DETERMINATION OF THE FLOOD LINE DELINEATION OF THE 1:100 YEAR FLOOD LINES: PROPOSED TOWNSHIP: TIGANE EXTENSION 8 CITY OF MATLOSANA.

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1. INTRODUCTION

CWT Consulting was appointed by ***MAXIM PLANNING SOLUTIONS Town Planners*** to calculate the 1:100 year flood lines for the proposed development of **Tigane Extension 8 of the City of Matlosana.**

According to section 144 of the National Water Act (ACT No. 36 of 1998), no person may establish a township unless the layout plan shows (in a form acceptable to the local authority concerned) lines indicating the maximum level likely to be reached by floodwaters on average once in every 100 years.

An unnamed non perennial stream exists on the property and the 1:100 year flood lines must therefore be shown on the layout plans.

2. LOCATION

The location of the area is shown below.

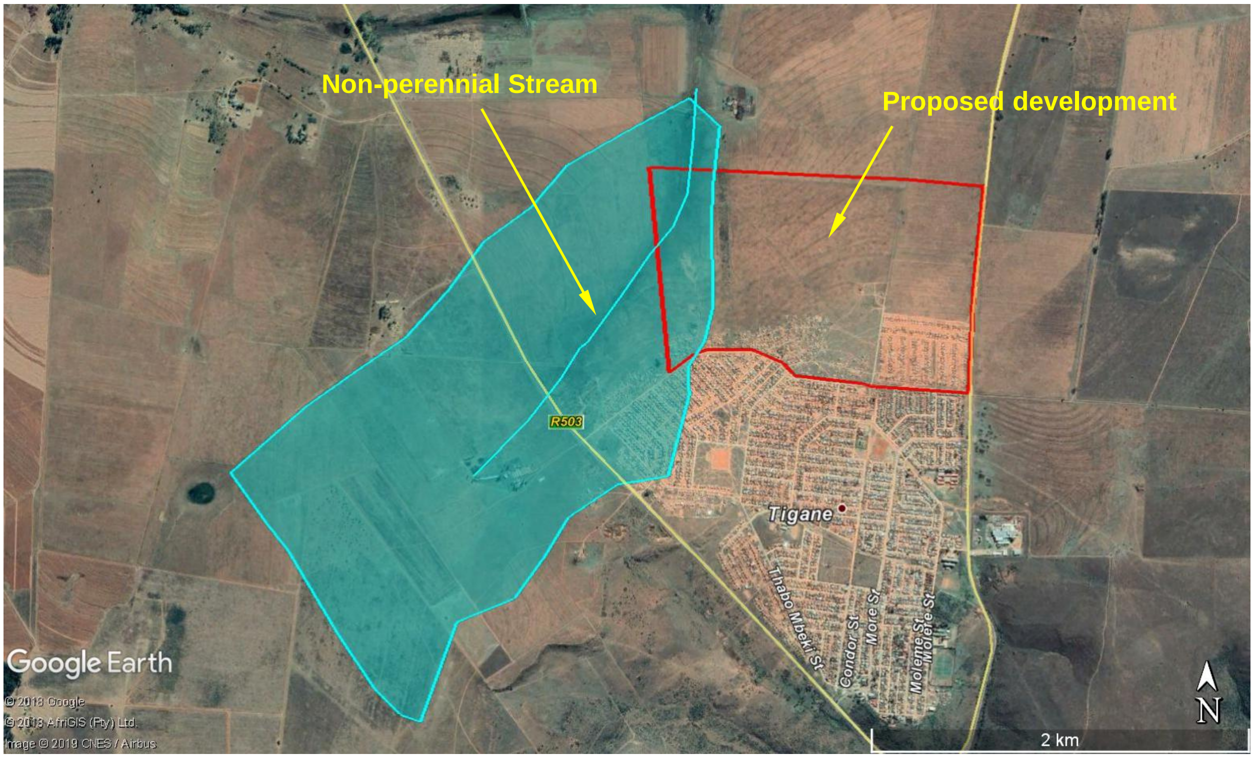

Figure 1

3. Hydrology

3.1 Rainfall Data

The rainfall data in **Table 1** below was derived using software to estimate the rainfall in any catchment where coordinates of the centroid of the catchment is used as the reference point. This program implements procedures to estimate design rainfall in South Africa developed by JC Smithers and RE Schulze. Funding for this project was obtained from the Water Research Commission through a project **entitled "Rainfall Statistics for Design Flood Estimation in South Africa" (WRC Project K5/1060)**, and from the University of Natal Research Fund. Details of the procedures are contained in the **WRC Report No. 1060/1/03** entitled "Design Rainfall and Flood Estimation in South Africa" by JC Smithers and RE Schulze. The software was developed by MJ Gorven. The Weather Bureau stations nearest to **the reference point in the Catchment of the Stream were used to determine the point storm rainfall depths for the 1:100 year storm associated with this catchment.**

