Input value
Q_p	Peak discharge	m^3/s	Calculated	
V	Catchment volume	m^3	Calculated	
A	Catchment area	km^2	Measured	0.100586
Q	Stormflow depth	mm	Calculated	
Event	Storm event	years		1:10
T_L	Catchment lag time	hours	Calculated	
L	Hydraulic length of catchment along main channel	km	Measured	0.785
S	Potential Maximum Soil Water Retention/Infiltration	mm	Calculated	
CN	Curve number	N/A	Chart	91.7
y	Average catchment slope	%	Calculated	
ARF	Areal reduction factor	%	Calculated	
T_c	Time of concentration	hours	Calculated	
r	Roughness coefficient	N/A	Tabulated with recommended values	0.3
P_d	Runoff potential	mm	Chart	90
I_a	Initial abstraction	mm	Calculated from S, based on curve number	23
S (Slope)	Based on Invert levels set for the design	m/m	Measured	N/A
N	Contour interval	m	Measured	10

Supporting info:

Surface description	Recommended value of r
Paved areas	0,02
Clean compacted soil, no stones	0,1
Sparse grass over fairly rough surface	0,3
Medium grass cover	0,4
Thick grass cover	0,8

SCS (Soil Conservation Service) - SA Method

The United States Department of Agriculture's Soil Conservation Service based techniques for the estimation of design flood volume and peak discharge from relatively small catchments with slopes of less than 30 % has been adapted for South African conditions by the Water Research Commission

Average catchment slope is calculated to be:

y 1.3 % — Invert levels set out in drawing - Reference 09160001E-C.9.20-01-001-01

Potential Maximum Soil Water Retention is calculated to be:

S 23 mm

$$S = \frac{25400}{CN} - 254$$

Stormflow depth is calculated to be:

Q 69.5 mm

$$Q = \frac{(P_D - I_A)^2}{P_D - I_A + S}$$

P reduced to PD

Aereal reduction factor is calculated to be:

ARF 120 %

$$ARF = (90\,000 - 12\,800 \ln A + 9\,830 \ln t)^{0.4}$$

Where:
ARF = Areal reduction factor (%)
A= Catchment area (km^2)
t = Time of concentration (min)

May not exceed 100

Time of Concentration is calculated to be:

T_c 0.8 hr

$$T_c = 0.604\left(\frac{rL}{S^{0.5}}\right)^{0.467}$$

Catchment volume

V Discharge to Sterkstroom River m^3 — V = Q x A

Catchment lag time is calculated to be:

T_L 0.38 hrs

$$TL = \frac{L^{0.8}(S + 25.4)^{0.7}}{7069(y^{0.5})}$$

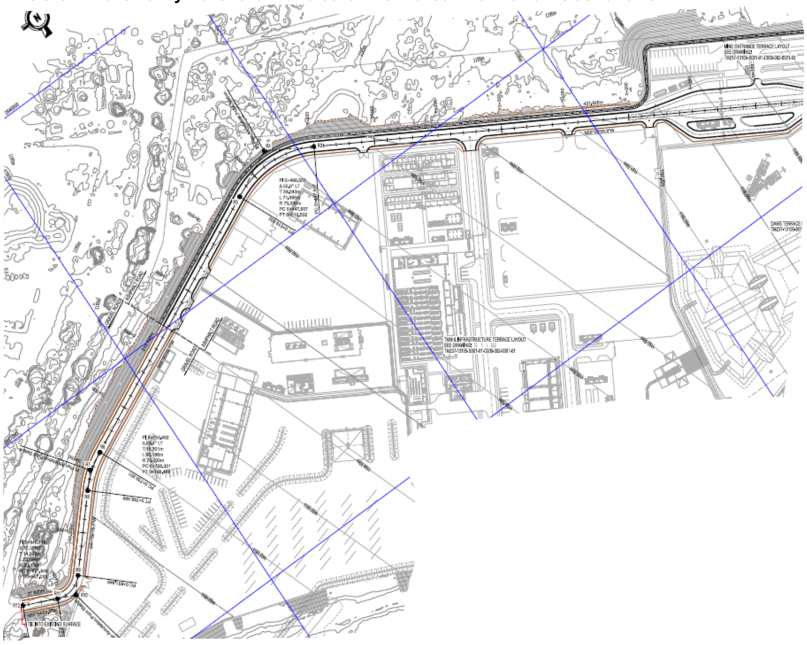
Peak discharge is calculated to be:

Q_p 2.1 m^3/s

$$Q_P = \frac{0.2083(A)(Q)}{1.83T_L}$$

Reference drawing TM237-13105-S001-01-C009-101-0001-01

The stormwater/dirty water drain and catchment area information is as follows:



Catchment area	100586 m^2		
Drain length	785 m		
Drain invert start	1193.127		
Drain invert end	1182.636		
Drain fall	**10.491 m**	**1.3 %**	**1:75**
Drain cross section	V Drain 2200 mm 1H/2V		

