

**PROPOSED TOWNSHIP ESTABLISHMENT OF GREATER SEVILLE
EXT 1 ON THE REMAINDER OF PORTION 2 AND PORTION 3 OF
THE FARM SEVILLE 224 KU, BUSHBUCKRIDGE, MPUMALANGA**

1:100 RETURN PERIOD FLOODLINE DETERMINATION REPORT

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1.0 INTRODUCTION

1.1 Study Request

The report study is to undertake floodline assessment relating to the proposed township development of Greater Seville Ext 1 on the Remainder of Portion 2 and Portion 3 of the Farm Seville 224 KU, Mpumalanga Province.

1.2 Locality

The proposed township is situated 145km north of Mbombela along the R40, in Mpumalanga Province, South Africa. The area is administered by Bushbuckridge Local Municipality under Ehlanzeni District Municipality. GPS coordinates of site are 24°39'30.99"S 31°24'34.87"E.

The locality map is shown on the figures below.

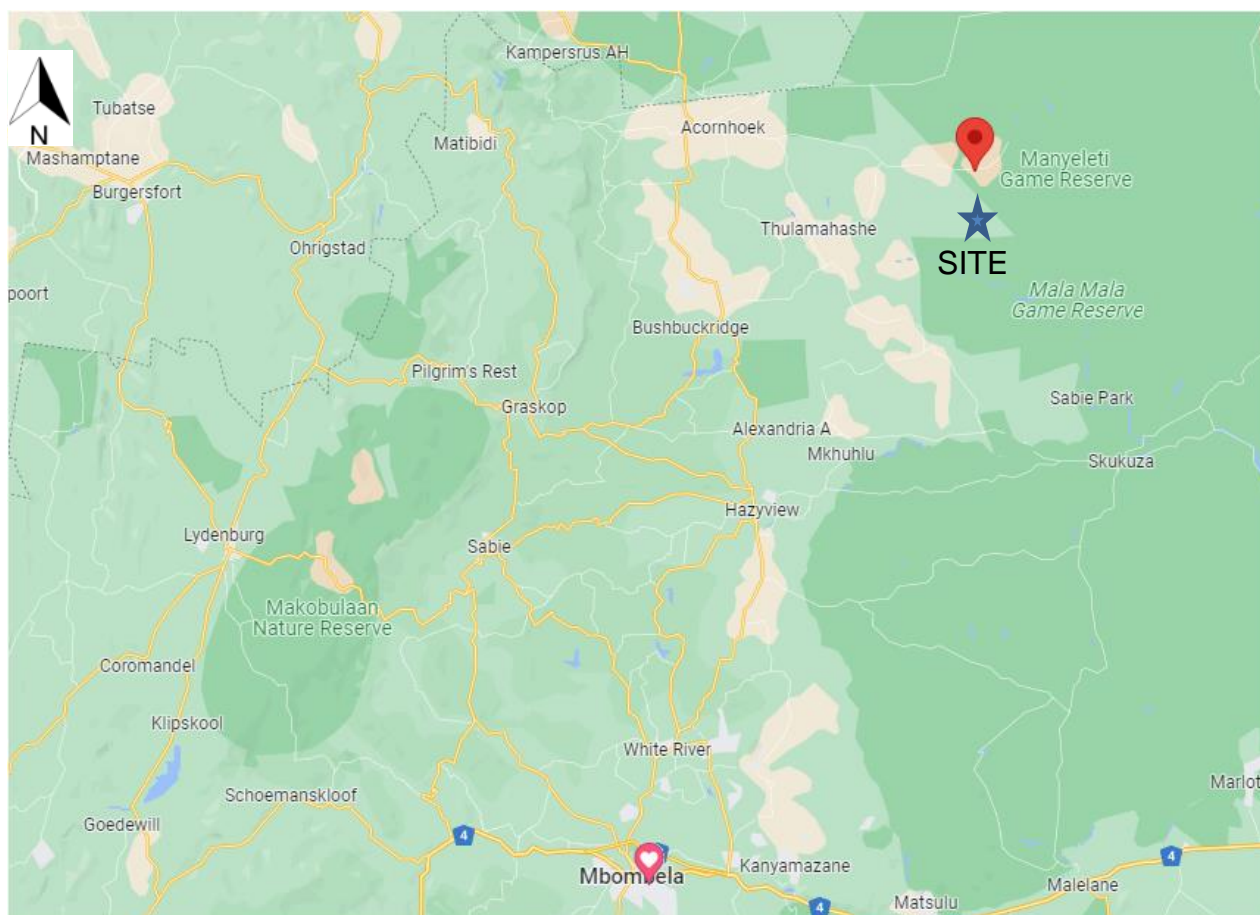


Figure 1 Location of development site

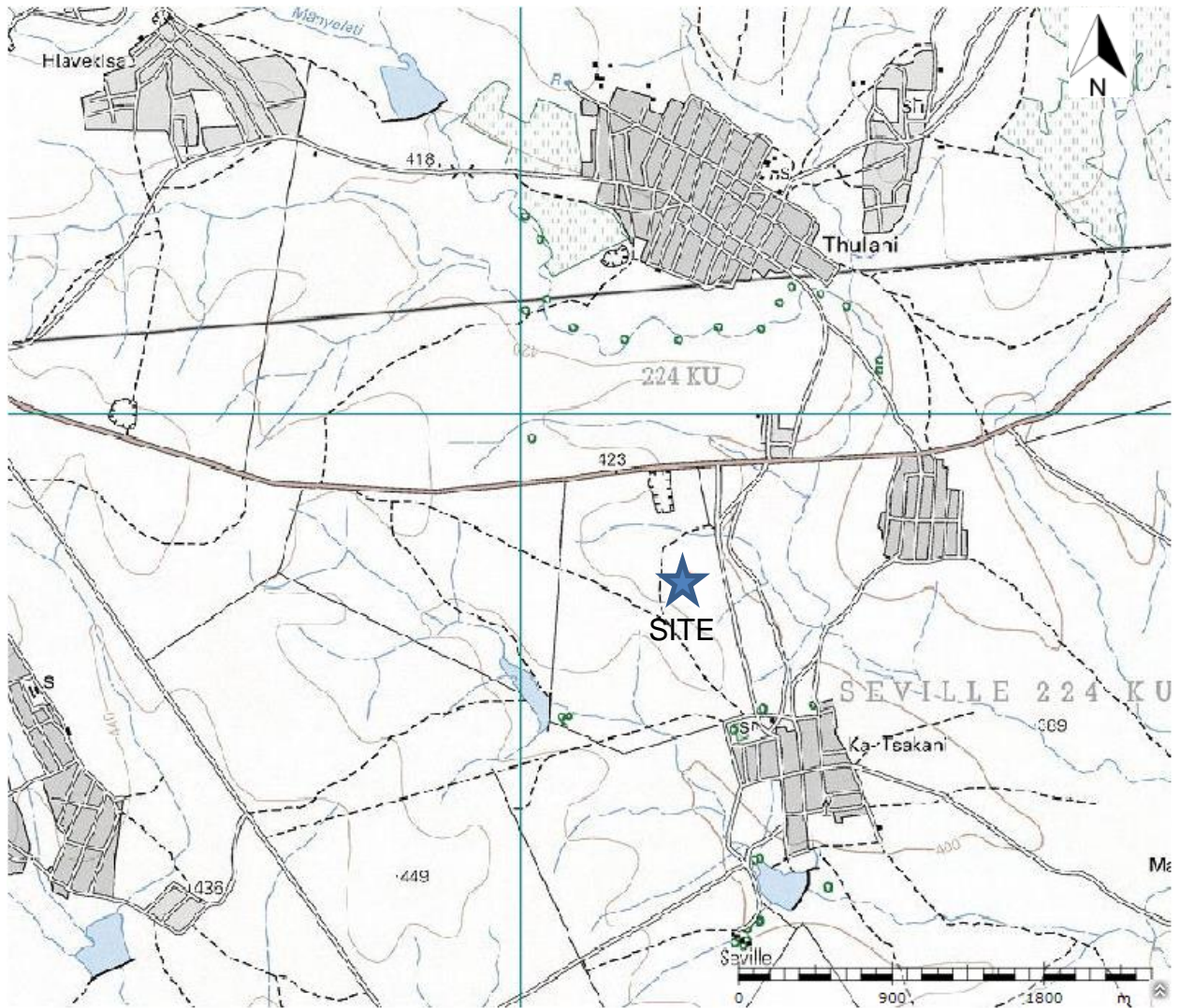


Figure 2 Project site

1.3 Excavations / Pits onsite

Site visit revealed excavation pits dotted within the proposed development site. The excavations onsite are shown as cyan colour polygons, while the site boundary is shown as a thick white line in the figure below.

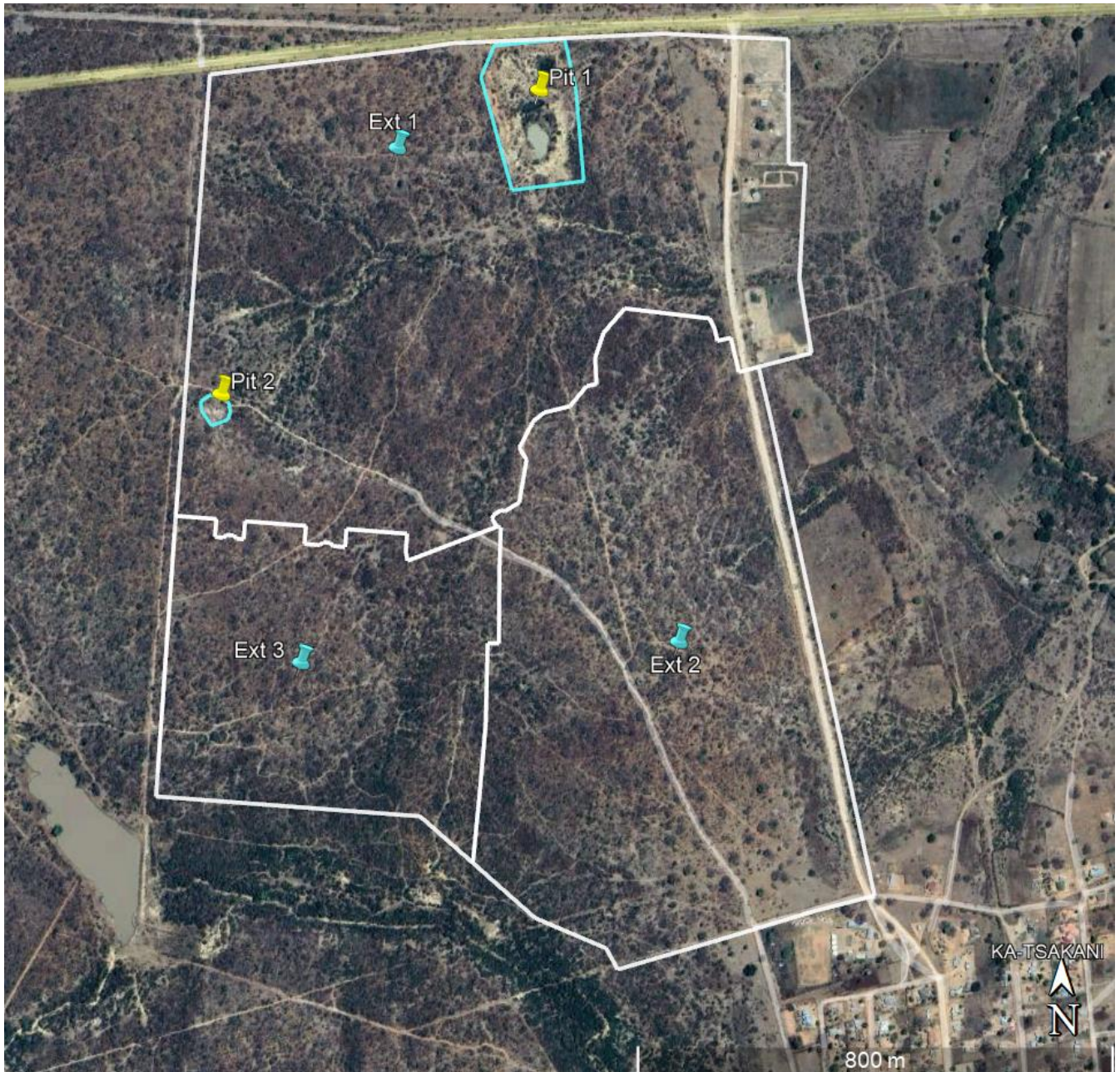


Figure 3 Excavations pits formation onsite



Figure 4 Pit 1 onsite



Figure 5 Pit 2 onsite

1.4 Background

A flood line analysis must be conducted along the stream / river traversing or in proximity of the site of proposed development.

See the figures below for the streams in catchment area in proximity to the site.

