Report

CITRUSDAL 900 UISP: FLOOD STUDY

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CONTENTS

DRAWING

CITRUSDAL 900 UISP:

FLOOD STUDY

1. SCOPE

Graeme McGill Consulting was appointed on 2023-11-15 to determine the Olifants River 1:50 and 1:100 floodlines for RE/3617 Citrusdal, between the N7 and Voortrekker Road. This portion of land is located on the eastern bank of the Olifants River.

The locality of the site is shown in Figure 1.

The original report (Rev 0) was completed on 2024-05-02. In July 2024 a major flood occurred in the Olifants River at Citrusdal resulting in flood levels exceeding previously recorded maximum levels (Figure 5). In the light of this event the 1:100 year flood levels have been reassessed and this report (Rev 1) provides a new higher floodline.

FIGURE 1: LOCALITY OF PROPOSED DEVELOPMENT ON ERF RE/3617, VOORTREKKER ROAD, CITRUSDAL ON OLIFANTS RIVER (RED OUTLINE)

The study undertaken comprised the following:

FLOOD HYDROLOGY

Determination of flow peaks for return periods of 1:50 year and 1:100 year, calculated using standard hydrological methods namely, Unit hydrograph, Standard Design Flood, and the Regional Maximum Flood Factor.

Check these results against the flood peaks recorded at the site over the last 50 years.

RIVER HYDRAULICS

Modelling the Olifants River and the Boontjies River using the water surface profile software package HEC-RAS. This required inputs from field observations, the survey data, any constraints, and the peak flows for floods of various return intervals.

Water surface profiles and flow velocities for the 1:50 year and 1:100 year flow peaks in the river are to be determined.

Determination of floodlines and demarcating of these in plan on a drawing.

2. DATA ACQUISITION

2.1 SITE INSPECTION

At the site inspection on 2023-10-19 the following was noted:

- Erf RE/3617 currently has a few scattered dwellings and roads. Most of the existing structures will be demolished to make way for a new proposed development.
- The river was in a low flow condition.
- Evidence of the June 2023 was visible. The surveyor undertook to record at least one of these points.
- The floodplains were covered mainly by grassland with a few shrubs.
- The bridge over the Boontjies River at Voortrekker Road was inspected.
- It was reported by Izak Rumboll, the land surveyor, that during the June 2023 flood, the flow capacity through the bridge at Voortrekker Road was exceeded and the excess flow flowed to the Olifants River along the route marked as “channel” on Figure 1
- It was therefore requested that the bridge and a portion of the Boontjies River be included in the survey.

