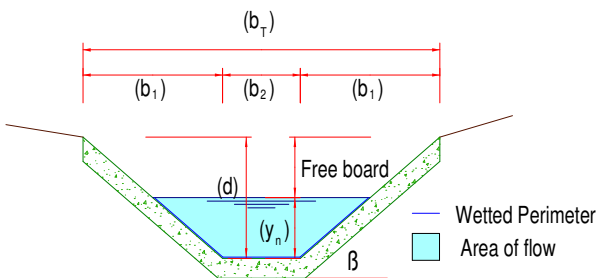


**FLOW RATE m<sup>3</sup>/s (Q) Return Period (50 years)**

**Channel Name: C01**

Design flow rate (Q <sub>d</sub> )	2.031	m <sup>3</sup> /s
<b>V-DRAIN</b>		
Roughness coefficient (n)	0.035	s/m <sup>1/3</sup>
Bottom width (b <sub>2</sub> )	0.000	m
Depth of Canal (d)	0.650	m
Free board	0.000	m
Angle of Incline wall (β)	23.4	° Degree
Channel slope (S)	0.036	m/m
Normal depth (Y <sub>n</sub> )	0.650	m
Wetted perimeter (P)	3.269	m
Flow area (A)	0.975	m <sup>2</sup>
Reynolds number (m)	0.298	m
Velocity (V)	2.404	m/s
<b>Flow rate (Q)</b>	<b>2.344</b>	<b>m<sup>3</sup>/s</b>
<b>Channel is adequate</b>		
Froude number (Fr)	0.95	
Flow type	Subcritical	
<b>Channel parameters</b>		
Incl wall horizon. Length (b <sub>1</sub> )	1.500	m
Bottom width (b <sub>2</sub> )	0.000	m
<b>Total channel width (b<sub>T</sub>)</b>	<b>2.999</b>	<b>m</b>
<b>Height of channel (d)</b>	<b>0.650</b>	<b>m</b>



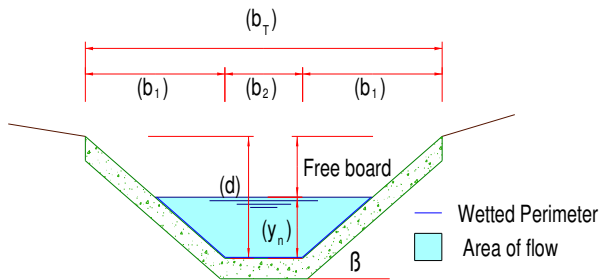
- a. Cement
  - 1. neat surface 0.013
  - 2. mortar 0.015
- b. Wood
  - 1. planed, untreated 0.014
  - 2. planed, creosoted 0.015
  - 3. unplanned 0.015
  - 4. plank with battens 0.018
  - 5. lined with roofing paper 0.017
- c. Concrete
  - 1. trowel finish 0.015
  - 2. float finish 0.016
  - 3. finished, with gravel on bottom 0.020
  - 4. unfinished 0.020
  - 5. gunite, good section 0.023
  - 6. gunite, wavy section 0.025
  - 7. on good excavated rock 0.020
  - 8. on irregular excavated rock 0.027
- d. Concrete bottom float finish with sides of:
  - 1. dressed stone in mortar 0.020
  - 2. random stone in mortar 0.024
  - 4. cement rubble masonry 0.030
  - 5. dry rubble or riprap 0.035
- e. Gravel bottom with sides of:
  - 1. formed concrete 0.025
  - 2. random stone mortar 0.026
  - 3. dry rubble or riprap 0.036
- f. Brick
  - 1. glazed 0.015
  - 2. in cement mortar 0.018
- g. Masonry
  - 1. cemented rubble 0.030
  - 2. dry rubble 0.035
- h. Dressed ashlar/stone paving 0.017
- i. Asphalt
  - 1. smooth 0.013
  - 2. rough 0.016
- j. Vegetal lining 0.500

**FLOW RATE m<sup>3</sup>/s (Q) Return Period (50 years)**

**Channel Name: C02**

Design flow rate (Q <sub>d</sub> )	0.106	m <sup>3</sup> /s
<b>V-Drain</b>		
Roughness coefficient (n)	0.035	s/m <sup>1/3</sup>
Bottom width (b <sub>2</sub> )	0.000	m
Depth of Canal (d)	0.250	m
Free board	0.000	m
Angle of Incline wall (β)	14.0	° Degree
Channel slope (S)	0.063	m/m
Normal depth (Y <sub>n</sub> )	0.250	m
Wetted perimeter (P)	2.062	m
Flow area (A)	0.250	m <sup>2</sup>
Reynolds number (m)	0.121	m
Velocity (V)	1.753	m/s
<b>Flow rate (Q)</b>	<b>0.438</b>	<b>m<sup>3</sup>/s</b>
<b>Channel is adequate</b>		
Froude number (Fr)	1.12	
Flow type	Supercritical	
<b>Channel parameters</b>		
Incl wall horizon. Length (b <sub>1</sub> )	1.000	m
Bottom width (b <sub>2</sub> )	0.000	m
<b>Total channel width (b<sub>T</sub>)</b>	<b>2.000</b>	<b>m</b>
<b>Height of channel (d)</b>	<b>0.250</b>	<b>m</b>

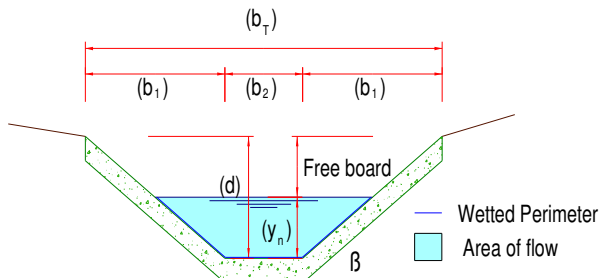
- a. Cement
  - 1. neat surface 0.013
  - 2. mortar 0.015
- b. Wood
  - 1. planed, untreated 0.014
  - 2. planed, creosoted 0.015
  - 3. unplanned 0.015
  - 4. plank with battens 0.018
  - 5. lined with roofing paper 0.017
- c. Concrete
  - 1. trowel finish 0.015
  - 2. float finish 0.016
  - 3. finished, with gravel on bottom 0.020
  - 4. unfinished 0.020
  - 5. gunite, good section 0.023
  - 6. gunite, wavy section 0.025
  - 7. on good excavated rock 0.020
  - 8. on irregular excavated rock 0.027
- d. Concrete bottom float finish with sides of:
  - 1. dressed stone in mortar 0.020
  - 2. random stone in mortar 0.024
  - 4. cement rubble masonry 0.030
  - 5. dry rubble or riprap 0.035
- e. Gravel bottom with sides of:
  - 1. formed concrete 0.025
  - 2. random stone mortar 0.026
  - 3. dry rubble or riprap 0.036
- f. Brick
  - 1. glazed 0.015
  - 2. in cement mortar 0.018
- g. Masonry
  - 1. cemented rubble 0.030
  - 2. dry rubble 0.035
- h. Dressed ashlar/stone paving 0.017
- i. Asphalt
  - 1. smooth 0.013
  - 2. rough 0.016
- j. Vegetal lining 0.500