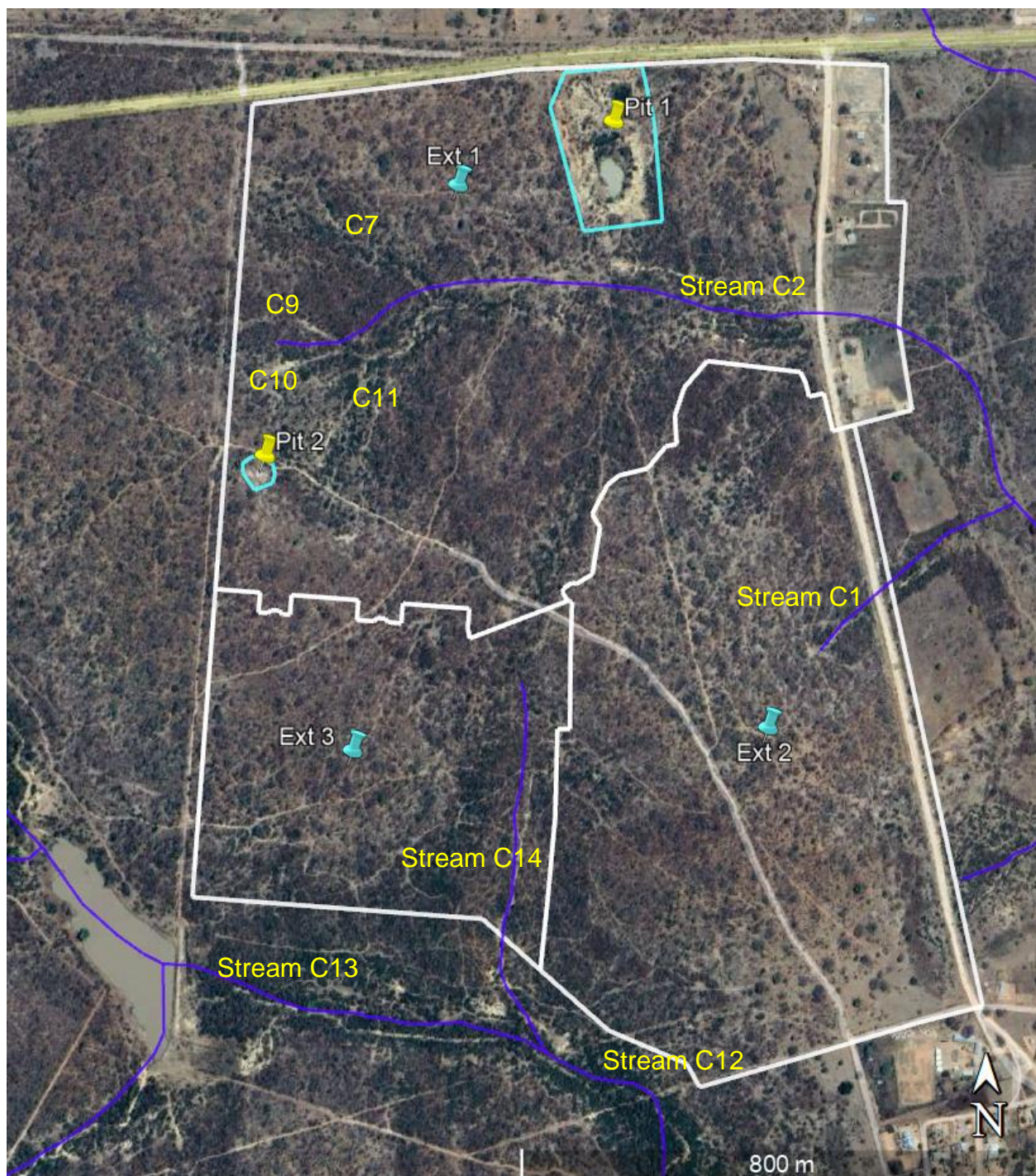


Figure 6 Streams (blue line)



Figure 7 Stream C1 culvert 1200mm high x 1200mm wide



Figure 8 Stream C1 onsite



Figure 9 Stream C2 onsite



Figure 10 Stream C2 culvert 900mm diameter



Figure 11 Stream C10 onsite



Figure 12 Stream C11 onsite

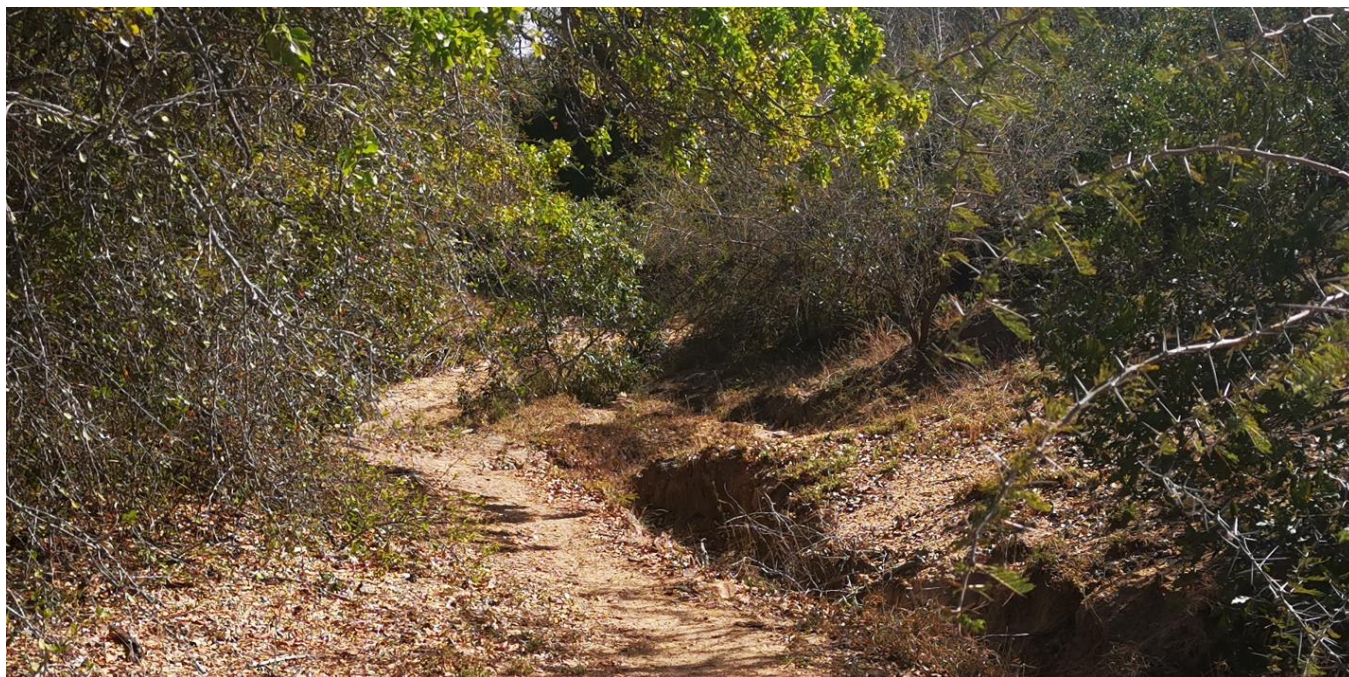


Figure 13 Stream C12 onsite



Figure 14 Stream C13 onsite



Figure 15 Stream C14 onsite

1.4 Methodology

1.4.1 general

The study consists of 2 major components:

- a flood analysis to determine the flood peak flow and,
- a surface water profile analysis to determine the flood line.

