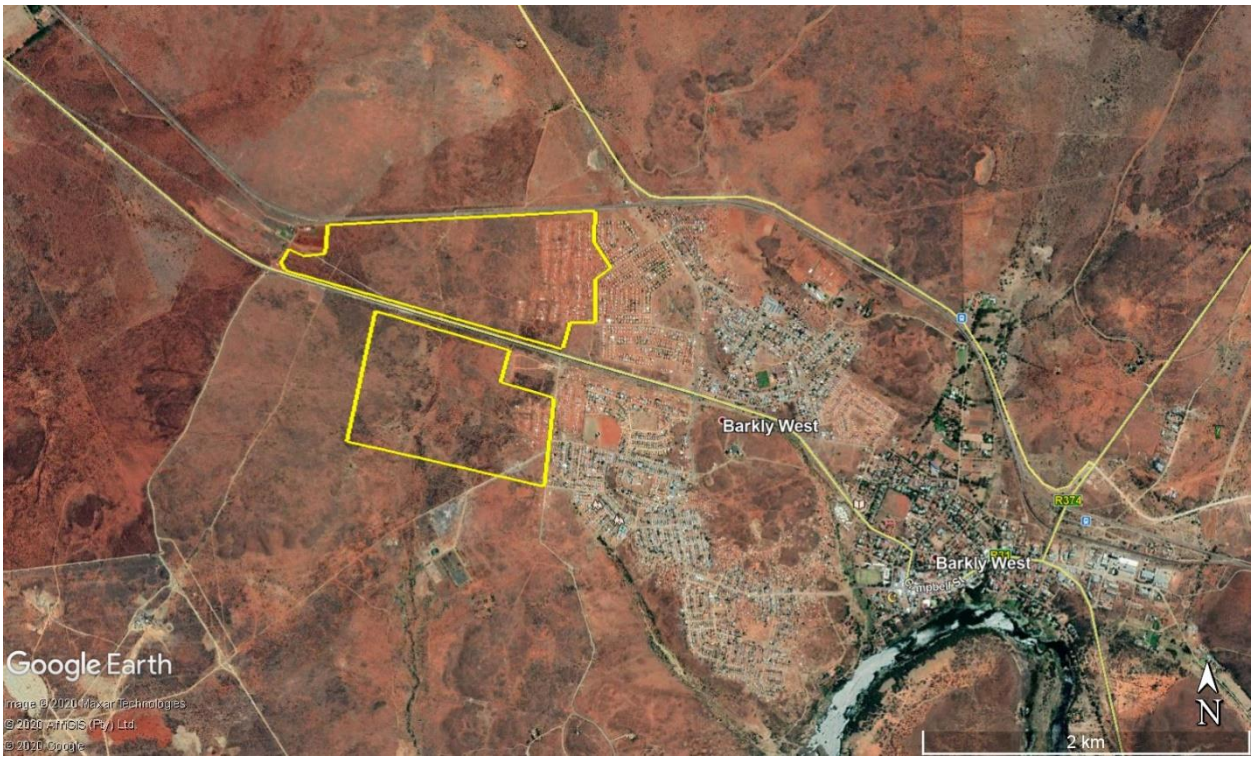
FLOOD LINE DELINEATION OF THE 1:100 YEAR FLOOD LINES PROPOSED TOWNSHIP: A PORTION OF THE REMAINING EXTEND OF ERF 687 BARKLY WEST (DIKGATLONG LOCAL MUNICIPALITY)



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CLIENT: MAXIM PLANNING SOLUTIONS

CWT Consulting

REPORT No. CWT 272020

DATE: 28 April 2020

CONTENTS

ADDENDA

ADDENDUM 1 1:100 YEAR FLOOD LINES IN THE STREAMS

ADDENDUM 2 LAYOUT OF ALL THE FLOOD LINE SECTIONS

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FLOOD LINE DELINEATION OF THE 1:100 YEAR FLOOD LINES PROPOSED TOWNSHIP: A PRTION OF THE REMAINING EXTEND OF ERF 687 BARKLY WEST (DIKGATLONG LOCAL MUNICIPALITY)

CLIENT

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1. INTRODUCTION

CWT Consulting was appointed by the ***Maxim Planning Solutions*** to calculate the 1:100 year flood levels in ***a non-perennial stream*** on a proposed new development at ***Barkly West*** in the ***Dikgatlong Local Municipality*** in the **Northern Cape Province.** According to **section 144 of the National Water Act (**ACT No. 36 of 1998) as amended, no person may establish a development 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. The area is riparian to a non-perennial stream and the 1:100 year flood lines must therefore be shown on the layout plans.

2. LOCATION

The areas to be developed is shown below. The R31 road bisects the area to be developed.

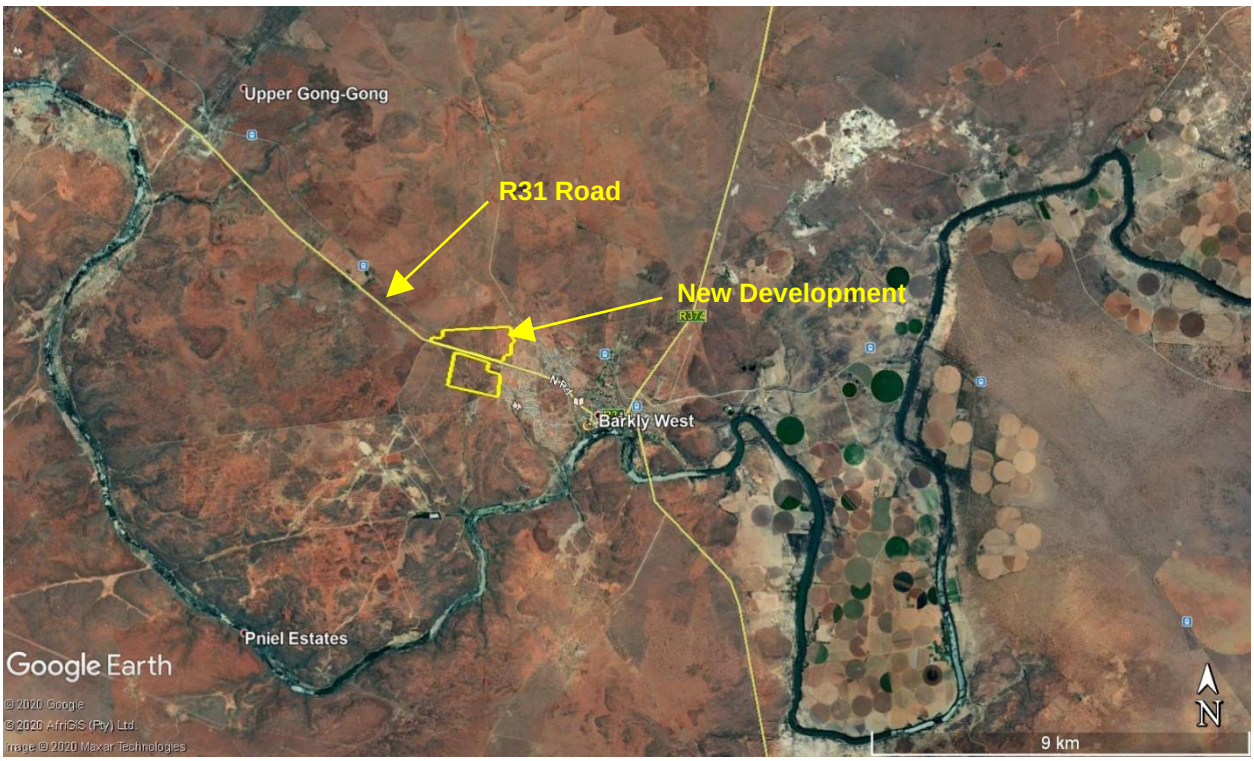


Figure 1

3. Hydrology

3.1 Rainfall Data

The area to be developed is located in the **C91E Quaternary Drainage Region.** The rainfall data in **Table 2** below was derived using software to estimate the rainfall in any catchment where coordinates of a ***reference point in the catchment*** are used. This program implements procedures to estimate design rainfall in South Africa developed by JC Smithers and RE Schulze. 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 study area were used to determine the point storm rainfall depth for the 1:100 year storm associated with the two catchments. The nearest Weather Bureau stations used for the Storm Rainfall are listed in **Table 1.**

Name of the Weather Bureau station	Number of the Weather Bureau station	Distance from the Reference point km	Length of record Years
BARKLY WEST (TNK)	0290032_W	4	99
PLATFONTEIN	0290191_W	19,1	50
ROCKLANDS	0324202_W	20,1	69
DELPORTSHOOP (POL)	0323535_W	22,6	31
SMITHSDALE	0324449_W	23,7	25

Table 1

The coordinates of the rainfall reference point in the catchment are:

Latitude: 28°31'15.06"S

Longitude: 24°29'21.46"E

Mean annual precipitation at the reference point: **376 mm**

The Storm Precipitation in ***mm*** associated with the 1:100 year storm is given in **Table2.**

Storm Duration (minutes)	Precipitation of 1:100 Year Storm (mm)
10	28
15	35
30	45
60	57
90	66
120	73
240	84

Table 2

The data was extracted from Daily Rainfall Estimate Database File.

3.2 Catchment of the Stream

The study of the contour survey revealed the following:

1. The storm water flow regime ***North of the R31*** road will be ***sheet flow***. No flood lines will develop in this area. The storm water will be channelled to a point where it will flow over the R31 road into the channelled stream on the Southern property.
2. The storm water flow regime ***South of the R31*** road will be ***channel flow*** and therefore flood lines will develop here. The flood water from the Northern property will be included into the flood water generated on the Southern property.