**FLOW RATE m<sup>3</sup>/s (Q) Return Period (50 years)**

**Channel Name: Drift**

Design flow rate (Q <sub>d</sub> )	0.521	m <sup>3</sup> /s
<b>V-Drain</b>		
Roughness coefficient (n)	0.015	s/m <sup>1/3</sup>
Bottom width (b <sub>2</sub> )	3.000	m
Depth of Canal (d)	0.100	m
Free board	0.000	m
Angle of Incline wall (β)	1.7	° Degree
Channel slope (S)	0.010	m/m
Normal depth (Y <sub>n</sub> )	0.100	m
Wetted perimeter (P)	9.742	m
Flow area (A)	0.637	m <sup>2</sup>
Reynolds number (m)	0.065	m
Velocity (V)	1.082	m/s
<b>Flow rate (Q)</b>	<b>0.689</b>	<b>m<sup>3</sup>/s</b>
<b>Channel is adequate</b>		
Froude number (Fr)	1.09	
Flow type	Supercritical	
<b>Channel parameters</b>		
Incl wall horizon. Length (b <sub>1</sub> )	3.369	m
Bottom width (b <sub>2</sub> )	3.000	m
<b>Total channel width (b<sub>T</sub>)</b>	<b>9.739</b>	<b>m</b>
<b>Height of channel (d)</b>	<b>0.100</b>	<b>m</b>

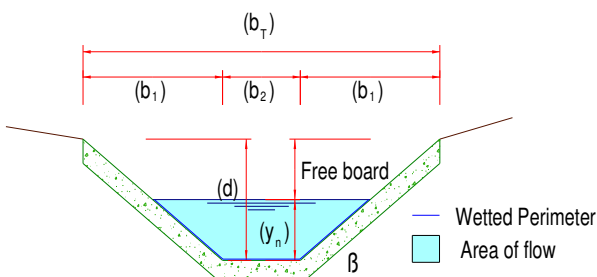


- a. Cement
  - 1. neat surface 0.013
  - 2. mortar 0.015
- b. Wood
  - 1. planed, untreated 0.014
  - 2. planed, creosoted 0.015
  - 3. unplanned 0.015
  - 4. plank with battens 0.018
  - 5. lined with roofing paper 0.017
- c. Concrete
  - 1. trowel finish 0.015
  - 2. float finish 0.016
  - 3. finished, with gravel on bottom 0.020
  - 4. unfinished 0.020
  - 5. gunite, good section 0.023
  - 6. gunite, wavy section 0.025
  - 7. on good excavated rock 0.020
  - 8. on irregular excavated rock 0.027
- d. Concrete bottom float finish with sides of:
  - 1. dressed stone in mortar 0.020
  - 2. random stone in mortar 0.024
  - 4. cement rubble masonry 0.030
  - 5. dry rubble or riprap 0.035
- e. Gravel bottom with sides of:
  - 1. formed concrete 0.025
  - 2. random stone mortar 0.026
  - 3. dry rubble or riprap 0.036
- f. Brick
  - 1. glazed 0.015
  - 2. in cement mortar 0.018
- g. Masonry
  - 1. cemented rubble 0.030
  - 2. dry rubble 0.035
- h. Dressed ashlar/stone paving 0.017
- i. Asphalt
  - 1. smooth 0.013
  - 2. rough 0.016
- j. Vegetal lining 0.500

FLOW RATE m<sup>3</sup>/s (Q) Return Period (50 years)

Channel Name: D01

Design flow rate (Q <sub>d</sub> )	2.15	m <sup>3</sup> /s
<b>V-Drain</b>		
Roughness coefficient (n)	0.013	s/m <sup>1/3</sup>
Bottom width (b <sub>2</sub> )	0.000	m
Depth of Canal (d)	0.500	m
Free board	0.000	m
Angle of Incline wall (β)	18.4	° Degree
Channel slope (S)	0.010	m/m
Normal depth (Y <sub>n</sub> )	0.500	m
Wetted perimeter (P)	3.162	m
Flow area (A)	0.750	m <sup>2</sup>
Reynolds number (m)	0.237	m
Velocity (V)	2.947	m/s
<b>Flow rate (Q)</b>	<b>2.210</b>	<b>m<sup>3</sup>/s</b>
<b>Channel is adequate</b>		
Froude number (Fr)	1.33	
Flow type	Supercritical	
<b>Channel parameters</b>		
Incl wall horizon. Length (b <sub>1</sub> )	1.500	m
Bottom width (b <sub>2</sub> )	0.000	m
<b>Total channel width (b<sub>T</sub>)</b>	<b>3.000</b>	<b>m</b>
<b>Height of channel (d)</b>	<b>0.500</b>	<b>m</b>

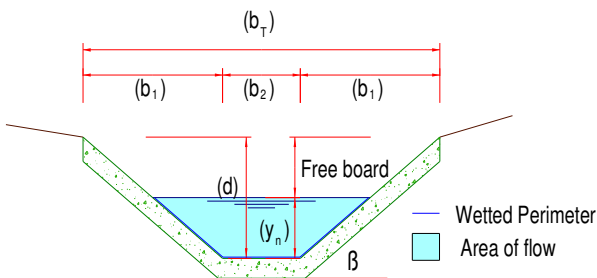


- a. Cement
  - 1. neat surface 0.013
  - 2. mortar 0.015
- b. Wood
  - 1. planed, untreated 0.014
  - 2. planed, creosoted 0.015
  - 3. unplanned 0.015
  - 4. plank with battens 0.018
  - 5. lined with roofing paper 0.017
- c. Concrete
  - 1. trowel finish 0.015
  - 2. float finish 0.016
  - 3. finished, with gravel on bottom 0.020
  - 4. unfinished 0.020
  - 5. gunite, good section 0.023
  - 6. gunite, wavy section 0.025
  - 7. on good excavated rock 0.020
  - 8. on irregular excavated rock 0.027
- d. Concrete bottom float finish with sides of:
  - 1. dressed stone in mortar 0.020
  - 2. random stone in mortar 0.024
  - 4. cement rubble masonry 0.030
  - 5. dry rubble or riprap 0.035
- e. Gravel bottom with sides of:
  - 1. formed concrete 0.025
  - 2. random stone mortar 0.026
  - 3. dry rubble or riprap 0.036
- f. Brick
  - 1. glazed 0.015
  - 2. in cement mortar 0.018
- g. Masonry
  - 1. cemented rubble 0.030
  - 2. dry rubble 0.035
- h. Dressed ashlar/stone paving 0.017
- i. Asphalt
  - 1. smooth 0.013
  - 2. rough 0.016
- j. Vegetal lining 0.500