The magnitude of a flood is dependent on many factors, such as catchment size, slope and rainfall intensity. There are several different methods for determining floods and in general, different methods arrive at different estimates of the peak flow rate. The accepted approach is therefore to use several methods and then make a judgment call as to which method is the most applicable to the catchment under consideration. For this study, the Rational, Alternative Rational, Standard Design Flood (SDF) methods were used to determine the peak flow rate for the 1:100 return flood.

The reason for choosing these methods was because they are applicable to the catchment and to show the variance in the flood line between the method that produced the highest flood peak and the method that produced the lowest flood peak. Hence a flood line has been produced to take cognisance of the uncertainty related to estimating floods and flood lines.

The area of the catchment in which the adjacent stream is located was determined using GIS software as were additional properties applicable to the catchment, such as the length of the watercourse and the centroid of the catchment. The flood peak flows provide the flow used in the flood line analysis using the *HEC-RAS* software.

Other input required for *HEC-RAS* is channel geometry and roughness parameters.

Channel cross-sections were taken at points along the river / stream course, within the area that contour lines were provided. The stream reaches that were analysed are in a natural state.

1.4.2 Flood Modelling Methodology

Flood peaks for the catchments selected for flood modelling were estimated by the following methods using the Utility Programs for Drainage (UPD) software, 2007 with the methods detailed in SANRAL, 2013:

- Rational Method (RM).
- Alternative Rational Method (ARM).
- Standard Design Flood (SDF).

1.4.2.1 Rational Method

This method is based on the conservation of mass and is applicable for catchment areas below 15 km². Aerial and time distributions of rainfall in this method are assumed to be uniform throughout the catchment. Flood peaks and empirical hydrographs can be determined by this method.

Where: The peak flow is obtained from the following relationship:

$$Q = \frac{CIA}{3.6}$$

Where: Q = peak flow (m³/s)

C = runoff coefficient (dimensionless)

I = average rainfall intensity over the catchment (mm/hour)

A = effective runoff area of the catchment (km²)

3.6 = conversion factor

1.4.2.2 Alternative Rational Method

This method is based on the rational method with the point precipitation being adjusted using the Design Rainfall Estimation Methodology developed by Smithers and Schulze (2003) to consider local South African conditions.

Design rainfall values for the study area were extracted from the database of six closest to site South African Weather Service stations, using the Design Rainfall Utility developed by Smithers and Schulze (2000).

Table 1 Design Rainfall Values for the site

Duration		Return Period (Years) Design Rainfall Depth (mm)						
		1:2	1:5	1:10	1:20	1:50	1:100	1:200
5	m	8.2	11.4	13.9	16.5	20.3	23.6	27.2
10	m	13.4	18.6	22.6	26.9	33.2	38.5	44.3
15	m	17.9	24.8	30.2	35.9	44.2	51.3	59.1
30	m	25	34.8	42.3	50.3	62	71.9	82.8
45	m	30.5	42.4	51.5	61.2	75.5	87.6	100.9
1	h	35.1	48.8	59.3	70.5	86.9	100.7	116.1
1.5	h	42.8	59.5	72.2	85.9	105.8	122.8	141.5
2	h	49.2	68.4	83.1	98.8	121.8	141.3	162.8
4	h	57.8	80.3	97.5	115.9	142.9	165.7	190.9
6	h	63.4	88.2	107	127.3	156.9	181.9	209.6
8	h	67.8	94.2	114.4	136	167.6	194.4	224
10	h	71.3	99.2	120.4	143.2	176.4	204.7	235.8
12	h	74.4	103.4	125.6	149.3	184	213.4	245.9
16	h	79.5	110.5	134.2	159.5	196.6	228.1	262.8
20	h	83.7	116.3	141.3	167.9	207	240.1	276.6
24	h	87.3	121.3	147.3	175.1	215.9	250.4	288.5
1	d	72.4	100.6	122.2	145.3	179.1	207.7	239.4
2	d	91.1	126.6	153.7	182.8	225.3	261.3	301.1
3	d	104.2	144.8	175.8	209	257.6	298.8	344.3
4	d	114.1	158.6	192.6	229	282.2	327.4	377.2
5	d	122.5	170.3	206.7	245.8	303	351.4	404.9
6	d	129.8	180.4	219.1	260.4	321	372.3	429
7	d	136.3	189.4	230	273.5	337.1	391	450.5

2.0 PROPOSED DEVELOPMENT

2.1 Flood Analysis

To make the analysis possible, properties of the catchments that influence the runoff relating to the 1:100 return flood event need to be determined. These properties are described in the following sections.

2.1.1 Catchment Properties

The catchment topography is composed of mainly flat areas, to hilly. The topographic elevation ranges from 393m to 445m above sea level. The landscape soils are mostly with moderate infiltration rates with slightly restricted permeability (Schulze, 2010). The soils are classified to be permeable and with a moderately low runoff potential.

The Mean Annual Precipitation (MAP) of the catchment was determined from weather stations gridded from in the vicinity of the site. The MAP for the catchment is estimated to be 805mm.

Table 2 Rainfall data

Station Name	SAWS Number	Distance (km)	Record (Years)	Latitude (°)		Longitude (°)		MAP (mm)
TSAKANE	0595579_W	7.2	32	24	39	31	20	638
ALLANDALE	0595463_W	17.7	36	24	43	31	15	729
NEWINGTON	0595711_W	21.6	33	24	51	31	24	643
KINGFISHERSPRUIT	0638748_W	21.9	42	24	27	31	26	631
CUNNINGMOORE	0595443_W	30	32	24	53	31	15	727
CUNNING MOOR	0595353_W	33.2	28	24	53	31	12	806

The climate is characterised by hot and rainy summers for a long period as well as cold and dry winters over a short period.

2.1.2 Catchment Delineation

There were fourteen catchments that were delineated.

The catchment area is within the Inkomati Water Management Area.