The nearest Weather Bureau stations used are listed in **Table 1.**

The data was extracted from **Daily Rainfall Estimate Database File.**

Name of the Weather Bureau station	Number of the Weather Bureau station	Distance from the centroid km	Length of record Years
HARTBEESFONTEIN (SKL)	0435735_W	4.0	95
OTTERFONTEIN	0435615_W	7,2	47
PAARDEPLAAS "MON REPOS"	0435608_W	12,1	46
WERK-MET-LUS	0435400_W	20,1	70

Table 1

The coordinates of the reference point are:

Latitude: 26° 44.138'S

Longitude: 26° 23.866'E

Mean annual precipitation at the reference point: **586 mm**

Precipitation in ***mm*** associated with various storm durations is given in **Table2.**

Storm Duration hours	Rainfall Return Period (RP)
	100 Years
0,25	42,6 mm
0,5	54,0 mm
0,75	61,9 mm
1	68,3 mm
2	86,5 mm

Table 2

3.2 Catchment of the Stream

The study area and the catchment draining to this portion of the Stream is shown in Figure 2.

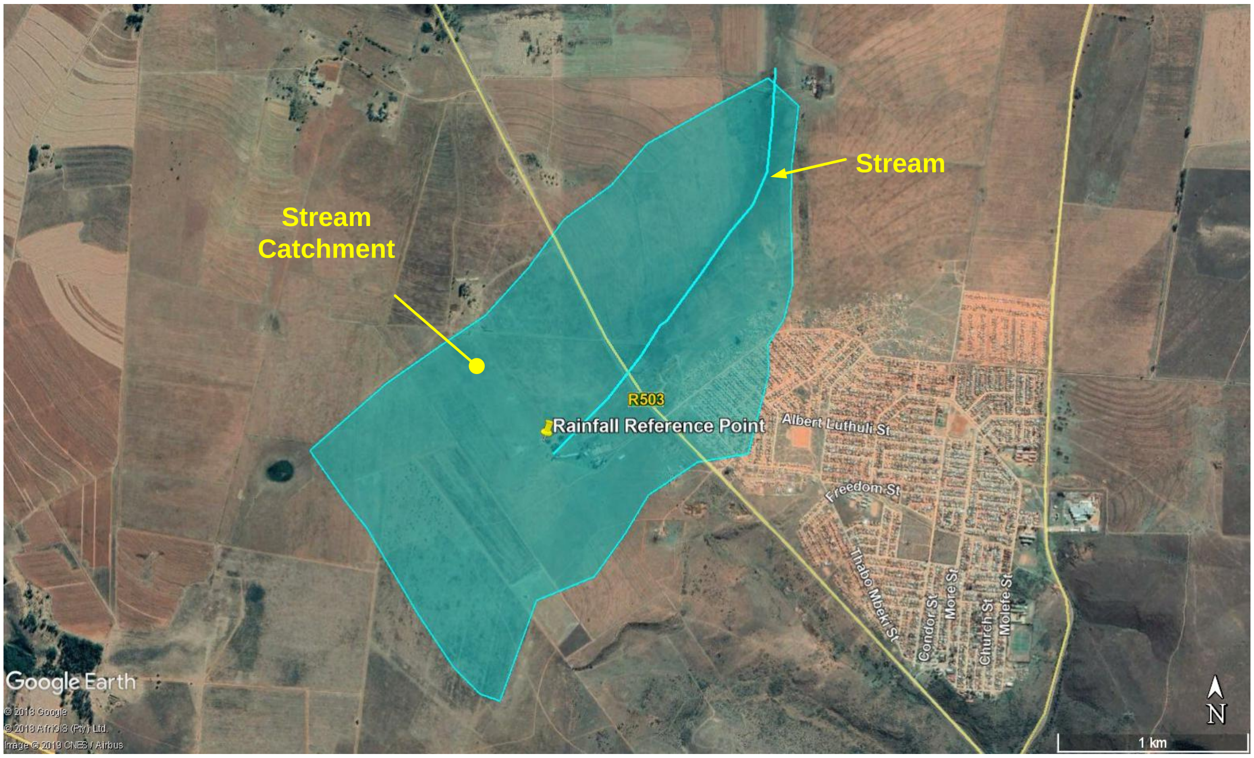

FIGURE 2

3.3 Characteristics of the catchment

Area of catchment:	4,0 km²
Length of longest watercourse:	2,45 km
Equal area height difference:	34,0 m
10 – 85 slope height difference:	29,0 m
Distance to catchment centroid:	1,88 km
Time of concentration	0,65 hour