FLOW RATE  $m^3/s$  (Q) Return Period (50 years)

Channel Name: D02

Design flow rate ( $Q_d$ )	1.07	$m^3/s$
<b>V-Drain</b>		
Roughness coefficient (n)	0.013	$s/m^{1/3}$
Bottom width ( $b_2$ )	0.000	m
Depth of Canal (d)	0.400	m
Free board	0.000	m
Angle of Incline wall ( $\beta$ )	17.7	$^\circ$ Degree
Channel slope (S)	0.014	m/m
Normal depth ( $Y_n$ )	0.400	m
Wetted perimeter (P)	2.624	m
Flow area (A)	0.500	$m^2$
Reynolds number (m)	0.190	m
Velocity (V)	3.017	m/s
<b>Flow rate (Q)</b>	<b>1.508</b>	<b><math>m^3/s</math></b>
Channel is adequate		
Froude number (Fr)	1.52	
Flow type	Supercritical	
Channel parameters		
Incl wall horizon. Length ( $b_1$ )	1.250	m
Bottom width ( $b_2$ )	0.000	m
<b>Total channel width (<math>b_T</math>)</b>	<b>2.500</b>	<b>m</b>
<b>Height of channel (d)</b>	<b>0.400</b>	<b>m</b>

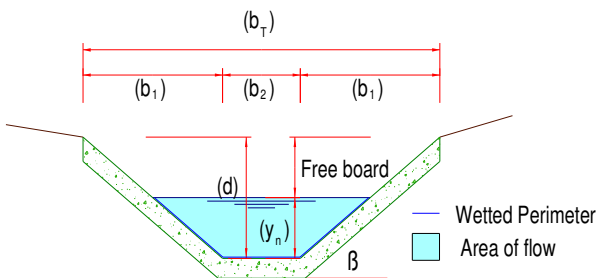


- a. Cement
  - 1. neat surface 0.013
  - 2. mortar 0.015
- b. Wood
  - 1. planed, untreated 0.014
  - 2. planed, creosoted 0.015
  - 3. unplaned 0.015
  - 4. plank with battens 0.018
  - 5. lined with roofing paper 0.017
- c. Concrete
  - 1. trowel finish 0.015
  - 2. float finish 0.016
  - 3. finished, with gravel on bottom 0.020
  - 4. unfinished 0.020
  - 5. gunite, good section 0.023
  - 6. gunite, wavy section 0.025
  - 7. on good excavated rock 0.020
  - 8. on irregular excavated rock 0.027
- d. Concrete bottom float finish with sides of:
  - 1. dressed stone in mortar 0.020
  - 2. random stone in mortar 0.024
  - 4. cement rubble masonry 0.030
  - 5. dry rubble or riprap 0.035
- e. Gravel bottom with sides of:
  - 1. formed concrete 0.025
  - 2. random stone mortar 0.026
  - 3. dry rubble or riprap 0.036
- f. Brick
  - 1. glazed 0.015
  - 2. in cement mortar 0.018
- g. Masonry
  - 1. cemented rubble 0.030
  - 2. dry rubble 0.035
- h. Dressed ashlar/stone paving 0.017
- i. Asphalt
  - 1. smooth 0.013
  - 2. rough 0.016
- j. Vegetal lining 0.500

FLOW RATE m<sup>3</sup>/s (Q) Return Period (50 years)

Channel Name: D03

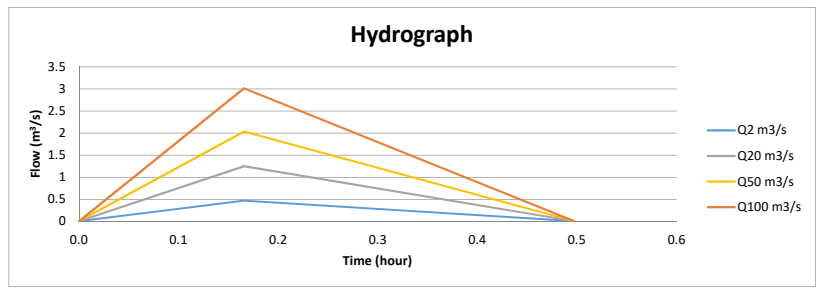
Design flow rate (Q <sub>d</sub> )	1.07	m <sup>3</sup> /s
<b>V-Drain</b>		
Roughness coefficient (n)	0.013	s/m <sup>1/3</sup>
Bottom width (b <sub>2</sub> )	0.000	m
Depth of Canal (d)	0.400	m
Free board	0.000	m
Angle of Incline wall (β)	17.7	° Degree
Channel slope (S)	0.010	m/m
Normal depth (Y <sub>n</sub> )	0.400	m
Wetted perimeter (P)	2.624	m
Flow area (A)	0.500	m <sup>2</sup>
Reynolds number (m)	0.190	m
Velocity (V)	2.547	m/s
<b>Flow rate (Q)</b>	<b>1.273</b>	<b>m<sup>3</sup>/s</b>
<b>Channel is adequate</b>		
Froude number (Fr)	1.29	
Flow type	Supercritical	
<b>Channel parameters</b>		
Incl wall horizon. Length (b <sub>1</sub> )	1.250	m
Bottom width (b <sub>2</sub> )	0.000	m
<b>Total channel width (b<sub>T</sub>)</b>	<b>2.500</b>	<b>m</b>
<b>Height of channel (d)</b>	<b>0.400</b>	<b>m</b>



- a. Cement
  - 1. neat surface 0.013
  - 2. mortar 0.015
- b. Wood
  - 1. planed, untreated 0.014
  - 2. planed, creosoted 0.015
  - 3. unplaned 0.015
  - 4. plank with battens 0.018
  - 5. lined with roofing paper 0.017
- c. Concrete
  - 1. trowel finish 0.015
  - 2. float finish 0.016
  - 3. finished, with gravel on bottom 0.020
  - 4. unfinished 0.020
  - 5. gunite, good section 0.023
  - 6. gunite, wavy section 0.025
  - 7. on good excavated rock 0.020
  - 8. on irregular excavated rock 0.027
- d. Concrete bottom float finish with sides of:
  - 1. dressed stone in mortar 0.020
  - 2. random stone in mortar 0.024
  - 4. cement rubble masonry 0.030
  - 5. dry rubble or riprap 0.035
- e. Gravel bottom with sides of:
  - 1. formed concrete 0.025
  - 2. random stone mortar 0.026
  - 3. dry rubble or riprap 0.036
- f. Brick
  - 1. glazed 0.015
  - 2. in cement mortar 0.018
- g. Masonry
  - 1. cemented rubble 0.030
  - 2. dry rubble 0.035
- h. Dressed ashlar/stone paving 0.017
- i. Asphalt
  - 1. smooth 0.013
  - 2. rough 0.016
- j. Vegetal lining 0.500