Catchment in the table below was delineated to cover the stream nearest to the project boundary and was utilised to determine the flood peaks for 1:100 return extreme events. The catchment information is listed in the table below.

Table 3 Catchment area

Catchment Site	Catchment area (km ²)	Remark	Quaternary catchment
Stream 1	0.105	Rural	X32H
Stream 2	0.837	Rural	X32H
Stream 3	0.649	Rural	X32H
Stream 4	0.108	Rural	X32H
Stream 5	0.112	Rural	X32H
Stream 6	0.478	Rural	X32H
Stream 7	0.079	Rural	X32H
Stream 8	0.256	Rural	X32H
Stream 9	0.054	Rural	X32H
Stream 10	0.073	Rural	X32H
Stream 11	0.069	Rural	X32H
Stream 12	4.497	Rural	X32H
Stream 13	3.980	Rural	X32H
Stream 14	0.220	Rural	X32H

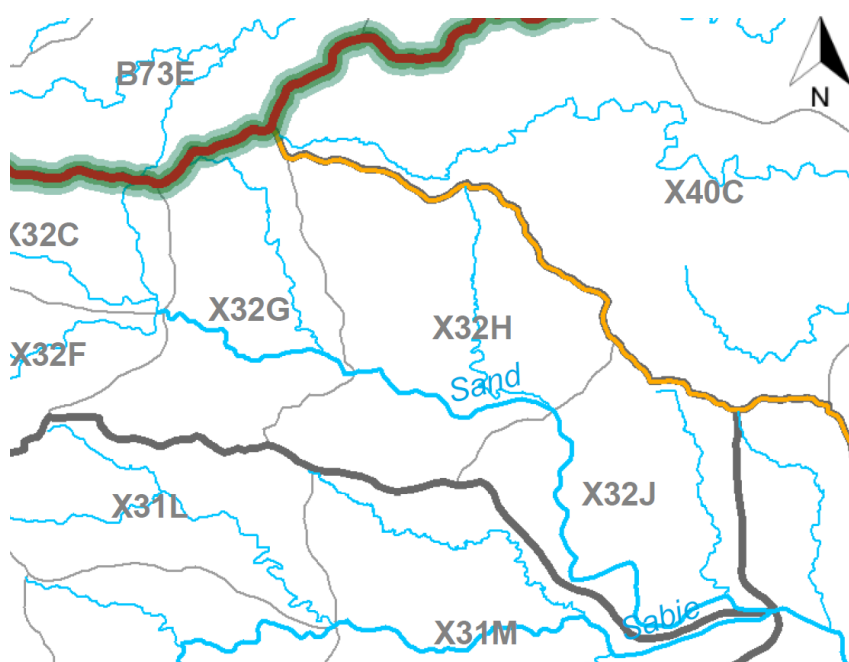


Figure 16 Quaternary catchments

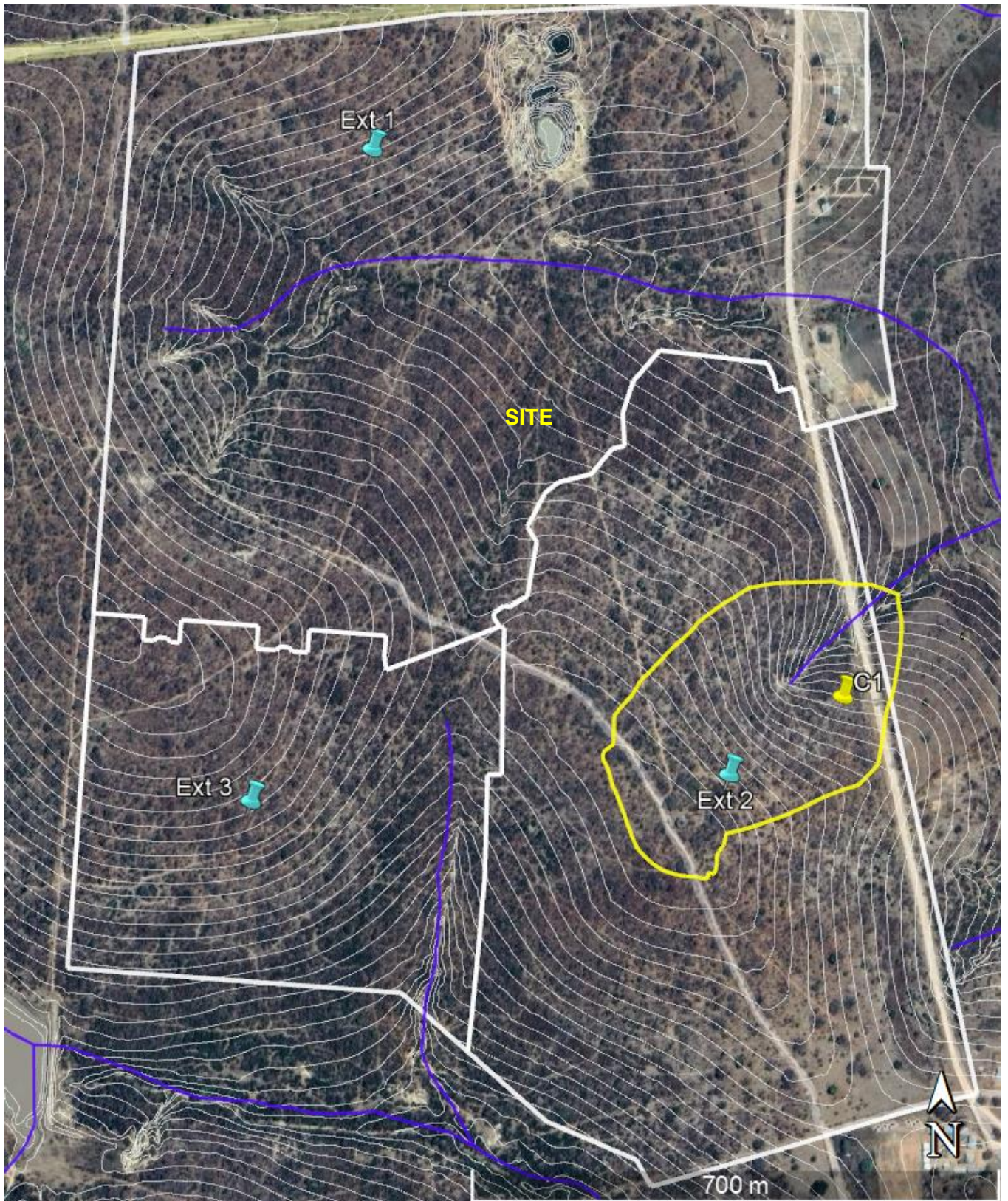


Figure 17 Catchment C1 delineation (yellow line boundary)