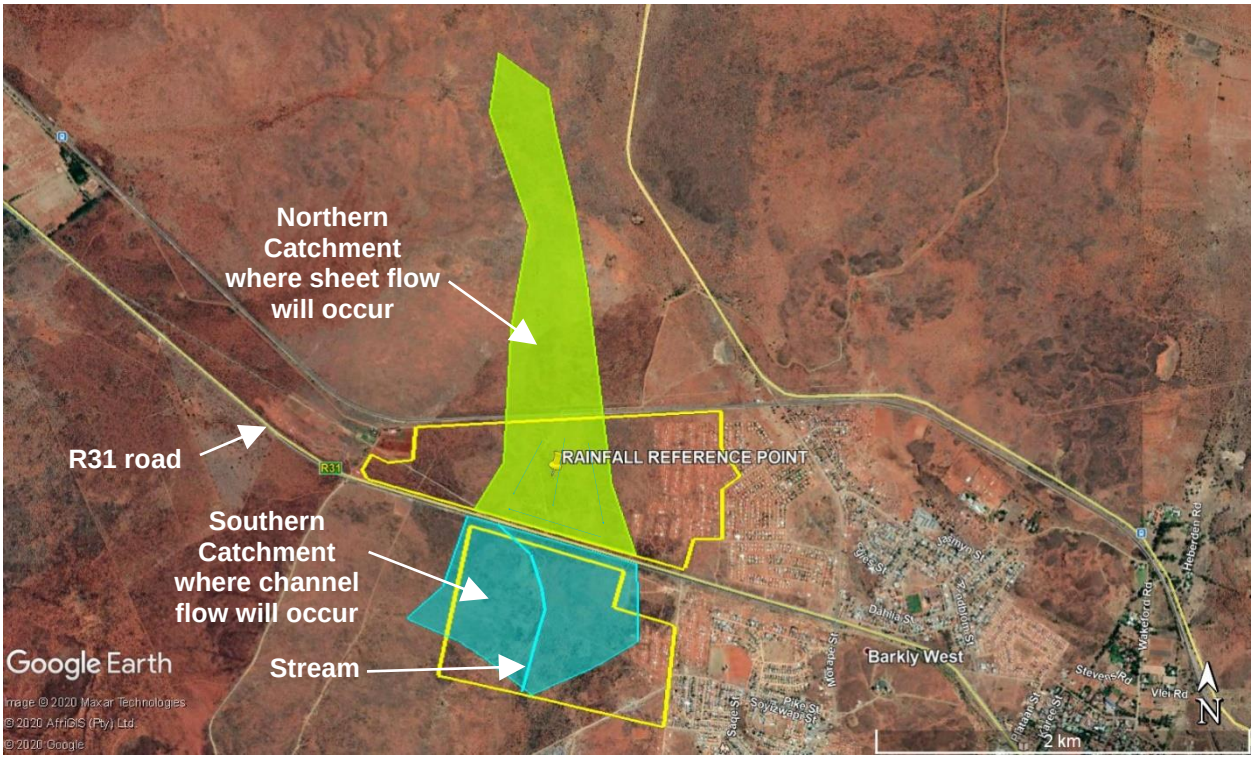


Figure 2

3.3 Characteristics of the catchments at the study site

3.3.1 Northern Catchment

Area of catchment:	1,036	km²
Length of longest watercourse:	1,93	km
Equal area height difference:	10	m
Distance to catchment centroid:	0,9	km
Time of concentration	96	minutes

3.3.2 Southern Catchment

Area of catchment:	0,71	km²
Length of longest watercourse:	0,83	km
Equal area height difference:	9,7	m
10 – 85 slope height difference:	8,0	m
Distance to catchment centroid:	0,45	km
Time of concentration	19	minutes

4. FLOOD PEAKS

4.1 The Effect of Dams on the Flood Peak

The effect of any dam in the catchment was not taken into account with the use of the deterministic methods because the 1:100 year flood peak will be attenuated by 5% or more by a dam with a smaller storage capacity than at **least *6 times the total mean annual runoff*** of the catchment draining into the dam. No dam(s) exist in the catchment of the stream that will attenuate the 1:100 year flood peak.

4.2 Methods used to calculate the Flood Peak

4.2.1 Analysis Methodology

The final recommended 1:100 year flood peaks were calculated after considering both **statistical methods** or **deterministic methods.**

Both totally different types of flood peak calculation were therefore considered to determine the final recommended 1:100 year flood peaks at the study site.

4.2.2 Statistical Methods

No flood record for floods in this stream exists and Statistical Methods can therefore not be used.

4.2.3 Deterministic Methods

Various different deterministic 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:

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

The following deterministic methods were considered:

1. Rational method as implemented by the Department of Water Affairs.
2. Rational method using an alternative implementation.
3. Standard Design Flood (SDF) method as developed at Pretoria University.
4. The Unit Hydrograph method.
5. The Herbst Algorithm as developed at the Department of Water & Sanitation.
6. The HRU Algorithm as developed at the University of Witwatersrand.
7. The Stephenson & Ten Noordt Algorithms as developed at the University of Witwatersrand.

Due to the ***size*** of the catchments the results obtained from only the **first four methods** mentioned above are deemed to be applicable for this study. See ***Addenda 6 and 7.***

4.2.4 Results of the Deterministic Flood Peak Calculations

The results for the storm return period of **1:100 year** are listed in **Table 2.**

Method	Flood peak North m^3/s	Flood peak South m^3/s	Flood peak Stream m^3/s
Rational Method as implemented by the Department of Water & Sanitation	4	8	**12**
Rational Method using Alternative Algorithms	6	11	**17**
Standard Design Flood Method (SDF) developed at the University of Pretoria	6	12	**18**
The Unit Hydrograph Method	15	7	**12**

Table 2

4.2.5 Recommended Flood Peaks

The flood peaks were calculated by applying the following algorithm:

$$\mathbf{Q_T = [\ RMDWS + RMA + SDF + UH\ ] / N}$$

With:

Q_T = Flood peak for return period T
T = Return Period: either 50 Year or 100 Year
RMDWS = Rational method DWS
RMA = Rational method Alternative Algorithms
SDF = SDF method
UH = Unit Hydrograph Method
N = 4

The recommended flood peaks in m^3/s (cubic meter per second) at the sites are listed in **Table 4** below:

Return Period Year	Flood peak in the Stream m^3/s
100	**15**

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. STREAM GEOMETRY

The final detailed contour survey was supplied by the client on **21 April 2020.** The geometry of the stream at the study site was obtained from **13 cross sections.** These sections were used to compile the two geometric models. Sections were interpolated at **5 m** interval to facilitate the calculations. The layout of all the **cross sections** is shown in **Figure 3 (Addendum 2).**

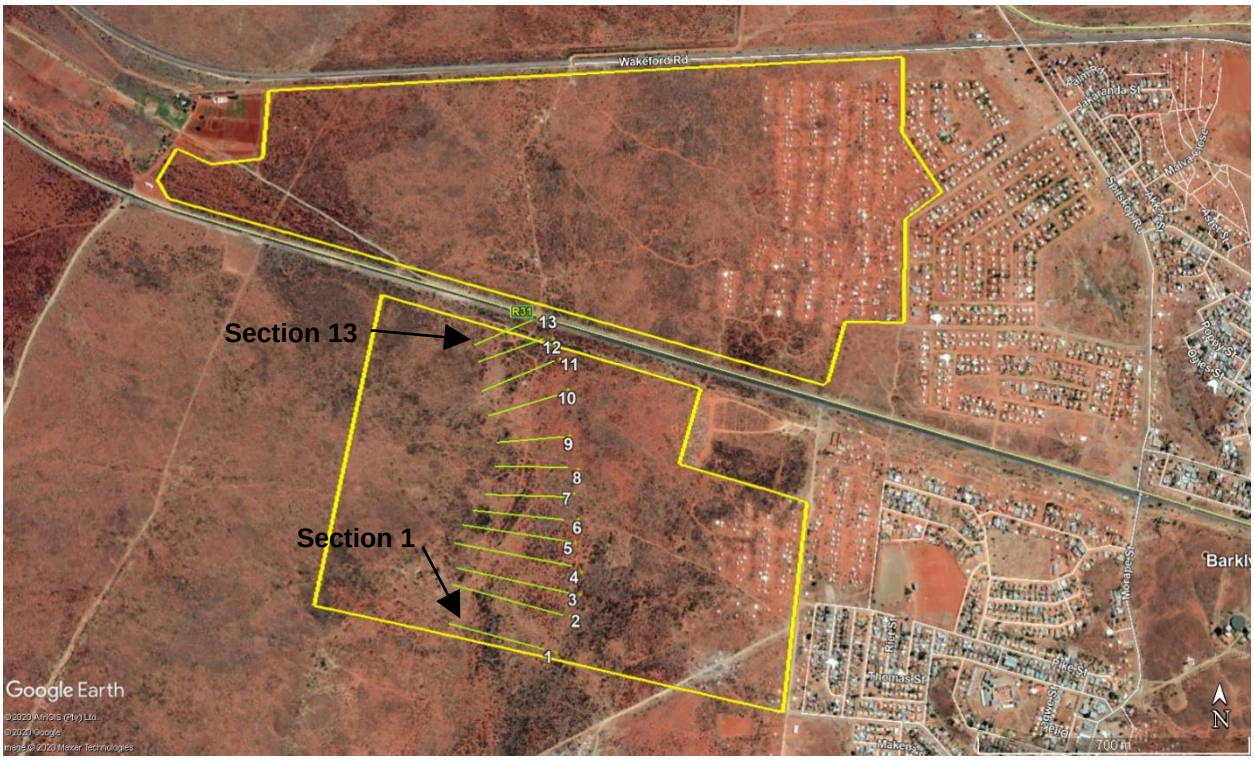


Figure 3

The exact geo-referenced layout of all the cross sections can be found in **Addendum 2 (Plan CWT 272020/2).**

7. RESULTS OF THE CALCULATION

The flow regime in the **Southern Catchment** will be **channel flow.** The flow regime in the **Northern Catchment** will be **sheet flow.** The sheet flow from the north will be dammed and diverted by the existing tarred Road R31 westwards to a point where it will flow southwards over the R31 Road into the stream where flood lines will develop. The flood peak generated from the Southern Catchment is also added to the final peak flow in the stream where the flood lines will develop. The 1:100 year flood lines are detailed in **Addendum 1 (Drawing CWT 272020/1).** The detailed flood peak calculations, water level calculations, cross sections and longitudinal sections are included in **Addenda 3 to 7.**