FIGURE 2: FLOODING OF OLIFANTS RIVER IN JUNE 2023

FIGURE 3: FLOODING OF OLIFANTS RIVER IN JUNE 2023

FIGURE 4: THE BOONTJIES RIVER AT THE VOORTREKKER ROAD BRIDGE IN JUNE 2023

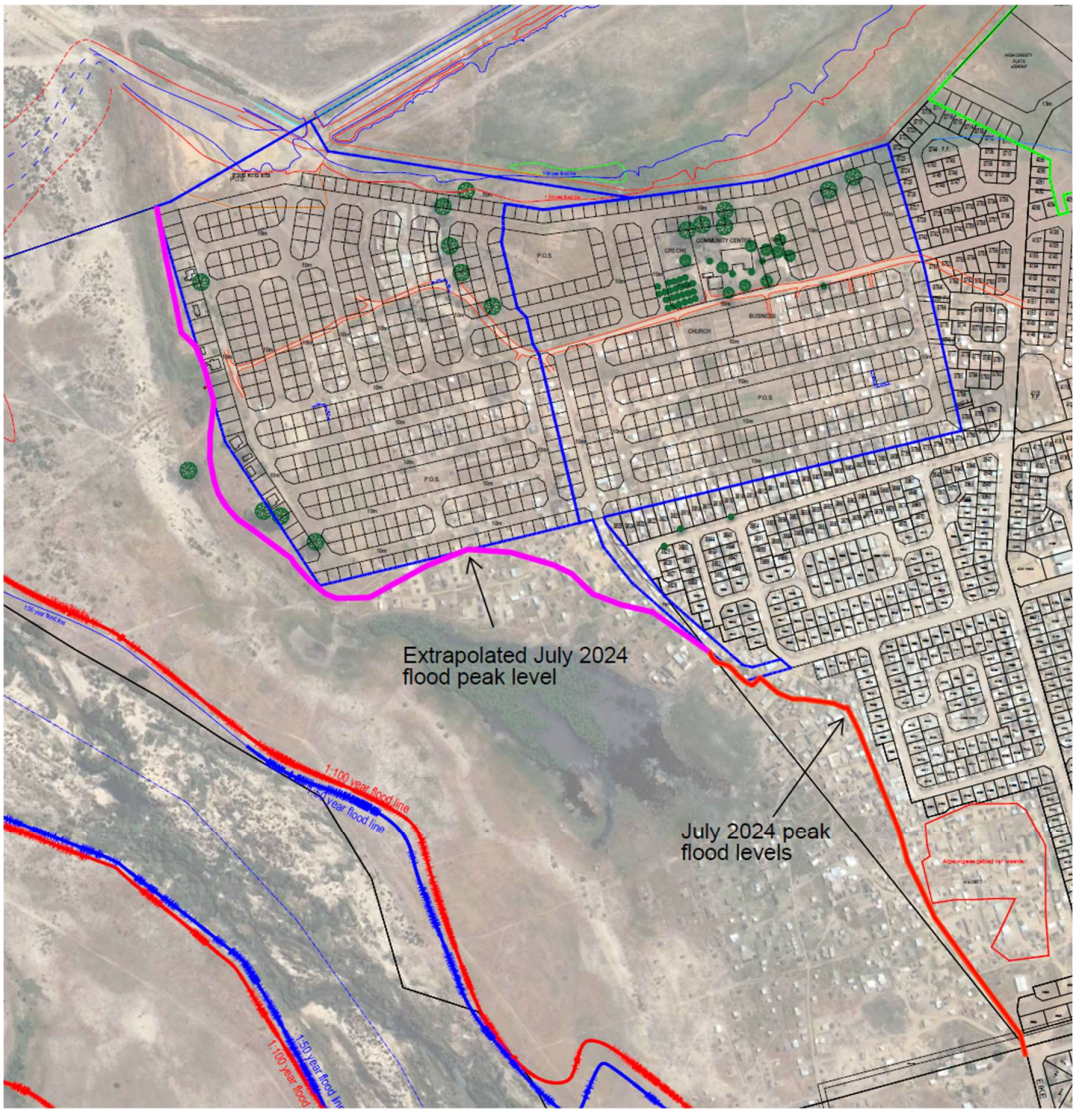

FIGURE 5: JULY 2024 FLOODLINE MEASURED BY CK RUMBOLL

2.2 TOPOGRAPHICAL SURVEY AND CADASTRAL BOUNDARY

C.K. Rumboll & Vennote was appointed to undertake a survey of the development area, the Olifants River, Boontjies River, and the linking channel in the form of multiple cross-sections measured through the rivers and perpendicular to the direction of flow.

In addition, C.K. Rumboll & Vennote previously also produced a topographical and cadastral survey of Erf RE/3617.

These surveys were combined for the purpose of this study.

3. FLOOD PEAK FLOWS

3.1 METHODOLOGY

In order to obtain a reliable estimate of the peak flood flows, generally recommended methods were used:

- Unit hydrograph
- Standard design flood
- Regional maximum flood factor

3.2 CATCHMENT PARAMETERS

The key catchment parameters as used in the Unit Hydrograph, Standard Design Flood, and Regional Maximum Flood Factor methods are listed in Table 1. The Olifants River basin and Boontjies River basin are shown in Figure 7.

TABLE 1: CATCHMENT PARAMETERS

PARAMETER	OLIFANTS	BOONTJIES
Catchment area (km2)	927.69	190.60
Longest collector (km)	90.52	26.77
Longest collector slope	0.52%	2.59
Height difference along equal area slope (m)	469	694
Height difference along 10-85 slope (m)	570	598
Distance to catchment centroid (km)	44.76	15.62
MAP (mm)	414	414
Veld type	2	2
SDF Basin no.	16	16
RMF K	4.0	4.0
Q_{50}/RMF	404.99	170.92
Q_{100}/RMF	535.72	228.23
Q_{200}/RMF	660.99	283.60

3.3 FLOOD PEAKS

The flood peaks for the Olifants River and Boontjies River were calculated using Utility Programs for Drainage software and the results are listed in Tables 2 and 3 with accompanying figures in Figure 5 and 6.

It was conservatively deemed to use the average of all methods for determining floodlines on Erf RE/3617. It was noted that the Boontjies River will spill over towards the Olifants River along an overland route once the channel capacity of 210 m^3/s in the Boontjies River is reached. Therefore, it was conservatively deemed that the overland route will convey the excess flow from the Boontjies River during the 50- and 100-year storms. The peak flows for the Channel are listed in Table 4.

TABLE 2: OLIFANTS RIVER DESIGN FLOOD PEAKS AT ERF RE/3617 EXCLUDING BOONTJIES RIVER INFLOW

METHOD	FLOOD PEAKS (m^3/s)		
	1:20 YEAR	1:50 YEAR	1:100 YEAR
Unit hydrograph	310.60	409.37	509.37
Standard design flood	262.39	380.39	482.78
Regional maximum flood factor	-	404.99	535.72
DESIGN FLOOD PEAKS	**286.50**	**401.25**	**509.29**