4. FLOOD PEAKS

The Effect of Dams on the Flood Peaks

The effect of any dam in the catchment was not taken into account because the flood peaks will ***not*** be attenuated by a dam with a smaller storage capacity than *6 times the total mean annual runoff* of the catchment draining into the dam.

Methods used to calculate the Flood Peaks

Various different methods were used to calculate the flood hydrology for the catchment as this increases the accuracy of the final flood peak calculation. All the methods used take the following into account:

All factors relating to storm water run-off.

- Evaporation during rain storm
- Wind during rainstorm
- Depth of rainstorm
- Infiltration
- Flow roughness of area.

The following methods were considered:

1. Rational method as implemented by the Department of Water & Sanitation.
2. Rational method using an alternative implementation.
3. Standard Design Flood (SDF) method as developed at Pretoria University.
4. The Unit Hydrograph Method

Most applicable methods for the catchment

Due to the size of the catchment the results obtained from the four mentioned methods are deemed to be applicable for this study.

Results of the calculations

The results are listed below. The flows indicated are in m^3/s (cubic meter per second).

Details of the calculations are shown in ***Addendum 6.***

Return Period Year	Rational method DWA	Rational method Alterna-tive algorithm	SDF method	Unit Hydrograph method
1:10	25	32	31	14
1:20	33	41	44	19
1:50	44	53	65	29
1:100	56	64	82	40

Table 3

Recommended Flood Peaks

The flood peaks were calculated by applying the following algorithm:

$$Q_T = [RMDWA + RMALT + SDF + UH] / N$$

With:

Q_T = Flood peak for return period T

T = Return Period

RMDWA = Rational method DWA

RMALT = Rational method alternative algorithm

SDF = SDF method

UH = Unit Hydrograph method

N = 4

The recommended flood peaks in m^3/s (cubic meter per second) at the site are listed in **Table 3** below:

Return Period (Year)	**Flood peak in the Stream** (m^3/s)
1:50	**48**
1:100	**61**

Table 4

5. DESCRIPTION OF THE FLOOD LINE CALCULATION

5.1 Hydraulic Model

The HEC-RAS model was used to perform the calculations of the water levels.

HEC-RAS is an integrated package of hydraulic analysis programs, in which the user interacts with the system through the use of a Graphical User Interface (GUI).

HEC-RAS is equipped to model a network of channels, a dendritic system or a single river reach. Certain simplifications must be made in order to model some complex flow

situations using the HEC-RAS one-dimensional approach. It is capable of modeling subcritical, supercritical, and mixed flow regime flow along with the effects of bridges, culverts, weirs, and structures.

5.2 Procedure

The basic computational procedure of HEC-RAS for steady flow is based on the solution of the one-dimensional energy equation. Energy losses are evaluated by friction and contraction / expansion. The momentum equation may be used in situations where the water surface profile is rapidly varied. These situations include hydraulic jumps, hydraulics of bridges, and evaluating profiles at river confluences.

For unsteady flow, HEC-RAS solves the full, dynamic, Saint-Venant equation using an implicit, finite difference method. The unsteady flow equation solver was adapted from Dr. Robert L. Barkau's UNET package.

6. RIVER GEOMETRY

The geometry of the stream was obtained from **17 sections** to build the model and sections were interpolated at **1 m** intervals to facilitate the calculation. The small dam was included in the model.

7. OUTPUT OF CALCULATION

The detailed flood peak calculations, water level calculations, cross sections and longitudinal section are included in **Addenda 3 to 6.**

The positions of the sections to compile the model are shown in **Addendum 2.** The flood lines are shown in **Addendum 1.** The flooded area is shown in **Figure 3** below.