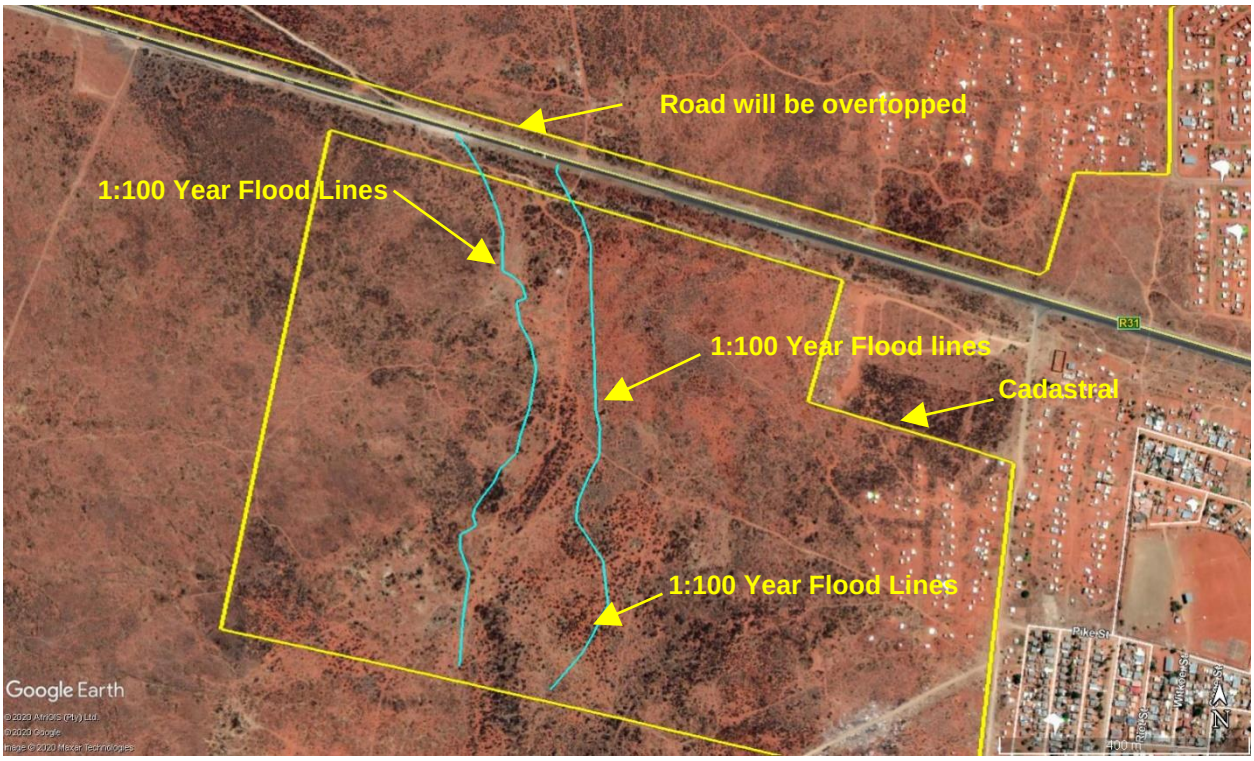
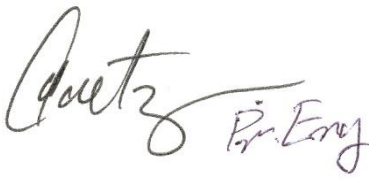


Figure 4

The1:100 year flood lines are shown in **Figure 4.** Relative low flow velocities will develop and no scour is expected. The flow depths will be less than 0,3 meter but the top width of the stream will vary from 90 meter to 233 m. – see **Addendum 3.** The existing road will be overtopped as indicated in **Addendum 1.** Refer to **Addenda 3 to 5** for all relevant hydraulic detail.

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. ***Department of Transport. (2005) Road Infrastructure Strategic Framework for South Africa. (RISFSA).***
12. ***Kruger. E.J. (editor)(2006) Drainage Manual South African Roads Agency Limited.***
13. ***Design Rainfall and Flood Estimation in South Africa: WRC Report No. 1060/1/03***
14. ***WRC Report WR2012 (updated to 2019)***



C. J. COETZER (Pr Eng) ECSA REG NUMBER: 800339

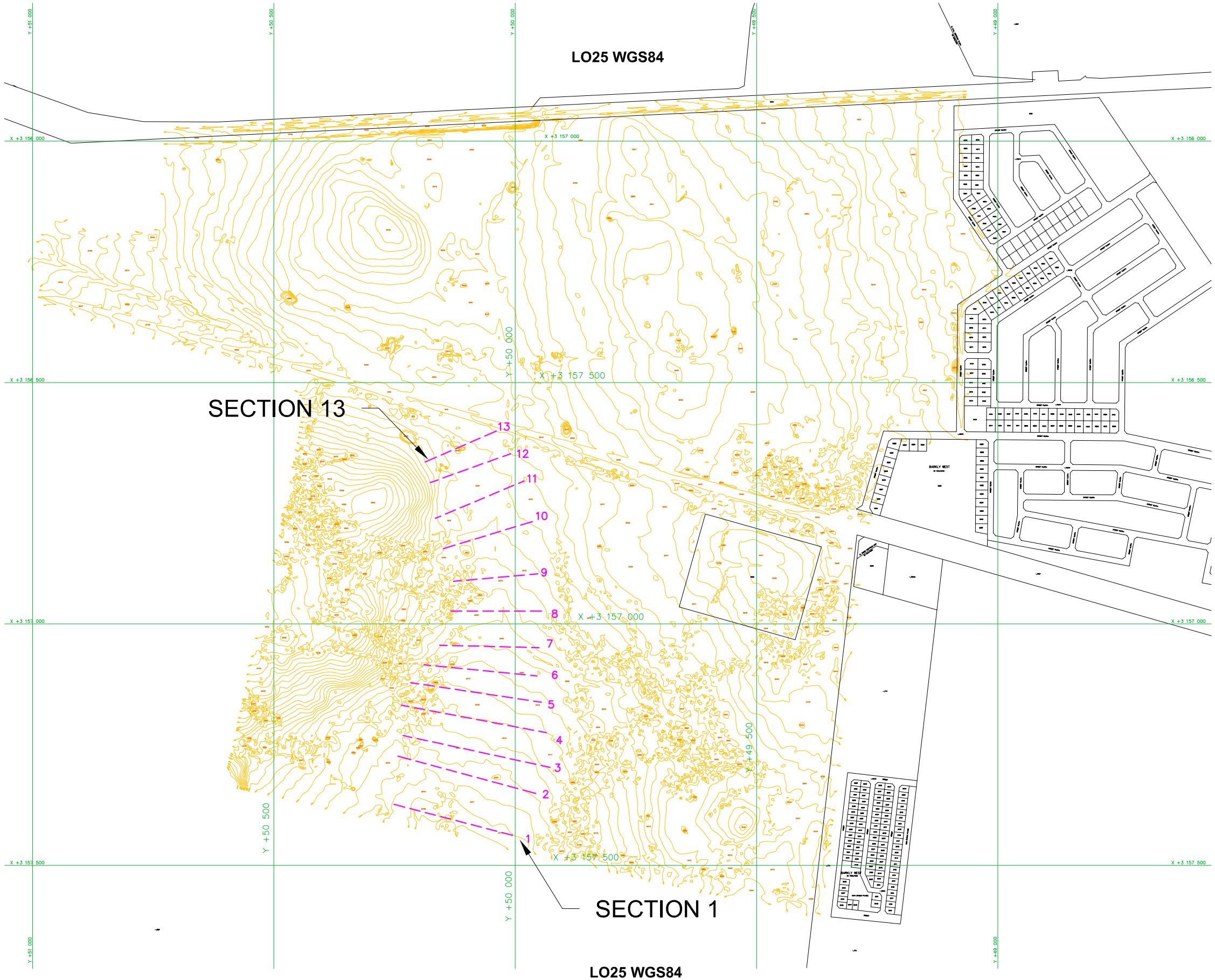
28 April 2020

ADDENDUM 1

DO NOT SCALE IF NOT PLOTTED ON A3

PROJECT	DESIGNED	ENGINEER	DATE	CWT CONSULTING 882 BEYERS STREET RIETFONTEIN, PRETORIA 0084 TEL 083 230 8752 FAX 012 331 1033 e-mail cas52@mweb.co.za	Water TECHNOLOGY CWT Consultant in Water Technology Cas Coetzer PrEng BSc Eng (Civ)(Pret) MECSA MSAICE	
1:100 YEAR FLOOD LINES PROPOSED TOWNSHIP: A PORTION OF THE REMAINING EXTEND OF ERF 687 BARKLY WEST (DIKGATLONG LOCAL MUNICIPALITY)	C. J. COETZER	C. J. COETZER No. 800339	24 APRIL 2020		PLAN NO.	CWT 272020/1