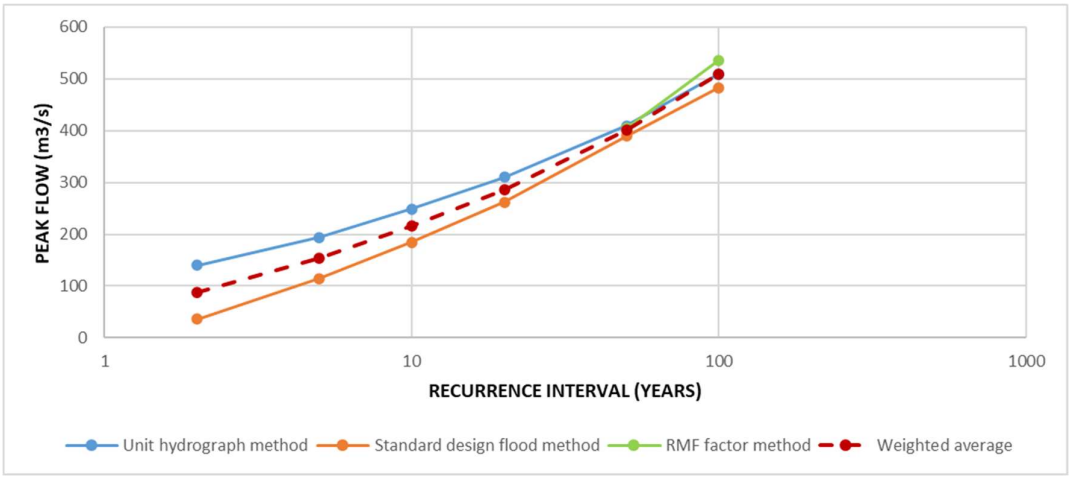

FIGURE 5: OLIFANTS RIVER PEAK FLOOD FLOW ANALYSIS RESULTS

TABLE 3: BOONTJIES RIVER DESIGN FLOOD PEAKS AT ERF RE/3617

METHOD	FLOOD PEAKS (m^3/s)		
	1:20 YEAR	1:50 YEAR	1:100 YEAR
Unit hydrograph	183.02	239.42	295.66
Standard design flood	199.24	291.77	369.49
Regional maximum flood factor	-	170.92	228.23
DESIGN FLOOD PEAKS	**191.13**	**234.04**	**297.79**

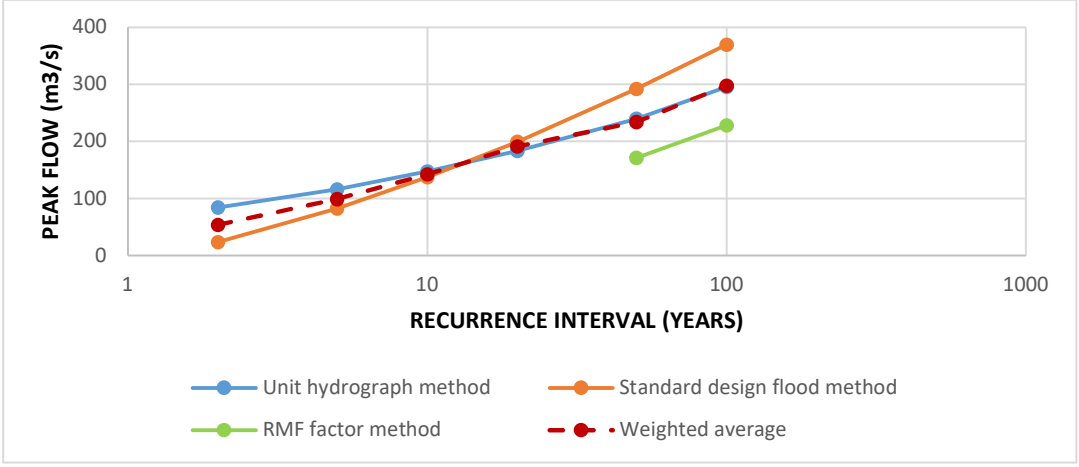

FIGURE 6: BOONTJIES RIVER PEAK FLOOD FLOW ANALYSIS RESULTS

TABLE 4: CHANNEL DESIGN FLOOD PEAKS AT ERF RE/3617

RECURRENCE INTERVAL (Years)	FLOOD PEAKS (m^3/s)
1:50	24
1:100	87

The Boontjies River overflow joins the Olifants River via the Channel downstream of the proposed development. In Tabe 5 below, the flood peaks of the Olifant River are listed indicating the flood peaks upstream from the development as well as downstream.

