1 Runoff Calculation of Existing Catchment

1.1 Runoff Estimation

1.1.1 Rational method is adopted for estimating the designed run-off

$$Q=0.278\ C \times I \times A$$

Table 1: Runoff Coefficients

Surface Characteristics	Runoff Coefficient
Asphalt	0.70-0.95
Concrete	0.80-0.95
Brick	0.70-0.85
Grassland (Heavy Soil)	
Flat	0.13-0.25
Steep	0.25-0.35
Grassland (Sandy Soil)	
Flat	0.05-0.15
Steep	0.15-0.2

Assuming that:

I. The total existing catchment area is about 16,931m^2;
II. Approximately 4,9191 m^2 is hard paved, and therefore the value of run-off co-efficient (k) is taken as 0.95, and approximately 12,012m^2 is steep grassland, and therefore the value of run-off co-efficient (k) is take as 0.25.
III. The areas of the existing catchment are shown in Figure 1.

Difference in Land Datum = 71.2m –29.1m = 42.1m
L = 179.7m
Average fall = 23.4m in 100m

According to the Brandsby-Williams Equation adopted from the "Stormwater Drainage Manual – Planning, Design and management" published by the Drainage Services Department (DSD),

Time of Concentration (t_c) = $0.14465[L/(H^{0.2} \times A^{0.1})]$
t_c = $0.14465[179.7/(23.4^{0.2} \times 16{,}931^{0.1})]$
t_c = 5.23 minutes

The rainfall intensity *i* is determined by using the Gumbel Solution:

$$i = \frac{a}{(td + b)^c}$$

Where *I* = Extreme mean intensity in mm/hr
td = Duration in minutes (td≤240)
a, b, c = Storm constants given in the table below

Table 2: Storm Constants for Different Return Periods of North District Area

Return Period T(years)	2	5	10	20	50
a	1004.5	1112.2	1157.7	1178.6	1167.6
b	17.24	18.86	19.04	18.49	16.76
c	0.644	0.614	0.597	0.582	0.561

$$i = 1167.6/[5.23+16.76]^{0.561}$$
$$i = 206.2mm/hr$$

By Rational Method, $Q = 0.25\times 206.2mm/hr \times 12{,}012/3600 + 0.95\times 206.2mm/hr \times 4{,}919/3600$

$Q = 440l/s = 0.440m^3/s = 26{,}385\ l/min$

2 Runoff Calculation of Additional Discharge from The Site and External Catchment to 0.7m Diameter Pipe

2.1 Runoff Estimation

2.1.1 Rational method is adopted for estimating the designed run-off

$$Q=0.278\ C \times I \times A$$

Table 1: Runoff Coefficients

Surface Characteristics	Runoff Coefficient
Asphalt	0.70-0.95
Concrete	0.80-0.95
Brick	0.70-0.85
Grassland (Heavy Soil)	
Flat	0.13-0.25
Steep	0.25-0.35
Grassland (Sandy Soil)	
Flat	0.05-0.15
Steep	0.15-0.2

Assuming that:

I. The internal catchment discharged into the Existing External Catchpit with Sandtrap #2, and thus does not pass through the 0.7m diameter pipe and will not be counted in this estimation

II. Only the external catchment area from the site will be discharged into the 0.7m Diameter pipe and will thus be counted

III. The total external catchment area is about 2,425 m^2, as shown in Figure 2;

IV. Approximately 2,261 m^2 is hard paved, and therefore the value of run-off co-efficient (k) is taken as 0.95, and approximately 164m^2 is steep grassland, and therefore the value of run-off co-efficient (k) is take as 0.25.

Difference in Land Datum = 40m –29.5m = 10.5m

L = 107.8m

Average fall = 9.74m in 100m

According to the Brandsby-Williams Equation adopted from the "Stormwater Drainage Manual – Planning, Design and management" published by the Drainage Services Department (DSD),

Time of Concentration (t_c) = $0.14465[L/(H^{0.2}\times A^{0.1})]$

$t_c = 0.14465[107.8/(9.74^{0.2}\times 2{,}425^{0.1})]$

t_c = 4.54 minutes

The rainfall intensity *i* is determined by using the Gumbel Solution:

$$i = \frac{a}{(td + b)^c}$$

Where *I* = Extreme mean intensity in mm/hr
td = Duration in minutes (td≤240)
a, b, c = Storm constants given in the table below

Table 2: Storm Constants for Different Return Periods of North District Area

Return Period T(years)	2	5	10	20	50
a	1004.5	1112.2	1157.7	1178.6	1167.6
b	17.24	18.86	19.04	18.49	16.76
c	0.644	0.614	0.597	0.582	0.561

i = $1167.6/[4.54+16.76]^{0.561}$
i = 209.9mm/hr

By Rational Method, Q = 0.95× 209.9mm/hr × 2,261/3600 +0.2× 209.9mm/hr × 164/3600
Q = 127l/s = 0.127m^3/s = 7,631 l/min