ADDENDUM 2



LO25 WGS84

DO NOT SCALE IF NOT PLOTTED ON A3

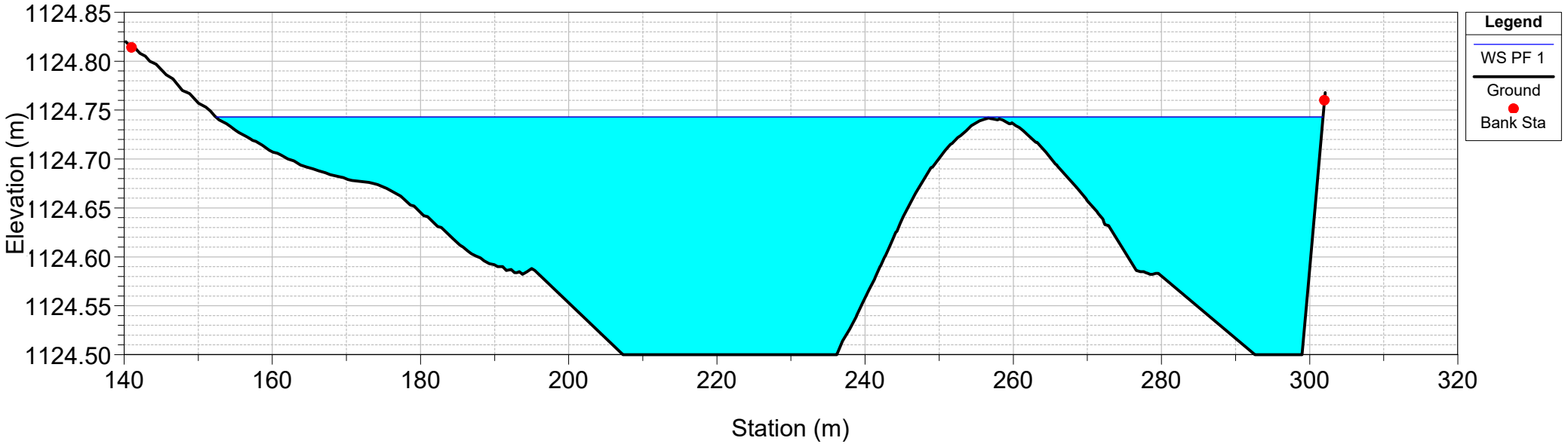
PROJECT	DESIGNED	ENGINEER	DATE	CWT CONSULTING 882 BEYERS STREET RIETFONTEIN, PRETORIA 0084 TEL 083 230 8752 FAX 012 331 1033 e-mail cas52@mweb.co.za	Water TECHNOLOGY CWT Consultant in Water Technology Cas Coetzer PrEng BSc Eng (Civ)(Pret) MECSA MSAICE	
1:100 YEAR FLOOD LINES PROPOSED TOWNSHIP: BARKLY WEST: LAYOUT OF THE SECTIONS TO CALCULATE THE FLOOD LEVELS	C. J. COETZER	C. J. COETZER No. 800339	24 APRIL 2020		PLAN NO.	CWT 272020/2

Addendum 3

Section No	Flow (m^3/s)	Bed level (m)	Water level (m)	Flow Depth (m)	Flow Velocity (m/s)	Top Width (m)	Froude No
1	15	1124.50	1124.74	0.14	0.71	149.43	0.60
2	15	1125.62	1125.87	0.11	0.63	210.90	0.60
3	15	1126.15	1126.35	0.12	0.57	224.02	0.53
4	15	1126.78	1127.04	0.11	0.59	233.56	0.57
5	15	1127.19	1127.54	0.14	0.67	154.63	0.56
6	15	1127.85	1128.08	0.15	0.71	144.62	0.60
7	15	1128.40	1128.65	0.15	0.77	125.92	0.63
8	15	1129.00	1129.41	0.18	0.78	105.60	0.59
9	14	1129.66	1129.96	0.20	0.77	90.38	0.55
10	12	1130.33	1130.63	0.16	0.64	115.67	0.50
11	10	1130.71	1131.00	0.18	0.50	112.37	0.38
12	9	1131.00	1131.20	0.18	0.42	118.88	0.32
13	7.75	1131.00	1131.28	0.22	0.33	105.83	0.22

SECTION 1

ADDENDUM 4



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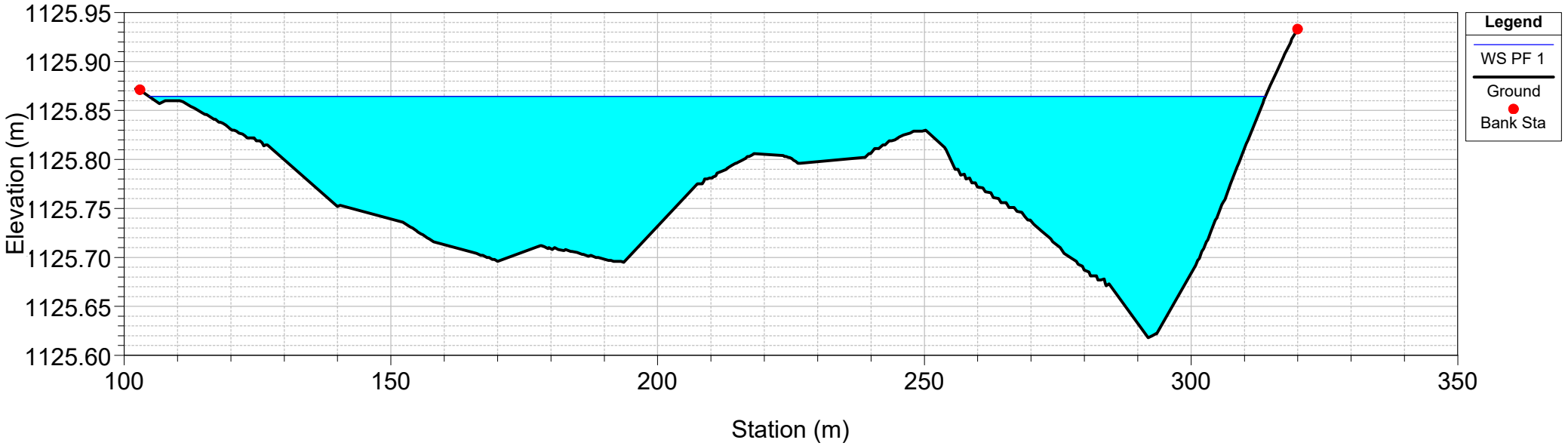

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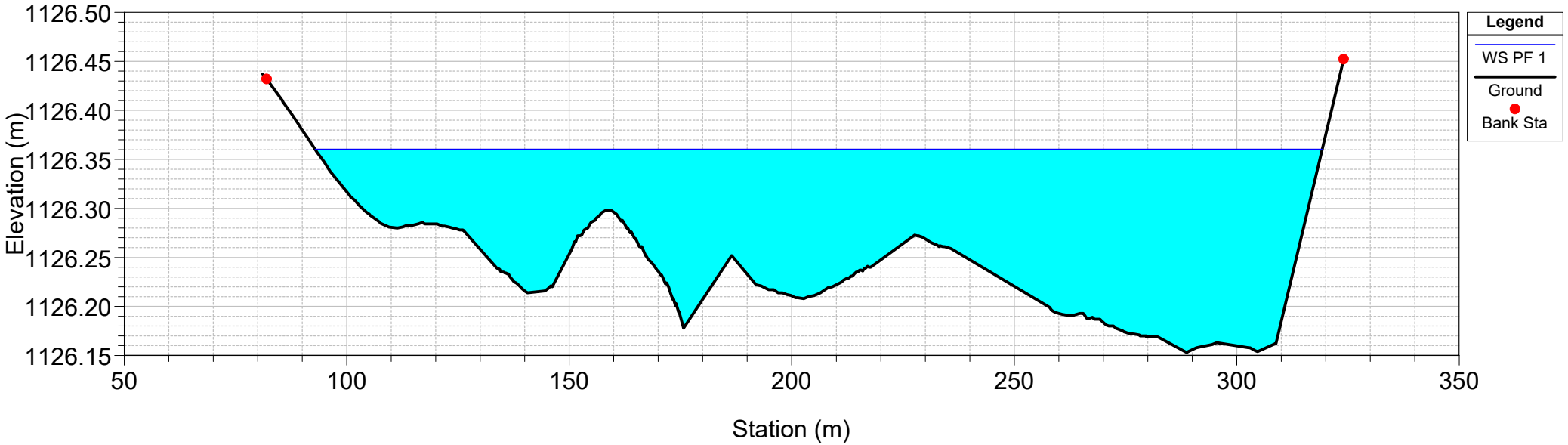
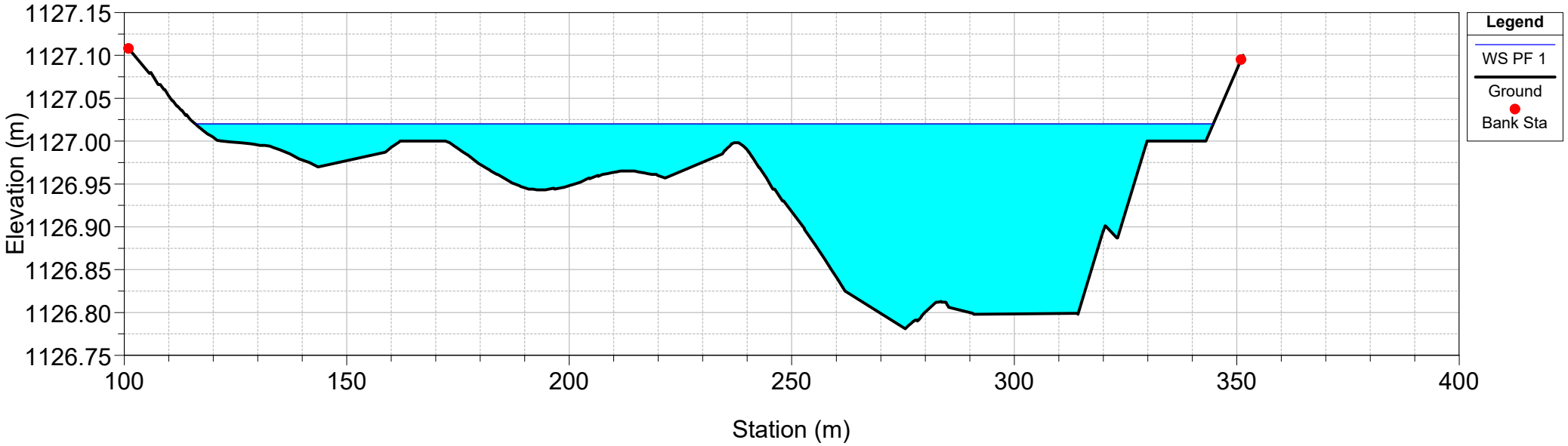