In order to calculate flood retention volume and peak discharge, the following will be utilized for the rational method:				
Abbreviation	**Item description**	**Unit of measure**	**Source**	**Input value**
Qp	Peak discharge	m^3/s	Calculated	
V	Catchment volume	m^3	Calculated	
A	Catchment area	km^2	Measured	0.100586
L	Hydraulic length of catchment along main channel	km	Measured	0.785
Event	Storm event	years		1:10
I	Rainfall Intensity	mm/hour	SAICE Chart 2	65
Tc	Time of concentraction	minutes	Calculated	
r	Roughness coefficient	N/A	Tabulated with recommended values	0.3
C	Runoff factor	N/A	Chart	0.85
S (SANRAL)	Average slope of the overland path	m/m	Measured	0.013
Time of Concentration is calculated to be:				
Tc	48	minutes	$T_c = 0.604\left(\frac{rL}{S^{0.5}}\right)^{0.467}$	
Catchment volume				
V	Discharge to Sterkstroom River	m^3	V = Q x 3Tc x 60/2	
Peak discharge is calculated to be:				
Q_p	1.54	m^3/s	Q = CIA/3.6	

In order to calculate flood retention volume and peak discharge, the following will be utilized for the SDF method:

Abbreviation	Item description	Unit of measure	Source	Input value
Q_t	Peak discharge	m^3/s	Calculated	
V	Catchment volume	m^3	Calculated	
A	Catchment area	km^2	Measured	0.100586
MAP	Mean annual precipitation	mm	Struan SAWS	550
Event	Storm event	years		1:10
L	Hydraulic length of catchment along main channel	km	Measured	0.785
Sav (SANRAL)	Average slope of the overland path	m/m	Measured	0.013
Pt.T	Point precipication depth	mm	Calculated	
It	Rainfall intensity	mm/hr	Calculated	
ARF	Areal reduction factor	%	Calculated	
T_c	Time of concentraction	hours	Calculated	
C_t	Runoff coefficient	N/A	Calculated	
r	Roughness coefficient	N/A	Tabulated with recommended values	0.3

Supporting info:

Table 3B.1: Information required for the calculation of the SDF

Basin	SAWS station number	SAWS site	M (mm)	R (days)	C_2 (%)	C_{100} (%)	MAP (mm)	MAE (mm)
1	546 204	Struan	56	30	10	40	550	1800

TABLE 8: RETURN PERIOD FACTORS

T =	2	5	10	20	50	100	200
Y_T =	0	0.84	1.28	1.64	2.05	2.33	2.58

Time of Concentration is calculated to be:

T_c 0.29 hrs

$$T_c = \left(\frac{0.87L^2}{1000S_{av}}\right)^{0.385}$$

Rainfall intensity is calculated to be (based on modified Herschfield equation):

$P_{t.T}$ 62.905 mm

$$P_{t,T} = 1.13(0.41 + 0.64lnT)(-0.11 + 0.27lnt)(0.79M^{0.69}R^{0.2})$$

Aereal reduction factor is calculated to be:

ARF 116.8 %

$$ARF = (90\,000 - 12\,800 \ln A + 9\,830 \ln t)^{0.4}$$

Where:
ARF = Areal reduction factor (%) May not exceed 100
A= Catchment area (km^2)
t = Time of concentration (min)

Runoff coefficient is calculated to be:

C_t 0.265

$$C_T = \frac{C_2}{100} + \left(\frac{Y_T}{2,33}\right)\left(\frac{C_{100}}{100} - \frac{C_2}{100}\right)$$

Catchment volume is calculated to be:

V Discharge to Sterkstroom River m^3

Rainfall intensity is calculated to be:

I_t 217 mm/hr

$$I_T = \frac{P_{t,T}}{T_c}$$

Peak discharge is calculated to be:

Q_t 1.6 m^3/s

$$Q_T = \frac{C_T I_T A}{3,6}$$

Calculation sheet number:	09160001C-01-CAL-0013
Caculation sheet description:	Channel Flow on Surface
Caculation type (if applicable):	
Date of calculations:	28-03-2025
Calculations done by:	Des Fourie

Conclusion:

The Rational method was used to size the drain. The cross section and fall is adequate to carry the peak discharge.

In order to do a channel flow design check, the following will be utilized:

Abbreviation	Item description	Unit of measure	Source	Input value
L	Length of channel	m	Drawings	0.785
$H_{0.10}$	10% of average slope	m	Calculated as 10% of fall of channel	
$H_{0.85}$	85% of average slope	m	Calculated as 85% of fall of channel	
$L_{0.10}$	10% of channel length	m	Calculated as 10% of length of channel	
$L_{0.85}$	85% of channel length	m	Calculated as 85% of length of channel	
S_{av}	Slope	m/m	SDF worksheet	0.013
A	Cross sectional area of channel	m^2	Calculated from drawing	0.605
P	Wetted perimeter of channel	m	Calculated from drawing	2.460
n	Roughness factor (Manning)	N/A	Drainage manual	0.014
v	Velocity	m/s	Calculated	
r	Ratio of area to perimeter	N/A	Calculated	

Reference drawing: TM237-13105-S001-01-C009-092-0003-01

From drawings:

Channel width: 2200 V Drain 1H:2V

Velocity is calculated as follows:

v 3.2 m/s $v = \frac{1}{n} r^{\frac{2}{3}} . s^{\frac{1}{2}}$

Peak discharge is calculated as follows:

Q 1.94 m^3/s Q = v x A

With Rational method, Peak discharge was calculated to be 1.54m^3/s, thus the channel size is sufficient.