Appendix B - Hydrology

Rational Method										
This Spread sheet should not be used by anyone without consultation										
Project Name:		Umlaas Quarry Stormwater Management								
Description of Catchment:		CleanCatchment_C_C01								
Physical Characteristics										
Slope Calc	Average	Size of Catchment	A	0.1045	km <sup>2</sup>	Rainfall Region				
H1	799	Longest Water Course	L	0.619	km	Area Distribution				
H2	777	Average Slope	Sav	0.035541	m/m	Rural (α)	Urban (β)	Lakes (γ)		
H <sub>0.1</sub>		Dolomite Area	D <sub>%</sub>	0	%	1	0	0		
H <sub>10.85</sub>		Mean Annual Rainfall	MAR	695	mm	1				
		Coastal (1) or Inland (2)		Inland		Lawns	1	others	1	
		Rural <sub>1</sub>				Urban <sub>2</sub>				
		Surface slope	%	Factor	C <sub>s</sub>	Description	%	Factor	C <sub>2</sub>	
		Veils and Pans ( S<3)	8	0.03	0.0024	Lawns	high=3 ,mean=2;Low=1		2	
		Flat Areas (3.0<S<10)	45	0.08	0.036	Sandy, flat (<2%)	0	0.075	0	
		Hilly (10<S<30)	45	0.16	0.072	Sand (2-7%)	0	0.125	0	
		Steep areas ( S>50)	2	0.26	0.0052	Sandy, steep (>7%)	0	0.175	0	
		<b>Total</b>	<b>100</b>		<b>0.1156</b>	Heavy Soil, flat (<2%)	0	0.15	0	
		Permeability	%	Factor	C <sub>p</sub>	Heavy Soil (2-7%)	0	0.21	0	
		Very Permeable	0	0.04	0	Heavy Soil, steep (>7%)	0	0.3	0	
		Permeable	60	0.08	0.048	<b>Residential</b>				
		Semi- Permeable	40	0.16	0.064	Houses	10	0.4	0.04	
		Impermeable	0	0.26	0	Flats	0	0.6	0	
		<b>Total</b>	<b>100</b>		<b>0.112</b>	<b>Industry</b>				
		Vegetation	%	Factor	C <sub>v</sub>	Light Industry	70	0.65	0.455	
		Thick bush and plantation	37	0.04	0.0148	Heavy Industry	0	0.75	0	
		Light bush and farm land	0.5	0.11	0.00055	<b>Business</b>				
		Grassland	61	0.21	0.1281	City Centre	0	0.825	0	
		No Vegetation	1.5	0.28	0.0042	Suburban	0	0.6	0	
		<b>Total</b>	<b>100</b>		<b>0.14765</b>	Streets	20	0.825	0.165	
		<b>Time of Concentration</b>				Maximum Flood	0			
		Overland flow	Defined Watercourse			<b>Total (Must = 100)</b>	<b>100</b>	<b>0.66</b>		
		T <sub>c</sub> =0.605(rL <sup>1/3</sup> /Sav) <sup>0.467</sup>	T <sub>c</sub> = τ(((0.87L) <sup>2</sup> /1000Sav) <sup>0.385</sup>			r=	2	0.1	τ=	1.00
						1	Paved Area	0.02		
						2	Clean Compacted Soil	0.1		
						3	Sparse Grass over rough surface	0.3		
						4	Medium Grass cover	0.4		
						5	Thick grass cover	0.8		
		<b>0.35965</b>	<b>0.16569</b>	<b>Hours</b>						
		<b>Defined Watercourse</b>		<b>0.16569</b>						
<b>Runoff Coefficient</b>										
Return Period (years), T	2	5	10	20	50	100	200			
Runoff Coefficient, C <sub>1</sub> (C <sub>1</sub> =C <sub>s</sub> +C <sub>p</sub> +C <sub>v</sub> )	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375		
Adjusted for Dolomite Areas, C <sub>1D</sub> (C <sub>1</sub> (1-D%)+C <sub>1D</sub> %(Σ(D <sub>factor</sub> ×C <sub>s</sub> %)))										
Adjustment Factor for initial saturation, F <sub>i</sub>	2	0.50	0.55	0.60	0.67	0.83	1.00	1.00		
Adjusted Runoff coefficient, C <sub>1T</sub>	0.188	0.206	0.225	0.251	0.311	0.375	0.375	0.375		
C <sub>T</sub> (=αC <sub>1T</sub> +βC <sub>2</sub> +γC <sub>3</sub> )	0.188	0.206	0.225	0.251	0.311	0.375	0.375	0.375		
<b>Rainfall</b>										
Return Period (years), T	2	5	10	20	50	100	200			
Intensity, I <sub>r</sub> (Ruan Small)	85.5	112.6	138.6	170.7	224.7	276.6	340.6			
Return Period (years), T	2	5	10	20	50	100	200			
Peak Flow (m <sup>3</sup> /s), Q <sub>T</sub> =C <sub>T</sub> I <sub>r</sub> A/3.6	0.47	0.67	0.91	1.25	2.03	3.01	3.71			
	l/s	465.7907	674.47443	905.8641	1245.362	2030.864232	3012.3942	3708.692		
Note: This Spreadsheet should be used hand in hand with the SANRAL drainage manual										
Choices that influence the outcome of the results.										
Variables that is specific to drainage areas!										
Notes:										
	Time (h)	Q <sub>2</sub> m <sup>3</sup> /s	Q <sub>5</sub> m <sup>3</sup> /s	Q <sub>10</sub> m <sup>3</sup> /s	Q <sub>20</sub> m <sup>3</sup> /s	Q <sub>50</sub> m <sup>3</sup> /s	Q <sub>100</sub> m <sup>3</sup> /s	Q <sub>200</sub> m <sup>3</sup> /s		
	0.0	0	0	0	0	0	0	0		
	0.2	0.47	0.67	0.91	1.25	2.03	3.01	3.71		
	0.5	0	0	0	0	0	0	0		
	Q <sub>total</sub> (m <sup>3</sup> )	417	603	810	1114	1817	2695	3318		



**Rational Method**  
**This Spread sheet should not be used by anyone without consultation**  
**Project Name: Umlaas Quarry Stormwater Management**  
**Description of Catchment: CleanCatchment\_C\_C02**

Slope Calc		Average		Physical Characteristics	
H1	800	Size of Catchment	A	0.1280	km <sup>2</sup>
H2	777	Longest Water Course	L	0.619	km
H <sub>0.1</sub>		Average Slope	Sav	0.037157	m/m
H <sub>0.85</sub>		Dolomite Area	D <sub>%</sub>	0	%
		Mean Annual Rainfall	MAR	695	mm