SECTION 4

ADDENDUM 4



SECTION 5

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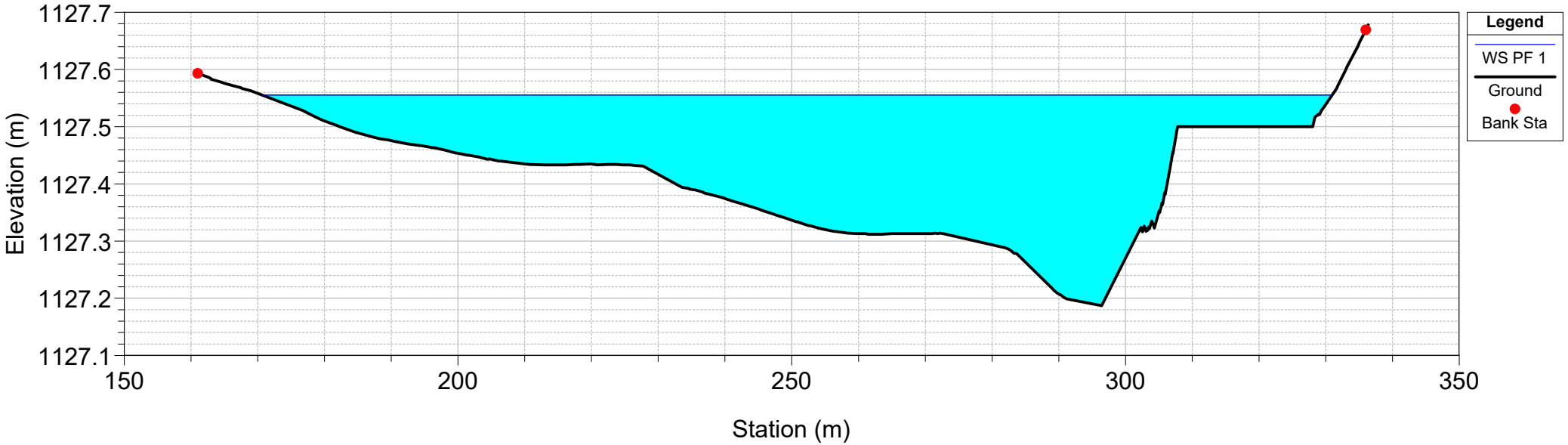

SECTION 6

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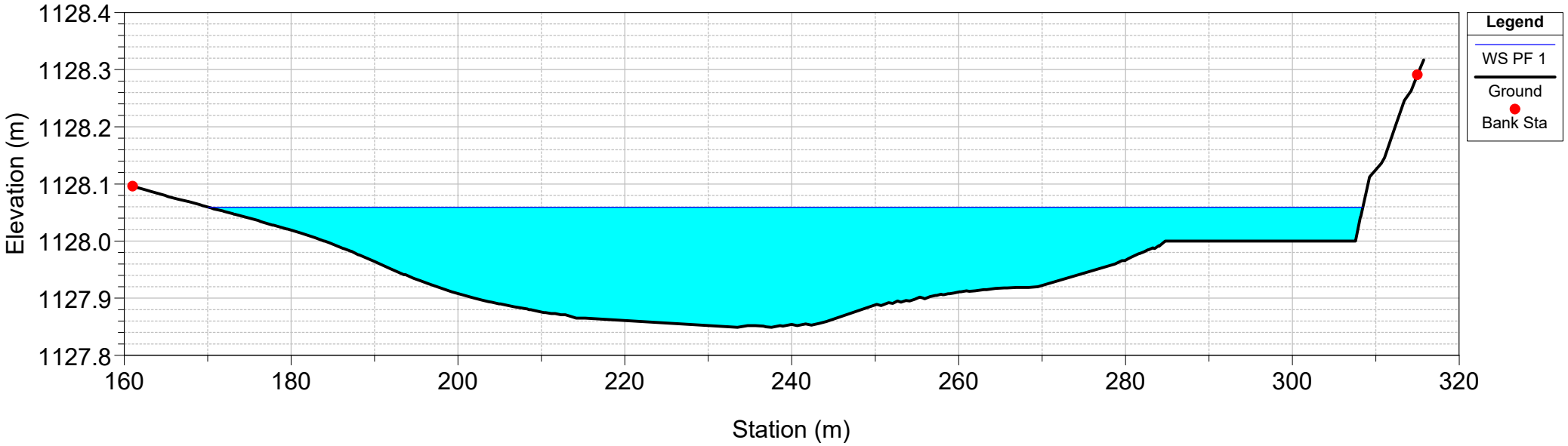

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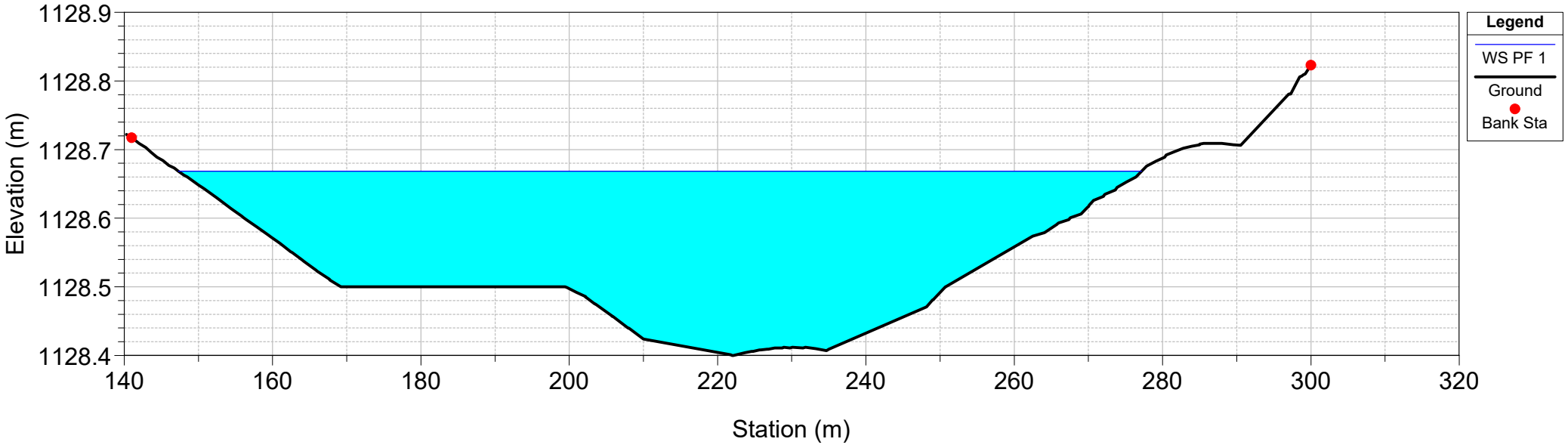

SECTION 8

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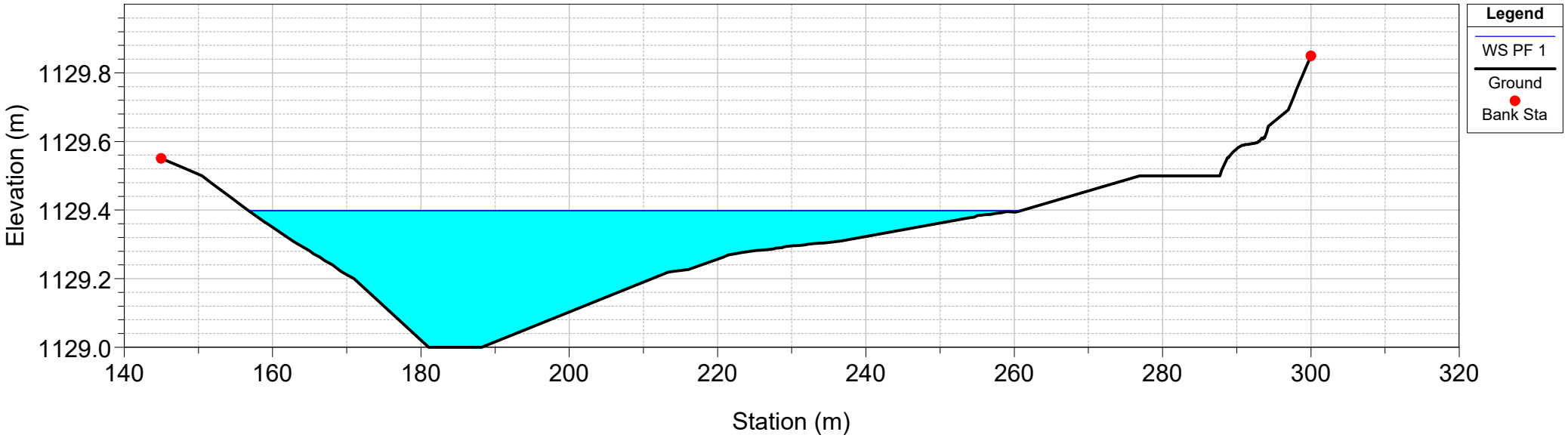

SECTION 9

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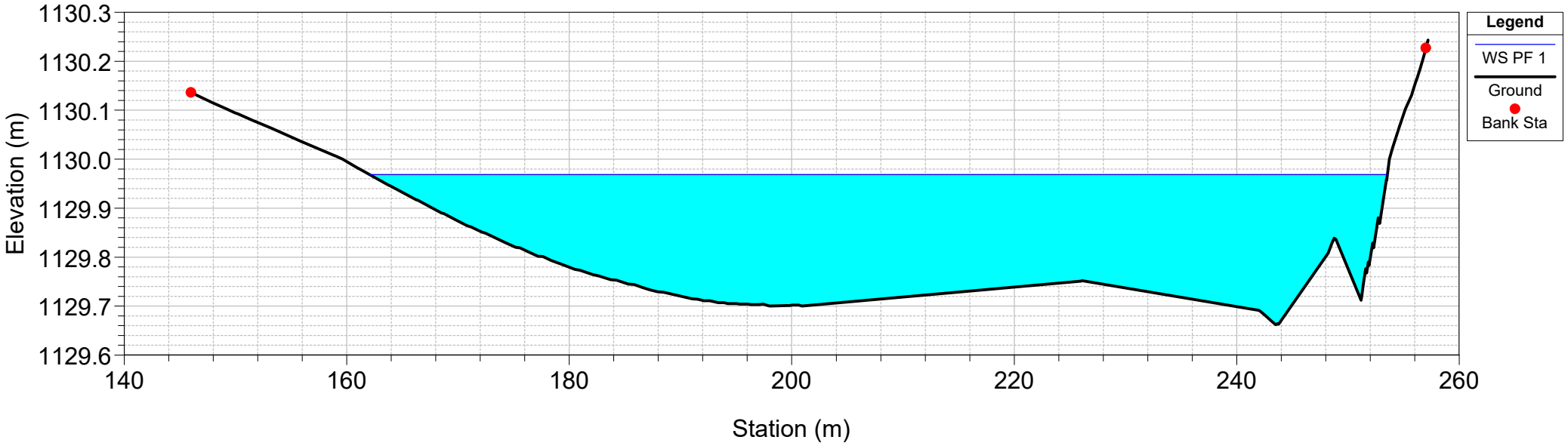