TABLE 5: OLIFANTS RIVER DESIGN FLOOD PEAKS

RI (YEARS)	BEFORE BOONTJIES RIVER OVERFLOW RE/3617 (m^3/s)	DOWNSTREAM OF BOONTJIES RIVER OVERFLOW RE/3617 (m^3/s)
1:50	401.25	425.25
1:100	509.29	596.29

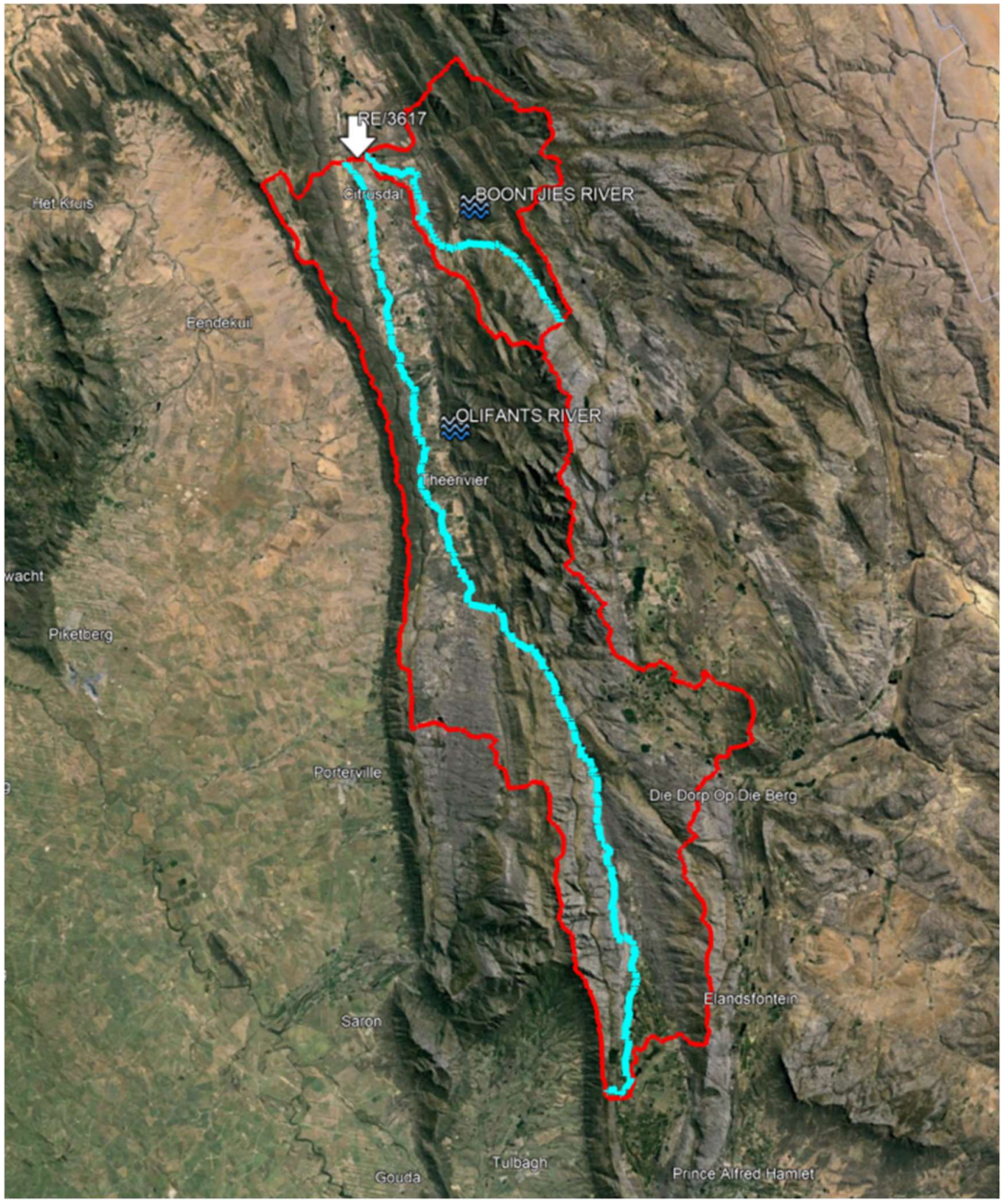

FIGURE 7: OLIFANTS RIVER AND BOONTJIES RIVER CATCHMENT BASIN

The Olifants River and Boontjies River catchment basins are shown in Figure 7 above lined in red with the respective rivers in blue. Erf RE/3617 is indicated with the white arrow.

4. FLOODLINES

4.1 METHODOLOGY

The software package HEC-RAS (Ver 6.4.1) was used to compute the water surface profiles for the 1:50 and 1:100 year recurrence intervals. The river cross-section data for the sections were obtained from the survey. The cross-sections were taken at intervals of approximately 200m, crossing the Olifants River, 30m for the Boontjies River, and 100m for the channel.

The hydraulic roughness for the Olifants River, Boontjies River and the channel was defined by Manning roughness values listed in Table 6.

Based on field observations, the upstream and downstream boundary conditions were deemed to be the normal depth, for all three river models, as defined by the river grades listed in Table 7. In addition, at the third most downstream cross-section of the Boontjies River the Voortrekker Road Bridge was modelled with 27% of the bridge openings being blocked to provide a conservative modelling scenario.