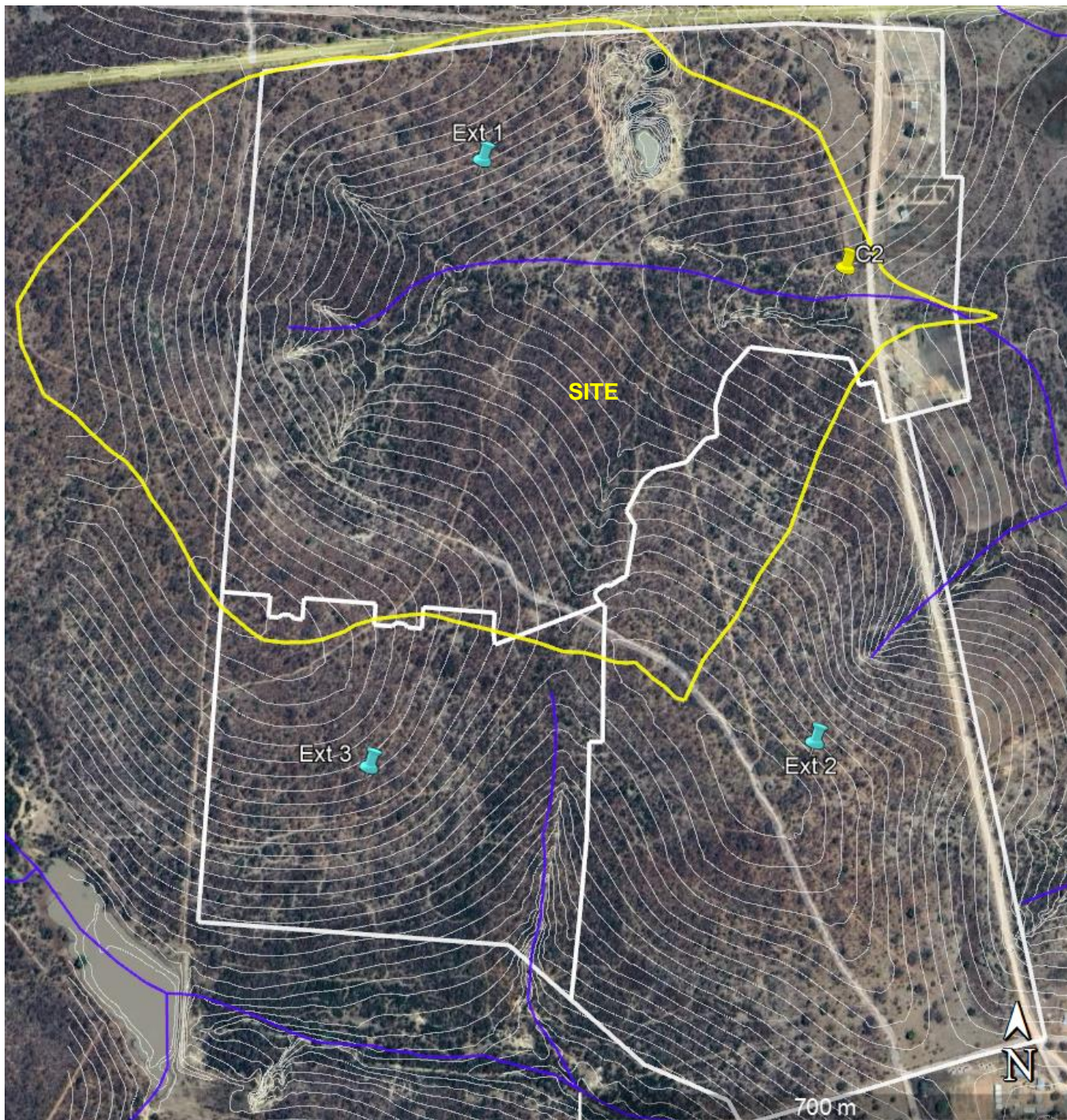


Figure 18 Catchment C2 (yellow line boundary)