SECTION 10

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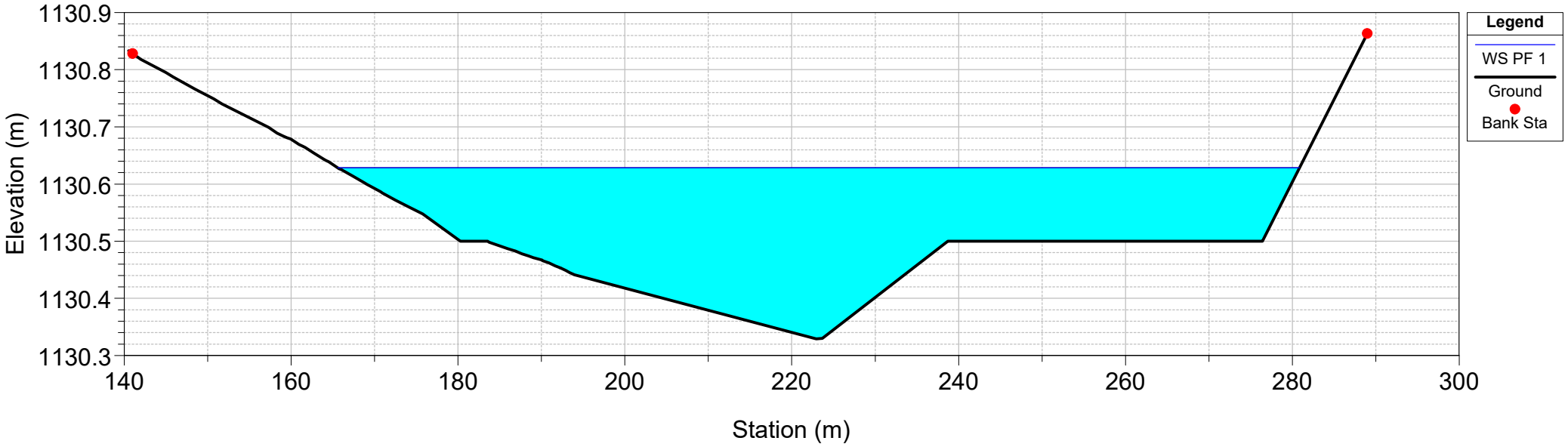

SECTION 11

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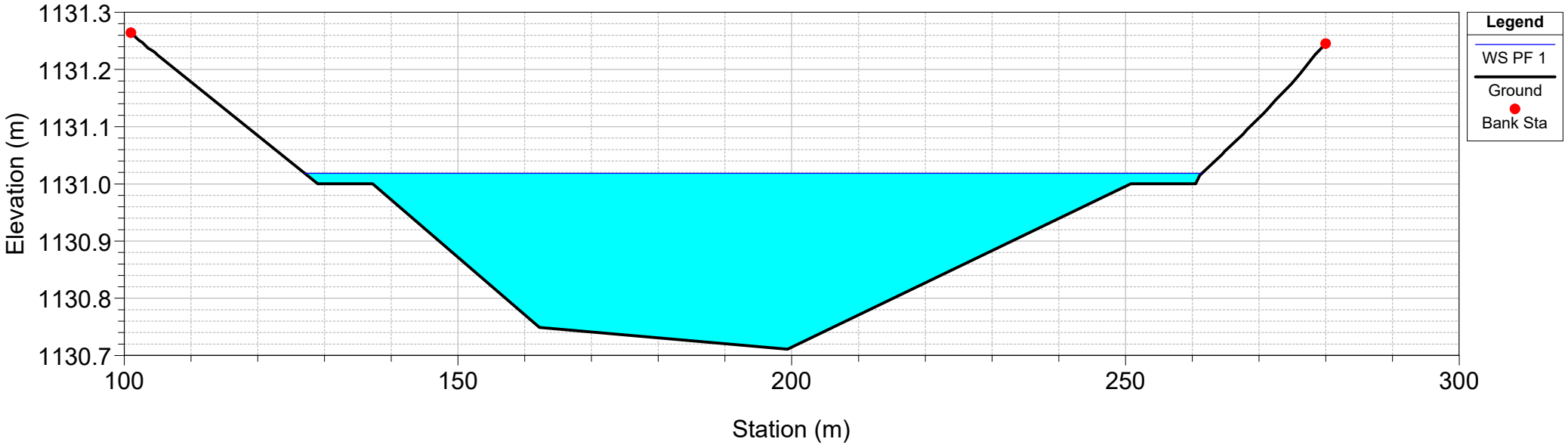

SECTION 12

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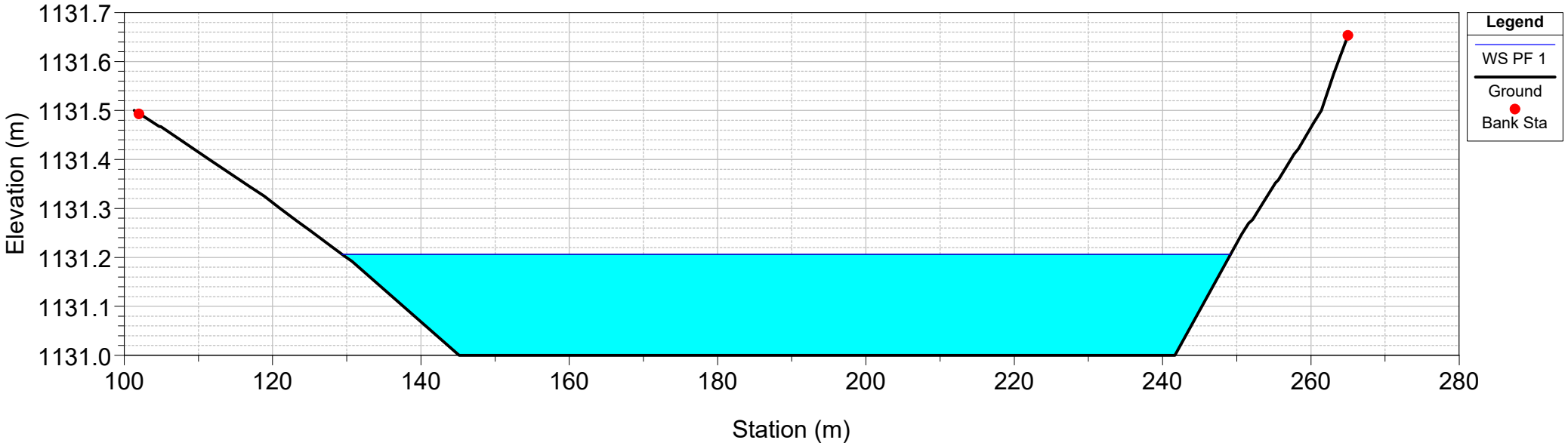