Coastal (1) or Inland (2)		Inland		Rainfall Region		Area Distribution	
Rural <sub>1</sub>		Urban <sub>2</sub>		Lawns		others	
Surfance slope		Description		Factor		C <sub>2</sub>	
Veis and Pans ( S<3)	8	0.03	0.0024	Lawns	high=3 .mean=2;Low=1		2
Flat Areas (3.0<S<10)	45	0.08	0.036	Sandy, flat (<2%)		0.075	0
Hilly (10<S<30)	45	0.16	0.072	Sand (2-7%)		0.125	0
Steep areas ( S>50)	2	0.26	0.0052	Sandy, steep (>7%)		0.175	0
<b>Total</b>	<b>100</b>		<b>0.1156</b>	Heavy Soil, flat (<2%)		0.15	0
Permeability		Factor		C <sub>p</sub>		Description	
Very Permeable	0	0.04	0	Heavy Soil (2-7%)		0.21	0
Permeable	60	0.08	0.048	Heavy Soil, steep (>7%)		0.3	0
Semi- Permeable	40	0.16	0.064	<b>Residential</b>			
Impermeable	0	0.26	0	Houses	10	0.4	0.04
<b>Total</b>	<b>100</b>		<b>0.112</b>	Flats	0	0.6	0
vegetation		Factor		C <sub>v</sub>		Description	
Thick bush and plantation	37	0.04	0.0148	Light Industry	70	0.65	0.455
Light bush and farm land	0.5	0.11	0.00055	Heavy Industry	0	0.75	0
				<b>Business</b>			
Grassland	61	0.21	0.1281	City Centre	0	0.825	0
No Vegetation	1.5	0.28	0.0042	Suburban	0	0.6	0
<b>Total</b>	<b>100</b>		<b>0.14765</b>	Streets	20	0.825	0.165

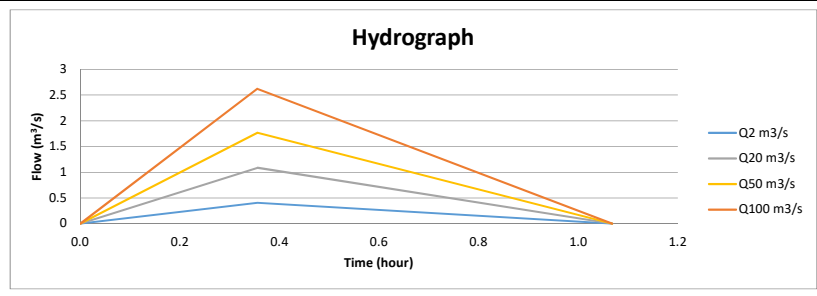
<b>Time of Concentration</b>				Maximum Flood			
Overland flow	Defined Watercourse		Total (Must = 100)		100		0.66
T <sub>c</sub> =0.605(rL <sup>0.77</sup> /Sav) <sup>0.467</sup>	T <sub>c</sub> = τ(((0.87L) <sup>2</sup> /1000Sav) <sup>0.385</sup>		r=	2	0.1	τ=	1.00
			1	Paved Area		0.02	
			2	Clean Compacted Soil		0.1	
			3	Sparse Grass over rough surface		0.3	
			4	Medium Grass cover		0.4	
			5	Thick grass cover		0.8	
<b>0.35594</b>	<b>0.16287</b>	<b>Hours</b>	<b>0.35594</b>				

<b>Runoff Coefficient</b>								
Return Period (years), T	2	5	10	20	50	100	200	
Runoff Coefficient, C <sub>1</sub> (C <sub>1</sub> =C <sub>s</sub> +C <sub>p</sub> +C <sub>v</sub> )	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375
Adjusted for Dolomite Areas, C <sub>1D</sub> (C <sub>1</sub> (1-D%)+C <sub>1D</sub> %(Σ(D <sub>factor</sub> ×C <sub>s</sub> %))								
Adjustment Factor for initial saturation, F <sub>i</sub>	2	0.50	0.55	0.60	0.67	0.83	1.00	1.00
Adjusted Runoff coefficient, C <sub>1T</sub>	0.188	0.206	0.225	0.251	0.311	0.375	0.375	0.375
C <sub>1T</sub> =(αC <sub>1T</sub> +βC <sub>2</sub> +γC <sub>3</sub> )	0.188	0.206	0.225	0.251	0.311	0.375	0.375	0.375

<b>Rainfall</b>								
Return Period (years), T	2	5	10	20	50	100	200	
Intensity, I <sub>r</sub> (Ruan Small)	60.8	80.0	98.5	121.2	159.6	196.4	241.9	
Return Period (years), T	2	5	10	20	50	100	200	
Peak Flow (m <sup>3</sup> /s), Q <sub>T</sub> =C <sub>1T</sub> A/3.6	0.41	0.59	0.79	1.08	1.77	2.62	3.23	
	l/s	405.2836	586.85889	788.19059	1083.587	1767.051017	2621.0783	3226.926

Note: This Spreadsheet should be used hand in hand with the SANRAL drainage manual  
 Choices that influence the outcome of the results.  
 Variables that is specific to drainage areas!

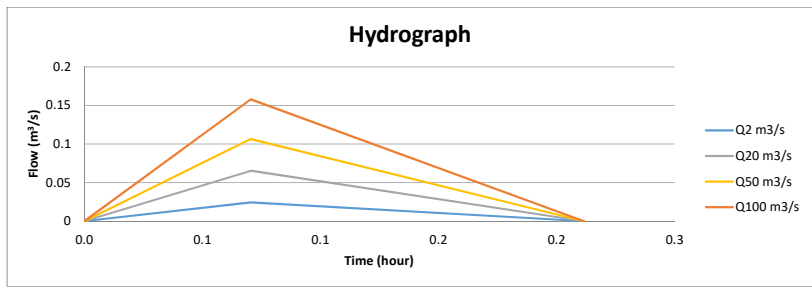
Notes:	Time (h)	Q <sub>2</sub> m <sup>3</sup> /s	Q <sub>5</sub> m <sup>3</sup> /s	Q <sub>10</sub> m <sup>3</sup> /s	Q <sub>20</sub> m <sup>3</sup> /s	Q <sub>50</sub> m <sup>3</sup> /s	Q <sub>100</sub> m <sup>3</sup> /s	Q <sub>200</sub> m <sup>3</sup> /s
	0.0	0	0	0	0	0	0	1
	0.4	0.41	0.59	0.79	1.08	1.77	2.62	3.23
	1.1	0	0	0	0	0	0	1
	Q <sub>total</sub> (m <sup>3</sup> )	779	1128	1515	2083	3396	5038	6202