TABLE 6: MANNING n VALUES

RIVER	LEFT FLOODPLAIN	CHANNEL	RIGHT FLOODPLAIN
OLIFANTS	0.03	0.04	0.03
BOONTJIES	0.05	0.04	0.05
CHANNEL	0.03	0.035	0.03

TABLE 7: UPSTREAM AND DOWNSTREAM SLOPES

REACH	UPSTREAM SLOPE	DOWNSTREAM SLOPE
OLIFANTS	0.003763	0.001113
BOONTJIES	0.007213	0.00847
CHANNEL	0.014984	0.0018

4.2 1:50 AND 1:100 YEAR FLOODLINES

The results of the water surface profile analyses for 1:50 year and 1:100 year floods are shown in Annexure A.

Note that these have been superseded following the July 2024 floods. The 1:100 year floodline has been set at 156.4 m amsl along the east bank of the floodplain for the length of the development.

These have been plotted on the accompanying drawing MC424-C900 Rev B.

The longitudinal section for all models for the full length of the analysis is shown in Annexure B.

5. CONCLUSIONS

Flood peaks for 1:50 and 1:100 year recurrence intervals were computed by using a number of standard methods. The peaks used to determine the floodlines on Erf RE/3617 were the averages of the different methods (Table 2 and 3).

Modelling of the flood levels in the Olifants River, Boontjies River, and channel was done by using the water surface profile software package HEC-RAS. The water surface results are given in Annexure A.

Floodlines representing the locations of the energy levels, as listed in Annexure A, are presented on drawing MC424-C900.

These floodlines have been revised after the July 2024 flood and are depicted on MC424-C900 Rev B.

It is recommended that for any development on Erf RE/3617, that floor levels are kept at least 300mm above the 1:100 year energy levels.

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ANNEXURE A: OLIFANTS RIVER, BOONTJIES RIVER, AND CHANNEL HEC-RAS WATER PROFILE RESULTS

TABLE A1. OLIFANTS RIVER 1:50 AND 1:100 YEAR WATER SURFACE PROFILES
(THESE FLOOD LEVELS HAVE BEEN SUPERSEDED FOLLOWING THE JULY 2024 FLOODS – REFER TO DRAWING MC424-C900 REV B)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
OLIFANTS RIVER	1667.66	50 YR	401.25	151.59	154.46	153.25	154.50	0.000827	0.89	457.00	371.68	0.24
OLIFANTS RIVER	1667.66	100 YR	509.29	151.59	154.76	153.41	154.80	0.000695	0.88	632.05	828.27	0.23
OLIFANTS RIVER	1537.46	50 YR	401.25	151.10	154.33		154.39	0.000824	1.07	389.18	320.98	0.25
OLIFANTS RIVER	1537.46	100 YR	509.29	151.10	154.66		154.71	0.000685	1.06	555.01	679.30	0.24
OLIFANTS RIVER	1380.61	50 YR	401.25	150.74	154.15		154.24	0.001118	1.32	303.55	168.19	0.30
OLIFANTS RIVER	1380.61	100 YR	509.29	150.74	154.48		154.57	0.001085	1.40	390.19	373.14	0.30
OLIFANTS RIVER	1228.34	50 YR	401.25	151.16	153.92		154.03	0.001713	1.43	283.96	226.95	0.36
OLIFANTS RIVER	1228.34	100 YR	509.29	151.16	154.30		154.39	0.001349	1.36	422.40	535.72	0.32
OLIFANTS RIVER	1085.21	50 YR	401.25	151.11	153.69		153.80	0.001485	1.45	276.35	149.19	0.34
OLIFANTS RIVER	1085.21	100 YR	509.29	151.11	154.07		154.19	0.001398	1.52	337.95	225.89	0.34
OLIFANTS RIVER	943.73	50 YR	401.25	150.79	153.60		153.65	0.000647	1.02	392.50	209.25	0.23
OLIFANTS RIVER	943.73	100 YR	509.29	150.79	153.99		154.05	0.000599	1.07	496.20	328.38	0.22
OLIFANTS RIVER	781.79	50 YR	401.25	150.78	153.46		153.52	0.000904	1.13	355.82	213.17	0.27
OLIFANTS RIVER	781.79	100 YR	509.29	150.78	153.87		153.93	0.000781	1.13	473.92	340.96	0.25
OLIFANTS RIVER	574.16	50 YR	401.25	150.67	153.24		153.31	0.001177	1.18	341.01	212.18	0.30
OLIFANTS RIVER	574.16	100 YR	509.29	150.67	153.70		153.76	0.000860	1.16	442.05	248.86	0.26
OLIFANTS RIVER	385.18	50 YR	425.25	149.43	153.10		153.16	0.000576	1.10	386.11	163.68	0.22
OLIFANTS RIVER	385.18	100 YR	596.29	149.43	153.53		153.61	0.000731	1.27	497.05	312.12	0.25
OLIFANTS RIVER	206.72	50 YR	425.25	149.55	152.95		153.03	0.000897	1.29	343.33	262.34	0.27
OLIFANTS RIVER	206.72	100 YR	596.29	149.55	153.38		153.47	0.000877	1.41	471.86	325.99	0.28
OLIFANTS RIVER	0	50 YR	425.25	149.32	152.72	151.20	152.82	0.001115	1.48	326.62	259.88	0.31
OLIFANTS RIVER	0	100 YR	596.29	149.32	153.17	151.60	153.27	0.001115	1.48	455.88	319.16	0.31