SECTION 13

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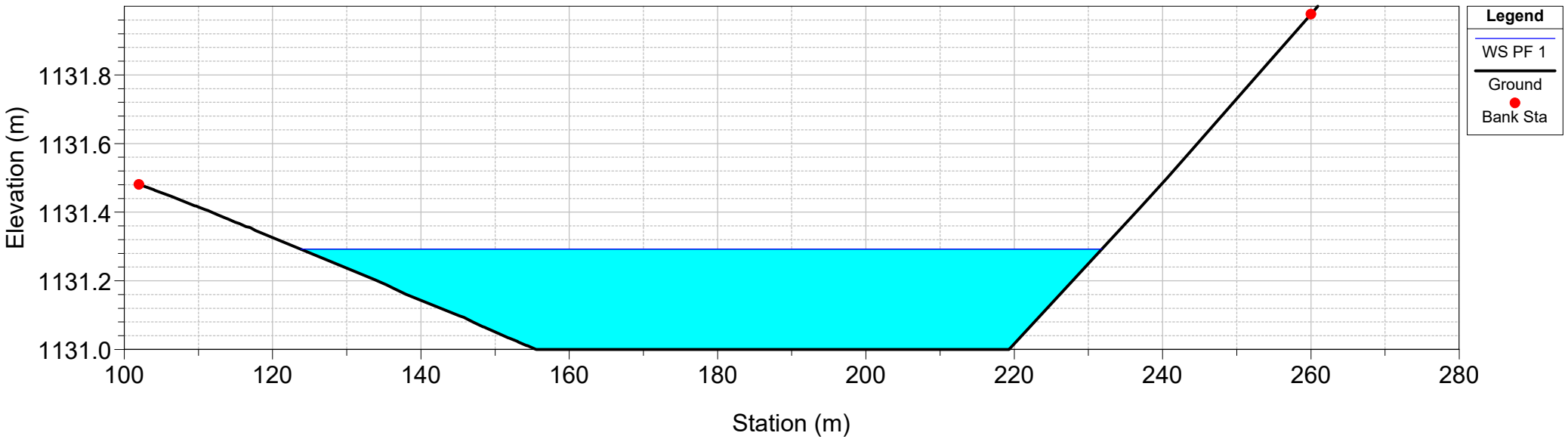
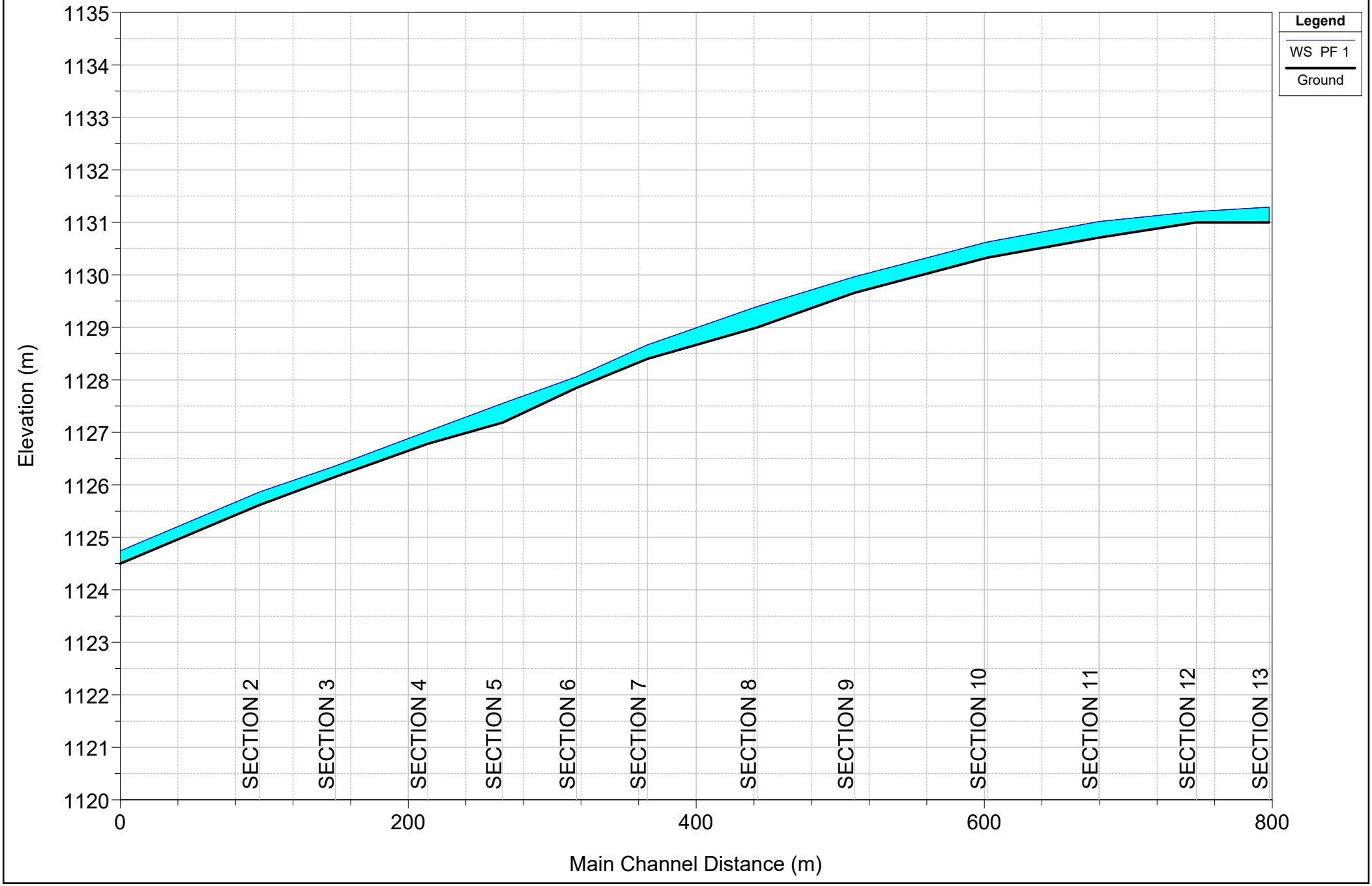


LONGITUDINAL SECTION 1:100 YEAR FLOOD

ADDENDUM 5



ADDENDUM 6

Rational Method

Project	= TASK 272020 BARKLEY WEST
Analysed by	= C J COETZER
Name of river	= **BARKLEY WEST SHEET FLOW**
Description of site	= REMAINING EXTEND OF ERF 687 BARKLEY WEST
Date	= 2020/04/22
Area of catchment	= 1.036 km²
Dolomitic area	= 0.0 %
Mean annual rainfall (MAR)	= 376.00 mm
Length of longest watercourse	= 1.93 km
Flow of water	= Overland flow
Height difference	= 10.0 m
Value of r for over land flow	= Sparse grass (r=0,3)
Rainfall region	= Inland
Area distribution	= Rural: 100 %, Urban: 0 %, Lakes: 0 %

Catchment description - Urban area (%)

Lawns		Residential and industry		Business	
Sandy, flat (<2%)	0	Houses	0	City centre	0
Sandy, steep (>7%)	0	Flats	0	Suburban	0

Heavy soil, flat (<2%)	0	Light industry	0	Streets	0
Heavy soil, steep (>7%)	0	Heavy industry	0	Maximum flood	0

Catchment description - Rural area (%)

Surface slopes		Permeability		Vegetation	
Lakes and pans	0	Very permeable	0	Thick bush & forests	0
Flat area	100	Permeable	0	Light bush & cultivated land	50
Hilly	0	Semi-permeable	100	Grasslands	50
Steep areas	0	Impermeable	0	Bare	0

Average slope = 0.00518 m/m

Time of concentration = 1.60 h

Run-off factor

Rural - C1 = 0.300

Urban - C2 = 0.000

Lakes - C3 = 0.000

Combined - C = 0.300

The HRU, Report 2/78, Depth-Duration-Frequency diagram was used to determine the point rainfall.

Return Period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m^3/s)
1:2	1.60	22.4	100.0	14.0	0.75	22.5	0.908
1:5	1.60	30.5	99.9	19.1	0.80	24.0	1.318
1:10	1.60	38.6	99.9	24.1	0.85	25.5	1.772
1:20	1.60	47.7	99.9	29.8	0.90	27.0	2.316
1:50	1.60	62.0	99.9	38.7	0.95	28.5	3.178
1:100	1.60	76.3	99.9	47.7	1.00	30.0	4.116

Run-off coefficient percentage includes adjustment saturation factors (Ft) for steep and impermeable catchments

Alternative Rational Method

Project	= TASK 272020 BARKLEY WEST
Analysed by	= C J COETZER
Name of river	= **BARKLEY WEST SHEET FLOW**
Description of site	= REMAINING EXTEND OF ERF 687 BARKLEY WEST
Date	= 2020/04/22
Area of catchment	= 1.036 km²
Dolomitic area	= 0.0 %
Length of longest watercourse	= 1.93 km
Flow of water	= Overland flow
Height difference	= 10.0 m
Value of r for over land flow	= Sparse grass (r=0,3)
Area distribution	= Rural: 100 %, Urban: 0 %, Lakes: 0 %

Catchment description - Urban area (%)

Lawns		Residential and industry		Business	
Sandy, flat (<2%)	0	Houses	0	City centre	0
Sandy, steep (>7%)	0	Flats	0	Suburban	0
Heavy soil, flat (<2%)	0	Light industry	0	Streets	0
Heavy soil, steep (>7%)	0	Heavy industry	0	Maximum flood	0

Catchment description - Rural area (%)

Surface slopes	Permeability	Vegetation

Lakes and pans	0	Very permeable	0	Thick bush & forests	0
Flat area	100	Permeable	0	Light bush & cultivated land	50
Hilly	0	Semi-permeable	100	Grasslands	50
Steep areas	0	Impermeable	0	Bare	0

Days on which thunder was heard = 60 days/year

Weather Services station number = 290032

Weather Services station location = BARKLY WEST

Mean annual precipitation (MAP) = 385 mm

Duration	2	5	10	20	50	100	200
1 day	43	61	75	91	114	134	156
2 days	54	80	101	124	159	190	225
3 days	59	87	109	133	169	200	235
7 days	72	110	140	173	223	266	314

The modified recalibrated Hershfield relationship was used to determine point rainfall.

Average slope = 0.00518 m/m

Time of concentration = 1.60 h

Run-off factor

Rural - C1 = 0.300

Urban - C2 = 0.000

Lakes - C3 = 0.000

Combined - C = 0.300

Return period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m^3/s)
1:2	1.60	25.99	100.0	16.25	0.75	22.5	1.052
1:5	1.60	43.84	100.0	27.42	0.80	24.0	1.894
1:10	1.60	57.35	100.0	35.86	0.85	25.5	2.632
1:20	1.60	70.85	100.0	44.31	0.90	27.0	3.443
1:50	1.60	88.71	100.0	55.47	0.95	28.5	4.550
1:100	1.60	102.21	100.0	63.92	1.00	30.0	5.518

Run-off coefficient percentage includes adjustment saturation factors (Ft) for steep and impermeable catchments

Unit Hydrograph Method

Project	= TASK 272020 BARKLEY WEST
Analysed by	= C J COETZER
Name of river	= **BARKLEY WEST SHEET FLOW**
Description of site	= REMAINING EXTEND OF ERF 687 BARKLEY WEST
Date	= 2020/04/22
Area of catchment	= 1.036 km²
Length of longest watercourse	= 1.93 km
Height difference along equal area slope	= 8.8 m
Distance to catchment centroid	= 0.897 km
Veld type	= Region 7
Duration interval	= 15 minutes

Slope of longest stream	= 0.0046 m/m
Catchment index	= 25.6
Catchment lag	= 0.608
Coefficient (Ku)	= 0.315 m³/s - hours/km²
Peak discharge of unit hydrograph (Qp)	= 0.536 m³/s

Return period	Storm duration (minutes)	Peak discharge (m^3/s)
1:2 year	30	1.850
1:5 year	15	3.200
1:10 year	15	4.875
1:20 year	15	7.020
1:50 year	15	10.90
1:100 year	15	15.32

Standard Design Flood method

Project name	= TASK 272020 BARKLEY WEST
Analysed by	= C J COETZER
Name of river	= **BARKLEY WEST SHEET FLOW**
Description of site	= REMAINING EXTEND OF ERF 687 BARKLEY WEST
Date	= 2020/04/22
Catchment characteristics:	
Area of catchment	= 1.036 km²
Length of longest watercourse	= 1.93 km
1085 height difference	= 10 m
Average slope	= 0.0069 m/m
Drainage basin characteristics:	
Drainage basin number	= 8
Mean annual daily max rain	= 47 mm
Days on which thunder was heard	= 29 days
Runoff coefficient C2	= 5 %
Runoff coefficient C100	= 20 %
Basin mean annual precipitation	= 380 mm
Basin mean annual evaporation	= 2100 mm
Basin evaporation index MAE/MAP	= 5.53

RAINFALL DATA

The rainfall data in the table below are derived from two sources. The daily rainfall is from the Department of Water Affair's publication TR102 for the representative site. The modified Hershfield equation is used for durations up to four hours. Linear interpolation is used for values between 4 hours and one day.