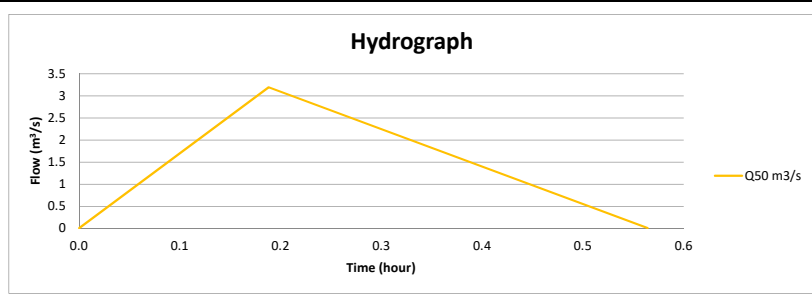




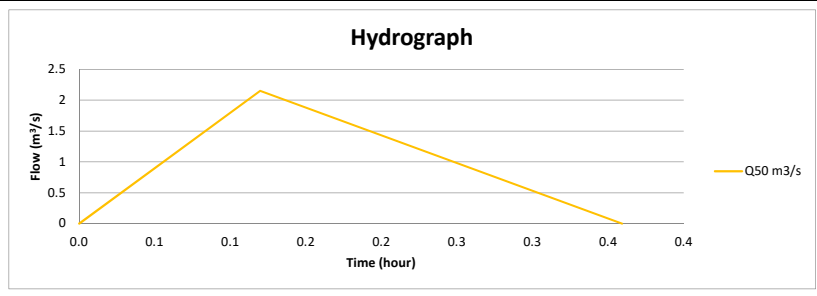
Rational Method									
This Spread sheet should not be used by anyone without consultation									
Project Name:		Umlaas Quarry Stormwater Management							
Description of Catchment:		CleanCatchment_C_C03							
Physical Characteristics									
Slope Calc	Average	Size of Catchment	A	0.0046	km <sup>2</sup>	Rainfall Region			
H1	799	Longest Water Course	L	0.271	km	Area Distribution			
H2	782	Average Slope	Sav	0.062731	m/m	Rural (α)	Urban (β)	Lakes (γ)	
H <sub>0.1</sub>		Dolomite Area	D <sub>%</sub>	0	%	1	0	0	
H <sub>0.85</sub>		Mean Annual Rainfall	MAR	695	mm	1			
		Coastal (1) or Inland (2)		Inland		Lawns	1	others	1
		Rural <sub>1</sub>				Urban <sub>2</sub>			
		Surface slope	%	Factor	C <sub>s</sub>	Description	%	Factor	C <sub>2</sub>
		Veils and Pans ( S<3)	100	0.03	0.03	Lawns	high=3 ,mean=2;Low=1		2
		Flat Areas (3.0<S<10)	0	0.08	0	Sandy, flat (<2%)	0	0.075	0
		Hilly (10<S<30)	0	0.16	0	Sand (2-7%)	0	0.125	0
		Steep areas ( S>50)	0	0.26	0	Sandy, steep (>7%)	0	0.175	0
		Total	100		0.03	Heavy Soil, flat (<2%)	0	0.15	0
		Permeability	%	Factor	C <sub>p</sub>	Heavy Soil (2-7%)	0	0.21	0
		Very Permeable	0	0.04	0	Heavy Soil, steep (>7%)	0	0.3	0
		Permeable	60	0.08	0.048	Residential			
		Semi- Permeable	40	0.16	0.064	Houses	10	0.4	0.04
		Impermeable	0	0.26	0	Flats	0	0.6	0
		Total	100		0.112	Industry			
		Vegetation	%	Factor	C <sub>v</sub>	Light Industry	70	0.65	0.455
		Thick bush and plantation	0	0.04	0	Heavy Industry	0	0.75	0
		Light bush and farm land	0	0.11	0	Business			
		Grassland	100	0.21	0.21	City Centre	0	0.825	0
		No Vegetation	0	0.28	0	Suburban	0	0.6	0
		Total	100		0.21	Streets	20	0.825	0.165
		Time of Concentration			Maximum Flood				
		Overland flow	Defined Watercourse		Total (Must = 100)		100	0.66	
		T <sub>c</sub> =0.605(rL <sup>1/3</sup> /Sav) <sup>0.467</sup>	T <sub>c</sub> = τ(((0.87L) <sup>2</sup> /1000Sav) <sup>0.385</sup>		τ=	2	0.1	τ= 1.00	
						1	Paved Area		0.02
						2	Clean Compacted Soil		0.1
						3	Sparse Grass over rough surface		0.3
						4	Medium Grass cover		0.4
						5	Thick grass cover		0.8
		0.21416	0.0705	Hours					
		Defined Watercourse		0.07048					
Runoff Coefficient									
Return Period (years), T	2	5	10	20	50	100	200		
Runoff Coefficient, C <sub>1</sub>	0.352		0.352	0.352	0.352	0.352	0.352	0.352	
(C <sub>1</sub> =C <sub>s</sub> +C <sub>p</sub> +C <sub>v</sub> )									
Adjusted for Dolomite Areas, C <sub>1D</sub>	(C <sub>1</sub> (1-D%)+C <sub>1</sub> D%(Σ(D <sub>factor</sub> ×C <sub>s</sub> %)))								
Adjustment Factor for initial saturation, F <sub>i</sub>	2	0.50	0.55	0.60	0.67	0.83	1.00	1.00	
Adjusted Runoff coefficient, C <sub>1T</sub>	0.176	0.194	0.211	0.236	0.292	0.352	0.352		
C <sub>1T</sub> =(αC <sub>1T</sub> +βC <sub>2</sub> +γC <sub>3</sub> )									
Rainfall									
Return Period (years), T	2	5	10	20	50	100	200		
Intensity, I <sub>r</sub> (Ruan Small)	108.5	142.9	175.9	216.6	285.1	351.0	432.1		
Return Period (years), T	2	5	10	20	50	100	200		
Peak Flow (m <sup>3</sup> /s), Q <sub>T</sub> =C <sub>1T</sub> A/3.6	0.02	0.04	0.05	0.07	0.11	0.16	0.19		
	l/s	24.40872	35.344327	47.469787	65.26042	106.4229085	157.85779		
194.3457									
Note: This Spreadsheet should be used hand in hand with the SANRAL drainage manual									
Choices that influence the outcome of the results.									
Variables that is specific to drainage areas!									
Notes:									
	Time (h)	Q <sub>2</sub> m <sup>3</sup> /s	Q <sub>5</sub> m <sup>3</sup> /s	Q <sub>10</sub> m <sup>3</sup> /s	Q <sub>20</sub> m <sup>3</sup> /s	Q <sub>50</sub> m <sup>3</sup> /s	Q <sub>100</sub> m <sup>3</sup> /s	Q <sub>200</sub> m <sup>3</sup> /s	
	0.0	0	0	0	0	0	0	0	
	0.1	0.02	0.04	0.05	0.07	0.11	0.16	0.19	
	0.2	0	0	0	0	0	0	0	
	Q <sub>total</sub> (m <sup>3</sup> )	9	13	18	25	41	60	74	