TABLE A2. BOONTJIES RIVER 1:50 AND 1:100 YEAR WATER SURFACE PROFILES

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
BOONTJIES RIVER	341.82	50 YR	234.04	158.14	161.18	161.18	161.68	0.00776	3.35	89.71	92.26	0.77
BOONTJIES RIVER	341.82	100 YR	297.79	158.14	161.38	161.38	161.94	0.00798	3.62	107.94	92.26	0.79
BOONTJIES RIVER	289.14	50 YR	234.04	157.76	159.66	159.97	160.94	0.02369	5.01	46.69	30.68	1.30
BOONTJIES RIVER	289.14	100 YR	297.79	157.76	160.17	160.58	161.30	0.01596	4.73	63.92	43.37	1.10
BOONTJIES RIVER	242.63	50 YR	234.04	157.62	159.92	159.70	160.29	0.00628	2.84	97.53	109.31	0.69
BOONTJIES RIVER	242.63	100 YR	297.79	157.62	160.38	159.96	160.65	0.00380	2.55	154.37	136.07	0.55
BOONTJIES RIVER	191.02	50 YR	234.04	157.33	159.87		160.02	0.00275	1.91	160.79	171.29	0.46
BOONTJIES RIVER	191.02	100 YR	297.79	157.33	160.39		160.48	0.00140	1.59	255.66	190.31	0.34
BOONTJIES RIVER	139.93	50 YR	234.04	157.03	159.76	158.75	159.91	0.00182	1.76	151.68	303.52	0.38
BOONTJIES RIVER	139.93	100 YR	297.79	157.03	160.28	159.03	160.41	0.00131	1.70	199.64	307.99	0.34
BOONTJIES RIVER	93.25	50 YR	234.04	156.76	159.74	158.43	159.83	0.00099	1.40	191.62	200.87	0.29
BOONTJIES RIVER	93.25	100 YR	297.79	156.76	160.27	158.67	160.35	0.00075	1.39	245.38	200.87	0.26
BOONTJIES RIVER	38.97	50 YR	234.04	156.40	159.63	158.20	159.76	0.00160	1.64	157.17	97.16	0.35
BOONTJIES RIVER	38.97	100 YR	297.79	156.40	160.18	158.62	160.30	0.00113	1.58	212.95	101.60	0.31
BOONTJIES RIVER	27.51		Bridge									
BOONTJIES RIVER	0.01	50 YR	234.04	156.07	158.63	158.17	159.06	0.00848	2.92	80.24	54.53	0.77
BOONTJIES RIVER	0.01	100 YR	297.79	156.07	158.12	158.59	159.45	0.02596	5.11	58.24	39.76	1.35

TABLE A3. CHANNEL 1:50 AND 1:100 YEAR WATER SURFACE PROFILES

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
CHANNEL	889.21	50 YR	24.00	155.06	156.67	156.69	157.19	0.01500	3.19	7.53	7.87	1.04
CHANNEL	889.21	100 YR	87.00	155.06	157.56	157.80	158.35	0.01499	4.20	26.28	51.80	1.13
CHANNEL	818.47	50 YR	24.00	154.00	156.25	155.57	156.41	0.00360	1.74	13.82	12.41	0.53
CHANNEL	818.47	100 YR	87.00	154.00	157.10	157.12	157.45	0.00814	2.69	35.39	64.52	0.81
CHANNEL	718.47	50 YR	24.00	153.52	156.04		156.14	0.00190	1.38	18.01	24.68	0.39
CHANNEL	718.47	100 YR	87.00	153.52	156.67	156.64	156.86	0.00328	2.30	56.06	112.58	0.53
CHANNEL	618.47	50 YR	24.00	154.64	155.79		155.87	0.00379	1.31	18.41	28.92	0.52
CHANNEL	618.47	100 YR	87.00	154.64	156.40		156.53	0.00303	1.79	63.50	118.95	0.51
CHANNEL	518.46	50 YR	24.00	153.00	155.46		155.58	0.00230	1.64	17.28	24.43	0.43
CHANNEL	518.46	100 YR	87.00	153.00	156.28		156.34	0.00103	1.46	93.15	130.50	0.31
CHANNEL	418.47	50 YR	24.00	152.77	155.41		155.44	0.00065	0.93	40.19	90.93	0.23
CHANNEL	418.47	100 YR	87.00	152.77	156.27		156.29	0.00024	0.76	158.86	145.84	0.15
CHANNEL	318.47	50 YR	24.00	152.50	155.40		155.40	0.00016	0.43	80.99	148.08	0.12
CHANNEL	318.47	100 YR	87.00	152.50	156.26		156.27	0.00011	0.47	212.57	160.27	0.10
CHANNEL	218.47	50 YR	24.00	152.18	155.39		155.40	0.00003	0.22	138.36	161.12	0.05
CHANNEL	218.47	100 YR	87.00	152.18	156.25		156.26	0.00005	0.34	287.02	176.22	0.07
CHANNEL	118.47	50 YR	24.00	152.00	155.39		155.39	0.00007	0.39	88.34	98.84	0.07
CHANNEL	118.47	100 YR	87.00	152.00	156.24		156.25	0.00012	0.59	180.80	114.64	0.10
CHANNEL	0.00	50 YR	24.00	154.50	155.32	154.97	155.36	0.00180	0.90	26.62	41.39	0.36
CHANNEL	0.00	100 YR	87.00	154.50	156.12	155.46	156.21	0.00180	1.28	67.74	61.44	0.39