Weather Services station ex TR102 = 322071 @ DANIELSKUIL

Point mean annual precipitation = 380 mm

Dur:	RP =2	5	10	20	50	100	200
.25 h	13	22	29	36	45	52	59
.50 h	17	29	38	47	59	68	77
1 h	21	36	47	58	72	83	94
2 h	25	42	56	69	86	99	112
4 h	29	49	64	80	100	115	130
1 day	47	69	86	104	132	156	183
2 days	60	91	116	144	187	224	267
3 days	65	100	128	160	208	250	297
7 days	79	126	164	207	272	329	393

CAUTION. The time of concentration is less than one hour.

Runoff coefficients C2 = 5 % C100 = 20 %

Return period (years)	Time of concentration (hours)	Point precipitation (mm)	ARF (%)	Catchment precipitation (mm)	Runoff coefficient (%)	Peak flow (m^3/s)
1:2	0.75	19.5	100.0	19.5	5.0	0.376
1:5	0.75	32.9	100.0	32.9	10.4	1.321
1:10	0.75	43.1	100.0	43.1	13.2	2.198
1:20	0.75	53.2	100.0	53.2	15.6	3.191
1:50	0.75	66.6	100.0	66.6	18.2	4.673
1:100	0.75	76.8	100.0	76.8	20.0	5.918

ADDENDUM 7

Rational Method

Project	= TASK 272020 BARKLY WEST
Analysed by	= C J COETZER
Name of river	**= BARKLY WEST CHANNEL FLOW**
Description of site	= REMAINING EXTEND OF ERF 687 BARKLY WEST
Date	= 2020/04/22
Area of catchment	= 0.708 km²
Dolomitic area	= 0.0 %
Mean annual rainfall (MAR)	= 376.00 mm
Length of longest watercourse	= 0.829 km
Flow of water	= Defined water course
Height difference along 10-85 slope	= 8.0 m
Rainfall region	= Inland
Area distribution	= Rural: 100 %, Urban: 0 %, Lakes: 0 %

Catchment description - Urban area (%)

Lawns		Residential and industry		Business	
Sandy, flat (<2%)	0	Houses	0	City centre	0
Sandy, steep (>7%)	0	Flats	0	Suburban	0
Heavy soil, flat (<2%)	0	Light industry	0	Streets	0

Heavy soil, steep (>7%)	0	Heavy industry	0	Maximum flood	0

Catchment description - Rural area (%)

Surface slopes		Permeability		Vegetation	
Lakes and pans	0	Very permeable	0	Thick bush & forests	0
Flat area	95	Permeable	0	Light bush & cultivated land	50
Hilly	5	Semi-permeable	100	Grasslands	50
Steep areas	0	Impermeable	0	Bare	0

Average slope = 0.01287 m/m

Time of concentration = 18.4 min

Run-off factor

Rural - C1 = 0.303

Urban - C2 = 0.000

Lakes - C3 = 0.000

Combined - C = 0.303

The HRU, Report 2/78, Depth-Duration-Frequency diagram was used to determine the point rainfall.

Return Period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m^3/s)
1:2	0.31	12.6	99.9	40.9	0.75	22.7	1.828
1:5	0.31	17.1	99.9	55.7	0.80	24.2	2.654
1:10	0.31	21.6	99.9	70.4	0.85	25.8	3.568
1:20	0.31	26.7	99.8	86.9	0.90	27.3	4.662
1:50	0.31	34.7	99.8	113.0	0.95	28.8	6.394
1:100	0.31	42.7	99.7	139.0	1.00	30.3	8.280

Run-off coefficient percentage includes adjustment saturation factors (Ft) for steep and impermeable catchments

Alternative Rational Method

Project	= TASK 272020 BARKLY WEST
Analysed by	= C J COETZER
Name of river	= BARKLY WEST CHANNEL FLOW
Description of site	= REMAINING EXTEND OF ERF 687 BARKLY WEST
Date	= 2020/04/22
Area of catchment	= 0.708 km²
Dolomitic area	= 0.0 %
Length of longest watercourse	= 0.829 km
Flow of water	= Defined water course
Height difference along 10-85 slope	= 8.0 m
Area distribution	= Rural: 100 %, Urban: 0 %, Lakes: 0 %

Catchment description - Urban area (%)

Lawns		Residential and industry		Business	
Sandy, flat (<2%)	0	Houses	0	City centre	0
Sandy, steep (>7%)	0	Flats	0	Suburban	0
Heavy soil, flat (<2%)	0	Light industry	0	Streets	0
Heavy soil, steep (>7%)	0	Heavy industry	0	Maximum flood	0

Catchment description - Rural area (%)

Surface slopes		Permeability		Vegetation	
Lakes and pans	0	Very permeable	0	Thick bush & forests	0

Flat area	95	Permeable	0	Light bush & cultivated land	50
Hilly	5	Semi-permeable	100	Grasslands	50
Steep areas	0	Impermeable	0	Bare	0

Days on which thunder was heard = 40 days/year

Weather Services station number = 290032

Weather Services station location = BARKLYWEST

Mean annual precipitation (MAP) = 385 mm

Duration	2	5	10	20	50	100	200
1 day	43	61	75	91	114	134	156
2 days	54	80	101	124	159	190	225
3 days	59	87	109	133	169	200	235
7 days	72	110	140	173	223	266	314

The modified recalibrated Hershfield relationship was used to determine point rainfall.

Average slope = 0.01287 m/m

Time of concentration = 18.4 min

Run-off factor

Rural - C1 = 0.303

Urban - C2 = 0.000

Lakes - C3 = 0.000

Combined - C = 0.303

Return period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m^3/s)
1:2	0.31	14.44	100.0	47.08	0.75	22.7	2.104
1:5	0.31	24.37	100.0	79.43	0.80	24.2	3.786
1:10	0.31	31.87	100.0	103.89	0.85	25.8	5.262
1:20	0.31	39.38	100.0	128.36	0.90	27.3	6.884
1:50	0.31	49.31	100.0	160.71	0.95	28.8	9.098
1:100	0.31	56.81	100.0	185.18	1.00	30.3	11.03

Run-off coefficient percentage includes adjustment saturation factors (Ft) for steep and impermeable catchments

Unit Hydrograph Method

Project	= TASK 272020 BARKLY WEST
Analysed by	= C J COETZER
Name of river	= BARKLY WEST CHANNEL FLOW
Description of site	= REMAINING EXTEND OF ERF 687 BARKLY WEST
Date	= 2020/04/22
Area of catchment	= 0.708 km²
Length of longest watercourse	= 0.829 km
Height difference along equal area slope	= 9.7 m
Distance to catchment centroid	= 0.451 km
Veld type	= Region 6
Duration interval	= 15 minutes

Slope of longest stream	= 0.0117 m/m
Catchment index	= 3.5
Catchment lag	= 0.293
Coefficient (Ku)	= 0.265 m³/s - hours/km²
Peak discharge of unit hydrograph (Qp)	= 0.639 m³/s

Return period	Storm duration (minutes)	Peak discharge (m^3/s)
1:2 year	15	1.451
1:5 year	15	2.575
1:10 year	15	3.924
1:20 year	15	5.651
1:50 year	15	8.781
1:100 year	15	12.34

Standard Design Flood method

Project name	= TASK 272020 BARKLY WEST
Analysed by	= C J COETZER
Name of river	= BARKLY WEST CHANNEL FLOW
Description of site	= REMAINING EXTEND OF ERF 687 BARKLY WEST
Date	= 2020/04/22
Catchment characteristics:	
Area of catchment	= 0.708 km²
Length of longest watercourse	= 0.829 km
1085 height difference	= 8 m
Average slope	= 0.0129 m/m
Drainage basin characteristics:	
Drainage basin number	= 8
Mean annual daily max rain	= 47 mm
Days on which thunder was heard	= 29 days
Runoff coefficient C2	= 5 %
Runoff coefficient C100	= 20 %
Basin mean annual precipitation	= 380 mm
Basin mean annual evaporation	= 2100 mm
Basin evaporation index MAE/MAP	= 5.53

RAINFALL DATA

The rainfall data in the table below are derived from two sources. The daily rainfall is from the Department of Water Affair's publication TR102 for the representative site. The modified Hershfield equation is used for durations up to four hours. Linear interpolation is used for values between 4 hours and one day.

Weather Services station ex TR102 = 322071 @ DANIELSKUIL

Point mean annual precipitation = 380 mm

Dur:	RP =2	5	10	20	50	100	200
.25 h	13	22	29	36	45	52	59
.50 h	17	29	38	47	59	68	77
1 h	21	36	47	58	72	83	94
2 h	25	42	56	69	86	99	112
4 h	29	49	64	80	100	115	130
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2 days	60	91	116	144	187	224	267
3 days	65	100	128	160	208	250	297
7 days	79	126	164	207	272	329	393

CAUTION. The time of concentration is less than one hour.

Runoff coefficients C2 = 5 % C100 = 20 %

Return period (years)	Time of concentration (hours)	Point precipitation (mm)	ARF (%)	Catchment precipitation (mm)	Runoff coefficient (%)	Peak flow (m^3/s)
1:2	0.31	14.4	100.0	14.4	5.0	0.462
1:5	0.31	24.3	100.0	24.3	10.4	1.622
1:10	0.31	31.8	100.0	31.8	13.2	2.700
1:20	0.31	39.3	100.0	39.3	15.6	3.919
1:50	0.31	49.2	100.0	49.2	18.2	5.739
1:100	0.31	56.6	100.0	56.6	20.0	7.268