Rational Method									
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Project Name:		Umlaas Quarry Stormwater Management							
Description of Catchment:		DirtyCatchment_C_Dpit							
Physical Characteristics									
Slope Calc	Average	Size of Catchment	A	0.1370	km <sup>2</sup>	Rainfall Region			
H1	790	Longest Water Course	L	0.272	km	Area Distribution			
H2	760	Average Slope	Sav	0.110294	m/m	Rural (α)	Urban (β)	Lakes (γ)	
H <sub>0.1</sub>		Dolomite Area	D <sub>k</sub>	0	%	1	0	0	
H <sub>10.85</sub>		Mean Annual Rainfall	MAR	695	mm	1			
		Coastal (1) or Inland (2)		Inland		Lawns	1	others	1
									20<T≤50
Rural <sub>1</sub>					Urban <sub>2</sub>				
Surface slope		%	Factor	C <sub>s</sub>	Description	%	Factor	C <sub>2</sub>	
Vleis and Pans ( S<3)		0	0.03	0	Lawns	high=3 ,mean=2;Low=1			2
Flat Areas (3.0<S<10)		100	0.08	0.08	Sandy, flat (<2%)		0	0.075	0
Hilly (10<S<30)		0	0.16	0	Sand (2-7%)		0	0.125	0
Steep areas ( S>50)		0	0.26	0	Sandy, steep (>7%)		0	0.175	0
Total		100		0.08	Heavy Soil, flat (<2%)		0	0.15	0
Permeability		%	Factor	C <sub>p</sub>	Heavy Soil (2-7%)		0	0.21	0
Very Permeable		0	0.04	0	Heavy Soil, steep (>7%)		0	0.3	0
Permeable		60	0.08	0.048	Residential				
Semi- Permeable		40	0.16	0.064	Houses		10	0.4	0.04
Impermeable		0	0.26	0	Flats		0	0.6	0
Total		100		0.112	Industry				
Vegetation		%	Factor	C <sub>v</sub>	Light Industry		70	0.65	0.455
Thick bush and plantation		0	0.04	0	Heavy Industry		0	0.75	0
Light bush and farm land		0	0.11	0	Business				
Grassland		0	0.21	0	City Centre		0	0.825	0
No Vegetation		100	0.28	0.28	Suburban		0	0.6	0
Total		100		0.28	Streets		20	0.825	0.165
Time of Concentration					Maximum Flood				
Overland flow		Defined Watercourse			Total (Must = 100)	100		0.66	
T <sub>c</sub> =0.605(rL <sup>0.5</sup> /Sav) <sup>0.467</sup>		T <sub>c</sub> = τ(((0.87L) <sup>2</sup> /1000Sav) <sup>0.385</sup>			r=	2	0.1	τ= 1.00	
					1	Paved Area		0.02	
					2	Clean Compacted Soil		0.1	
					3	Sparse Grass over rough surface		0.3	
					4	Medium Grass cover		0.4	
					5	Thick grass cover		0.8	
0.18805		0.0569		Hours					
Overland Flow		0.18805							
Runoff Coefficient									
Return Period (years), T	2	5	10	20	50	100	200		
Runoff Coefficient, C <sub>1</sub> (C <sub>1</sub> =C <sub>s</sub> +C <sub>p</sub> +C <sub>v</sub> )	0.472	0.472	0.472	0.472	0.472	0.472	0.472	0.472	
Adjusted for Dolomite Areas, C <sub>1D</sub> (C <sub>1</sub> (1-D%)+C <sub>1D</sub> %Σ(D <sub>factor</sub> ×C <sub>s</sub> %)									
Adjustment Factor for initial saturation, F <sub>i</sub>	2	0.50	0.55	0.60	0.67	0.83	1.00	1.00	
Adjusted Runoff coefficient, C <sub>1T</sub>	0.236	0.260	0.283	0.316	0.392	0.472	0.472	0.472	
C <sub>1T</sub> =(αC <sub>1T</sub> +βC <sub>2</sub> +γC <sub>3</sub> )	0.236	0.260	0.283	0.316	0.392	0.472	0.472	0.472	
Rainfall									
Return Period (years), T	2	5	10	20	50	100	200		
Intensity, I <sub>r</sub> (Ruan Small)	81.6	107.4	132.2	162.7	214.2	263.7	324.7		
Return Period (years), T	2	5	10	20	50	100	200		
Peak Flow (m <sup>3</sup> /s), Q <sub>T</sub> =C <sub>1T</sub> A/3.6	0.73	1.06	1.42	1.96	3.19	4.74	5.83		
	l/s	732.4738	1060.637	1424.5062	1958.38	3193.612241	4737.1059	5832.061	
Note: This Spreadsheet should be used hand in hand with the SANRAL drainage manual									
Choices that influence the outcome of the results.									
Variables that is specific to drainage areas!									
Notes:									
	Time (h)	Q <sub>2</sub> m <sup>3</sup> /s	Q <sub>5</sub> m <sup>3</sup> /s	Q <sub>10</sub> m <sup>3</sup> /s	Q <sub>20</sub> m <sup>3</sup> /s	Q <sub>50</sub> m <sup>3</sup> /s	Q <sub>100</sub> m <sup>3</sup> /s	Q <sub>200</sub> m <sup>3</sup> /s	
	0.0	0	0	0	0	0	0	0	
	0.2	0.73	1.06	1.42	1.96	3.19	4.74	5.83	
	0.6	0	0	0	0	0	0	0	
	Q <sub>total</sub> (m <sup>3</sup> )	744	1077	1447	1989	3243	4810	5922	