3 Checking the Capacity of the Existing 0.7m Diameter Drainage Pipes

Manning Equation

$$V = \frac{HMD^{\frac{2}{3}} \times S_f^{0.5}}{n}$$

Hydraulic Mean Depth (HMD) = 0.291 × D
HMD = 0.291 × 0.7
HMD = 0.204
n = 0.013 s/$m^{1/3}$
for good uncoated cast iron pipe
(Table 13 of Stormwater Drainage Manual)
V = $[0.204^{2/3}]\times[0.01^{0.5}]/0.013$
V = 2.67m/sec

Maximum Capacity Q_{Max} = V × A

A = πR^2
A = $\pi 0.35^2$
A = 0.385m^2
Q_{Max} = 2.67m/sec × 0.385m^2
Q_{Max} = 1.03m^3/sec
1.03m^3/sec > (0.440+0.127)m^3/sec
1.03m^3/sec > 0.567m^3/sec
Q_{Max} > Q

4 **Conclusion**

Based on the Above calculations, the existing pipe has more than sufficient capacity, 1.03m^3/sec, to cater the existing catchment, 0.44m^3/sec, as well as the additional discharge from the proposed application, 0.127m^3/sec.

Figure 1 Existing Catchment Area

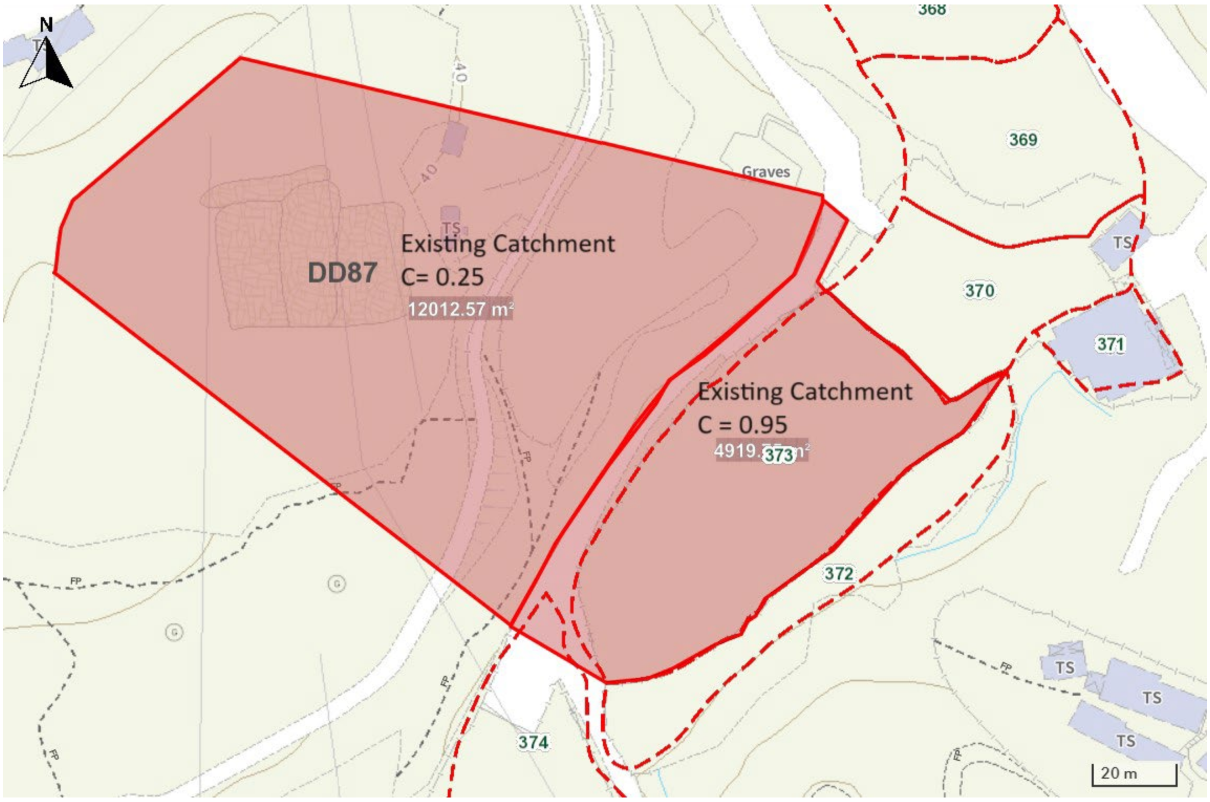

Figure 2 External Catchment Area