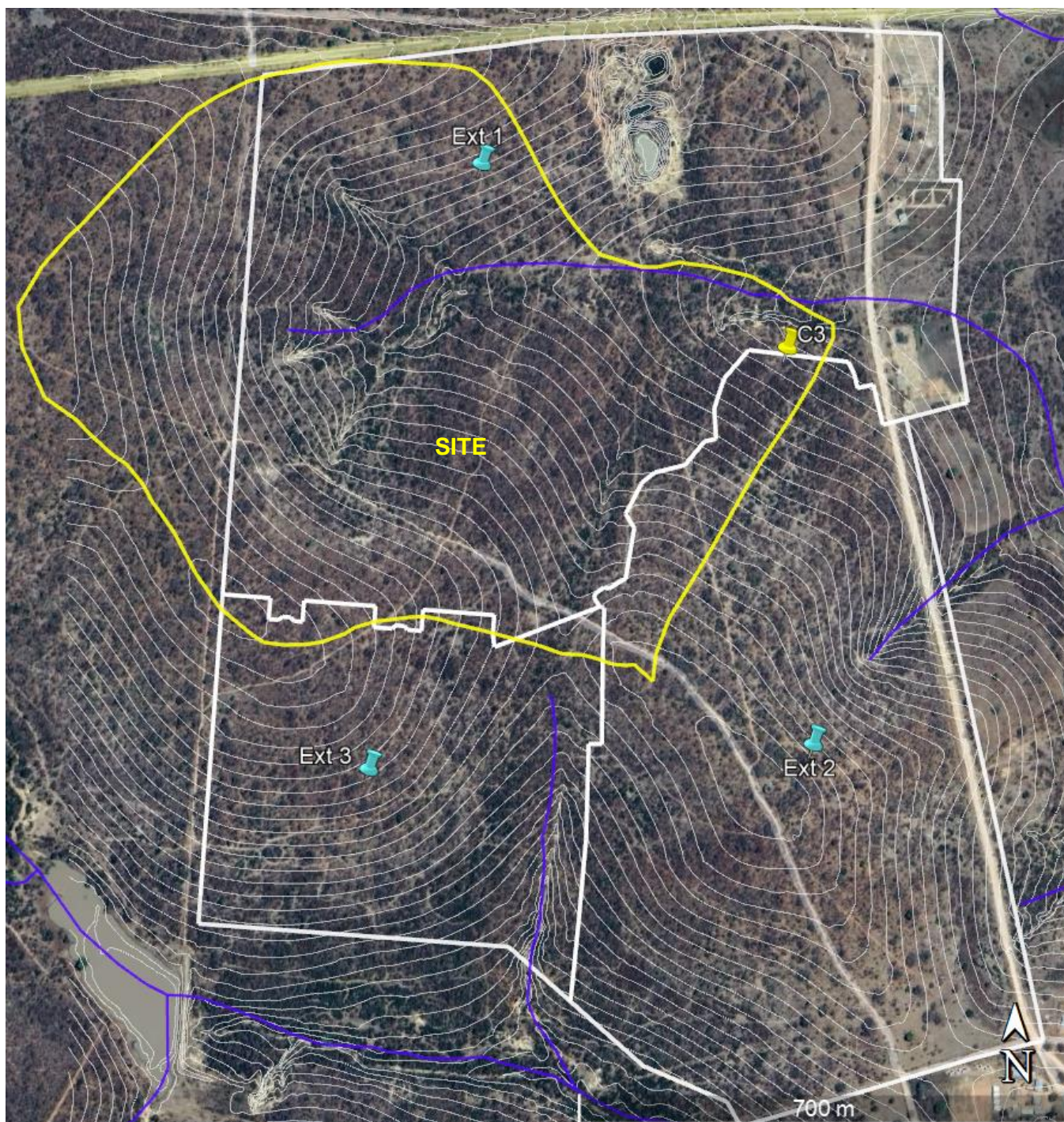


Figure 19 Catchment C3 (yellow line boundary)

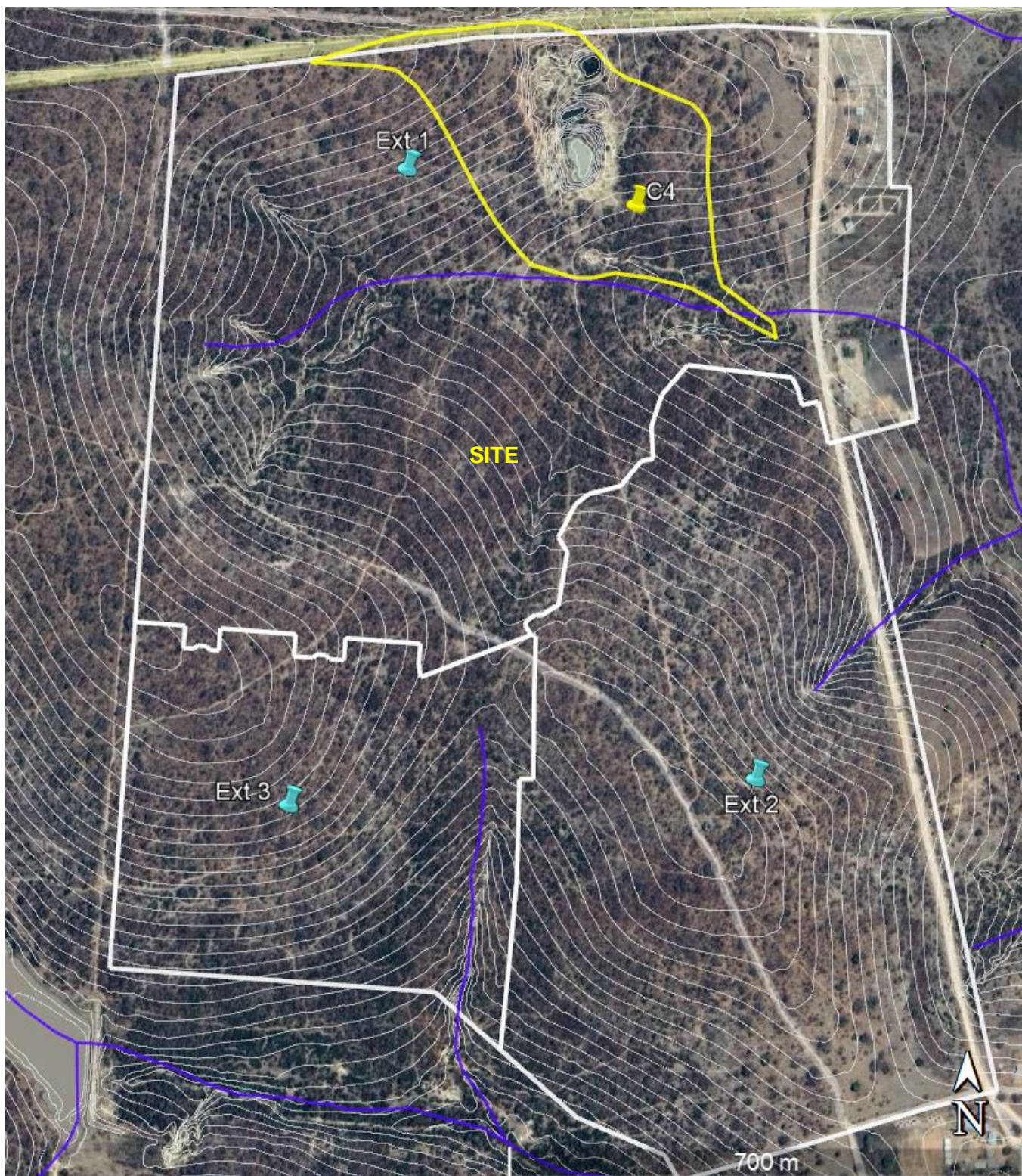


Figure 20 Catchment C4 (yellow line boundary)