Rational Method									
This Spread sheet should not be used by anyone without consultation									
Project Name:		Umlaas Quarry Stormwater Management							
Description of Catchment:		DirtyCatchment_C_D01							
Physical Characteristics									
Slope Calc	Average	Size of Catchment	A	0.0790	km <sup>2</sup>	Rainfall Region			
H1	785	Longest Water Course	L	0.397	km	Area Distribution			
H2	771.5	Average Slope	Sav	0.034005	m/m	Rural (α)	Urban (β)	Lakes (γ)	
H <sub>0.1</sub>		Dolomite Area	D <sub>%</sub>	0	%	1	0	0	
H <sub>10.85</sub>		Mean Annual Rainfall	MAR	695	mm	1			
		Coastal (1) or Inland (2)		Inland		Lawns	1	others	1
		Rural <sub>1</sub>				Urban <sub>2</sub>			
		%	Factor	C <sub>s</sub>		Description	%	Factor	C <sub>2</sub>
		0	0.03	0		Lawns	high=3 ;mean=2;Low=1		2
		100	0.08	0.08		Sandy, flat (<2%)	0	0.075	0
		0	0.16	0		Sand (2-7%)	0	0.125	0
		0	0.26	0		Sandy, steep (>7%)	0	0.175	0
		100		0.08		Heavy Soil, flat (<2%)	0	0.15	0
		%	Factor	C <sub>p</sub>		Heavy Soil (2-7%)	0	0.21	0
		0	0.04	0		Heavy Soil, steep (>7%)	0	0.3	0
		60	0.08	0.048		Residential			
		40	0.16	0.064		Houses	10	0.4	0.04
		0	0.26	0		Flats	0	0.6	0
		100		0.112		Industry			
		%	Factor	C <sub>v</sub>		Light Industry	70	0.65	0.455
		0	0.04	0		Heavy Industry	0	0.75	0
		0	0.11	0		Business			
		0	0.21	0		City Centre	0	0.825	0
		100	0.28	0.28		Suburban	0	0.6	0
		100		0.28		Streets	20	0.825	0.165
		Time of Concentration				Maximum Flood			
		Overland flow		Defined Watercourse		Total (Must = 100)		100	0.66
		T <sub>c</sub> =0.605(L/√Sav) <sup>0.467</sup>		T <sub>c</sub> =τ(((0.87L) <sup>2</sup> /1000Sav) <sup>0.385</sup>		τ=	2	0.1	τ=
		0.29531		0.1197		Hours		0.11971	
		Defined Watercourse		0.11971		Paved Area		0.02	
						Clean Compacted Soil		0.1	
						Sparse Grass over rough surface		0.3	
						Medium Grass cover		0.4	
						Thick grass cover		0.8	
Runoff Coefficient									
Return Period (years), T	2	5	10	20	50	100	200		
Runoff Coefficient, C <sub>1</sub>	0.472		0.472	0.472	0.472	0.472	0.472	0.472	
(C <sub>1</sub> =C <sub>s</sub> +C <sub>p</sub> +C <sub>v</sub> )									
Adjusted for Dolomite Areas, C <sub>1D</sub>									
(C <sub>1</sub> (1-D%)+C <sub>1</sub> D%(Σ(D <sub>factor</sub> ×C <sub>s</sub> %)))									
Adjustment Factor for initial saturation, F <sub>i</sub>	2	0.50	0.55	0.60	0.67	0.83	1.00	1.00	
Adjusted Runoff coefficient, C <sub>1T</sub>	0.236	0.260	0.283	0.316	0.392	0.472	0.472	0.472	
C <sub>1T</sub> =(αC <sub>1T</sub> +βC <sub>2</sub> +γC <sub>3</sub> )									
Rainfall									
Return Period (years), T	2	5	10	20	50	100	200		
Intensity, I <sub>r</sub> (Ruan Small)	95.2	125.3	154.3	190.0	250.1	307.9	379.0		
Return Period (years), T	2	5	10	20	50	100	200		
Peak Flow (m <sup>3</sup> /s), Q <sub>T</sub> =C <sub>1T</sub> A/3.6	0.49	0.71	0.96	1.32	2.15	3.19	3.93		
	l/s	493.0879	714.00129	958.95131	1318.345	2149.880883	3188.9323	3926.036	
Note: This Spreadsheet should be used hand in hand with the SANRAL drainage manual									
Choices that influence the outcome of the results.									
Variables that is specific to drainage areas!									
Notes:									
	Time (h)	Q <sub>2</sub> m <sup>3</sup> /s	Q <sub>5</sub> m <sup>3</sup> /s	Q <sub>10</sub> m <sup>3</sup> /s	Q <sub>20</sub> m <sup>3</sup> /s	Q <sub>50</sub> m <sup>3</sup> /s	Q <sub>100</sub> m <sup>3</sup> /s	Q <sub>200</sub> m <sup>3</sup> /s	
	0.0	0	0	0	0	0	0	1	
	0.1	0.49	0.71	0.96	1.32	2.15	3.19	3.93	
	0.4	0	0	0	0	0	0	1	
	Q <sub>total</sub> (m <sup>3</sup> )	319	462	620	852	1390	2061	2538	



Appendix B - PCD sizes

<b>Project Name:</b>	<b>Umlaas Quarry Stormwater Management</b>	
<b>Description of Project:</b>	<b>Quarry Dirty Water</b>	
<b>PCD SIZING</b>		
<b>Dirty Area (m<sup>2</sup>)</b>		<b>79072.00</b>
<b>Dirty Area Runoff Co-eff (1:50)</b>		<b>0.33</b>
<b>1:50 Year x 24 hour storm (mm)</b>		<b>113.50</b>
<b>Operating Volume (m<sup>3</sup>)</b>		
<b>Required 24 Hour Storage (m<sup>3</sup>) (24 Hour)</b>		<b>2962.6</b>
<b>Required 24 Hour Storage (m<sup>3</sup>) (Rational Method)</b>		<b>1389.8</b>
<b>Required PCD Capacity (m<sup>3</sup>)</b>		<b>2962.6</b>

Appendix C

WATER BALANCE: AFRISAM SWMP		
Project Name:		17-315-04-Umlaas Storm Water Management Plan
Description of Project:		Umlaas Aggregate Quarry

WATER BALANCE	
OPEN CAST	
IN (m <sup>3</sup> /d)	
PIT Rainfall	19.99267
Dirty Runoff	36.19695
Ground Water Inflow	22.37544
Stone Washing Return Flow	0
Slurry Dam Return Flow	0
<b>TOTAL</b>	<b>78.6</b>
OUT (m <sup>3</sup> /d)	
Pumping to Balancing Dam	41.6
Evaporation	37.0
Dust Suppression	0.0
Product washing plant	0.0
Discharge	0.0
<b>TOTAL</b>	<b>78.6</b>
BALANCING DAM (RESERVOIR)	
IN (m <sup>3</sup> /d)	
Open Cast	41.6
Dam Rainfall	N/A
Dirty Runoff	N/A
<b>TOTAL</b>	<b>41.6</b>
OUT (m <sup>3</sup> /d)	
Roads Dust Suppression	32.9
Plant Dust Suppression	8.7
<b>TOTAL</b>	<b>41.6</b>
LOWER PCD	
IN (m <sup>3</sup> /d)	
Runoff	3.4
PCD Rainfall	4.0
<b>TOTAL</b>	<b>7.3</b>
OUT (m <sup>3</sup> /d)	
Evaporation	4.0
Infiltration	3.3
<b>TOTAL</b>	<b>7.3</b>
DOMESTIC	
IN (m <sup>3</sup> /d)	
Umgeni Water	30.7
<b>TOTAL</b>	<b>30.7</b>
OUT (m <sup>3</sup> /d)	
Septic Tank	24.6
Losses	6.1
<b>TOTAL</b>	<b>30.7</b>