ANNEXURE B: BOONTJIES RIVER, AND CHANNEL HEC-RAS LONGITUDINAL SECTION

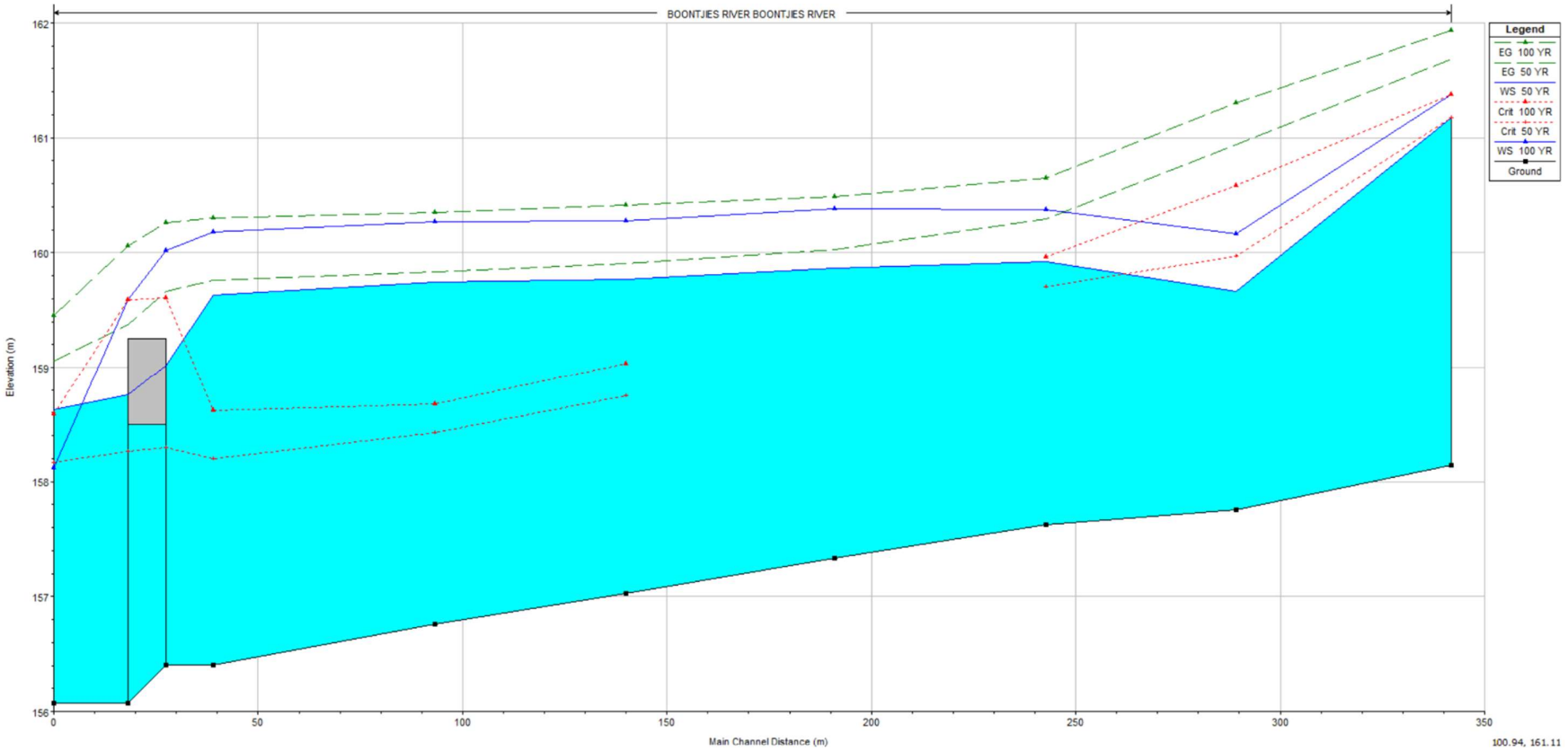

FIGURE B1: BOONTJIES RIVER LONG-SECTION SHOWING WATER SURFACE AND ENERGY LEVELS

Notes:

1. EG: Energy grade; WS: Avg water surface level; Crit: Critical depth level
2. Main Channel Distance is measured from the most downstream cross-section.