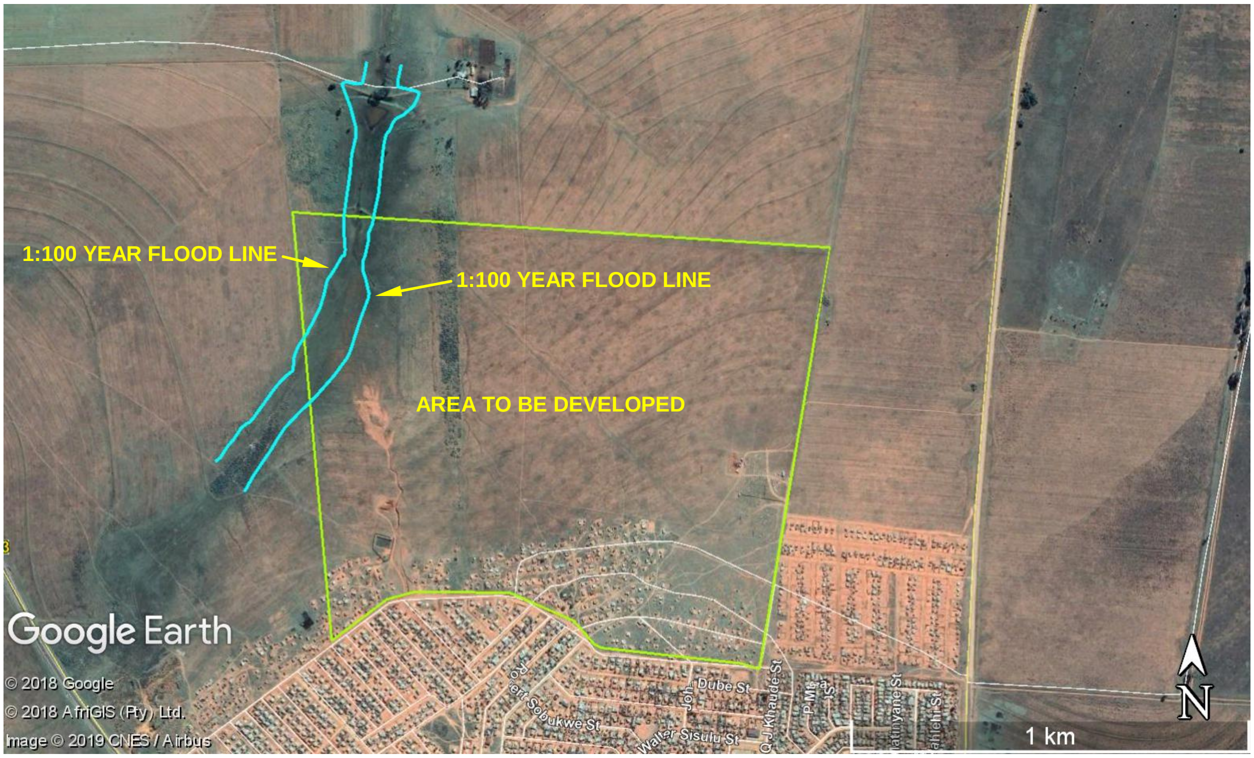

Figure 3

The calculated water levels, flow velocities and flow depths are shown in **Table 5.**

Section	Water level 1:100 yr m	1:100 yr Flow velocity m/s
1	1504.53	1.97
2	1505.52	1.87
3	1507.03	0.33
4	1507.22	1.88
5	1508.50	2.06
6	1510.06	2.03
7	1511.23	2.06
8	1512.49	2.82
9	1514.64	1.82
10	1515.93	1.90
11	1517.68	1.81
12	1519.24	1.80
13	1520.60	1.99
14	1521.71	2.05
15	1523.11	1.95
16	1524.24	1.83
17	1525.31	1.47

Table 5

Due to relative low peak flow velocities little or no scour is expected.

The small dam will be overtopped by 0,5 m and will probably be washed away.

8. REFERENCES

1. ***Water Research Commission (WRC) Report TT 382/08.***
2. ***Department of Water Affair's publication TR102.***
3. ***Hydrological Research Unit Report No. 1/72.***
4. ***Planet-GIS Geographic Information System (GIS) software suite.***
5. ***Other relative documents and spreadsheets in my possession.***
6. ***Department of Water Affair's publication Floods Database.***
7. ***GN.704 of 4 June 1999.***
8. ***GN.636 of 23 August 2013.***
9. ***HRU, Report 2/78, Depth-Duration-Frequency diagram.***
10. ***Hec-Ras model software.***
11. ***WRC Report No. 1060/1/03***
12. ***Department of Transport. (2005) Road Infrastructure Strategic Framework for South Africa. (RISFSA).***
13. ***Kruger, E.J. (editor)(2006) Drainage Manual South African Roads Agency Limited.***

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