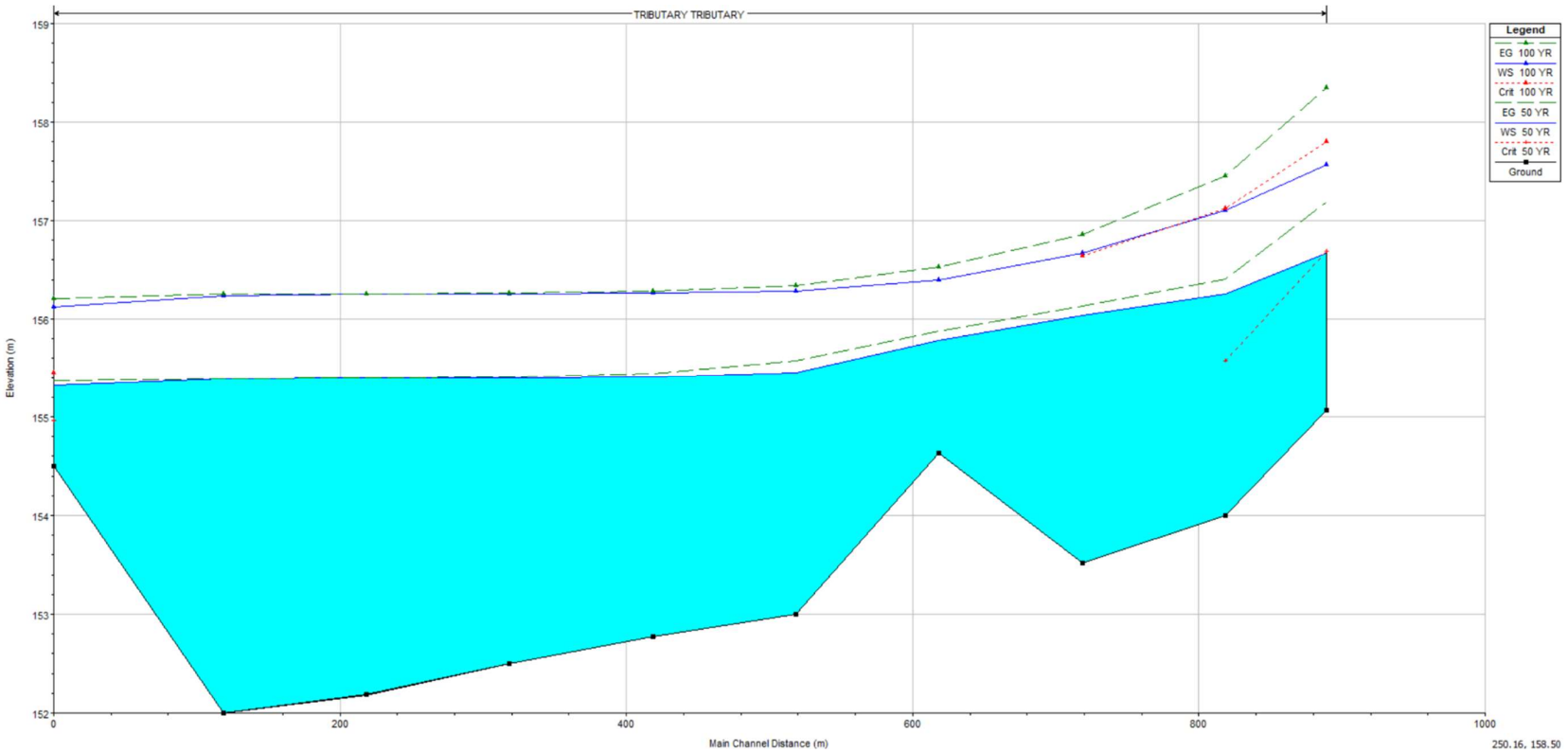

FIGURE B2: CHANNEL LONG-SECTION SHOWING WATER SURFACE AND ENERGY LEVELS

Notes:

3. EG: Energy grade; WS: Avg water surface level; Crit: Critical depth level
4. Main Channel Distance is measured from the most downstream cross-section.

REVISION:

No.	DATE	DESCRIPTION
B	2024-09-20	REVISED 1:100 YEAR FLOODLINE

LEGEND:

- CADASTRAL BOUNDARY
- CONTOURS MAJOR
- CONTOURS MINOR
- OLIFANTS RIVER
- BOONTJIES RIVER
- CHANNEL
- 50-YEAR FLOODLINE
- 100-YEAR FLOODLINE (REV A)
- JULY 2024 PEAK FLOOD LEVEL (CK RUMBOLL)
- REVISED 100 YEAR FLOODLINE
- PROPOSED DEVELOPMENT

PROJECT:

CITRUSDAL 900
UISP FLOOD STUDY

DRAWING TITLE

1:50 AND 1:100 YEAR FLOODLINES

CLIENT

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DRAWN BY	DESIGNED BY
JW DE BRUIJN	GA McGILL Pr Eng No. 780269
DATE	2024-09-20
SCALE	1:3000 (A0)
DRAWING NO	MC424-C900
REVISION	B