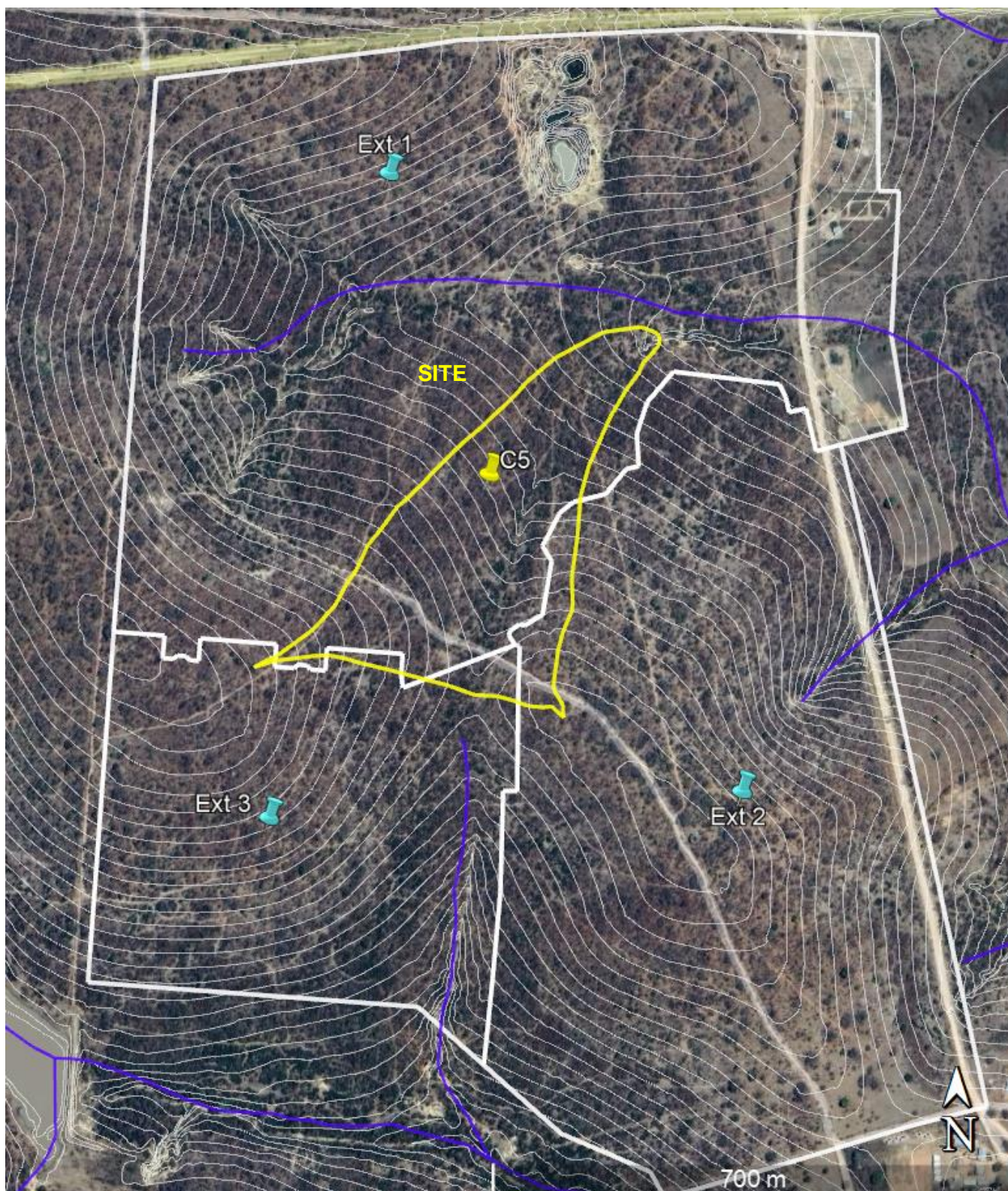


Figure 21 Catchment C5 (yellow line boundary)

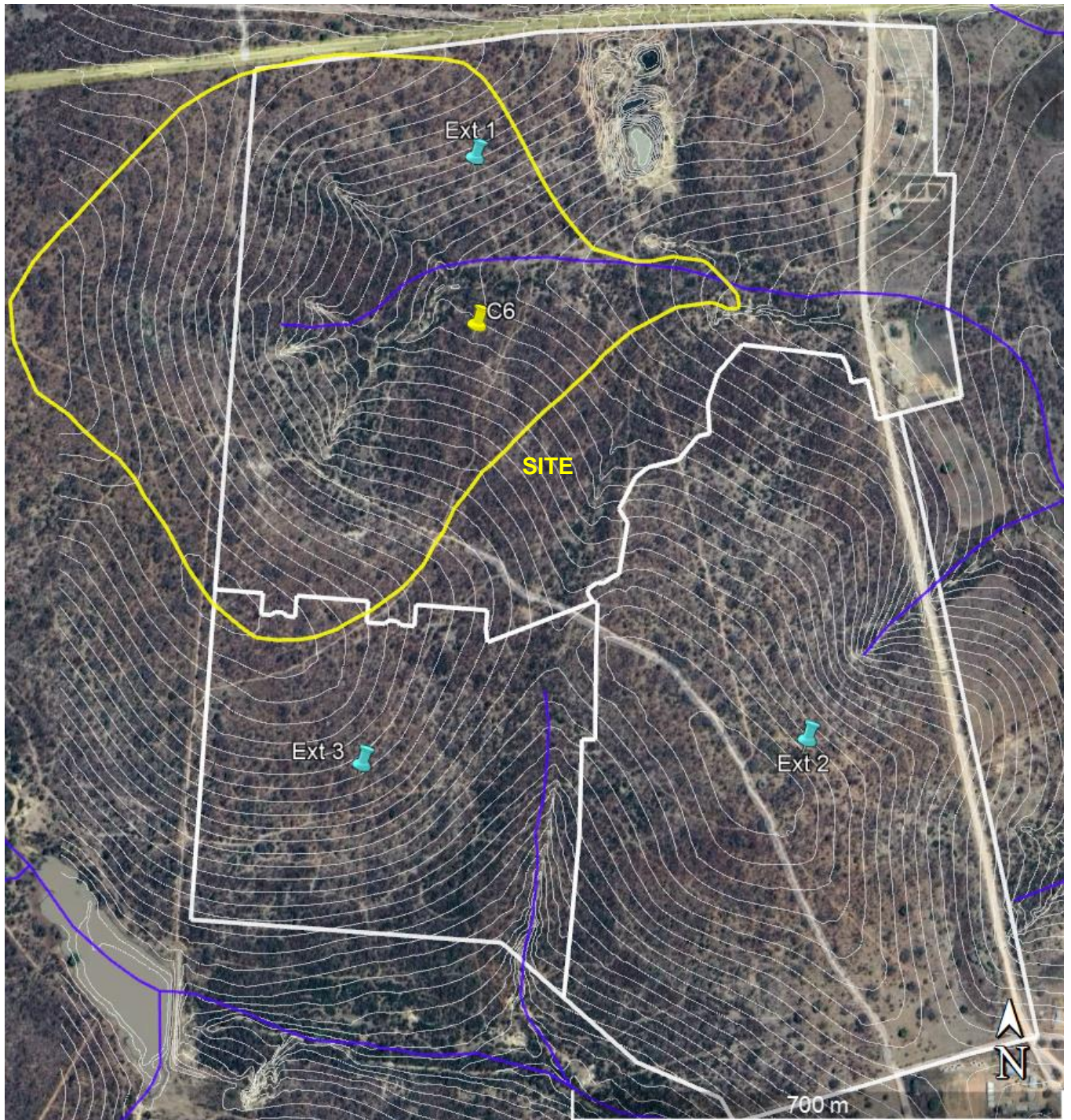


Figure 22 Catchment C6 (yellow line boundary)

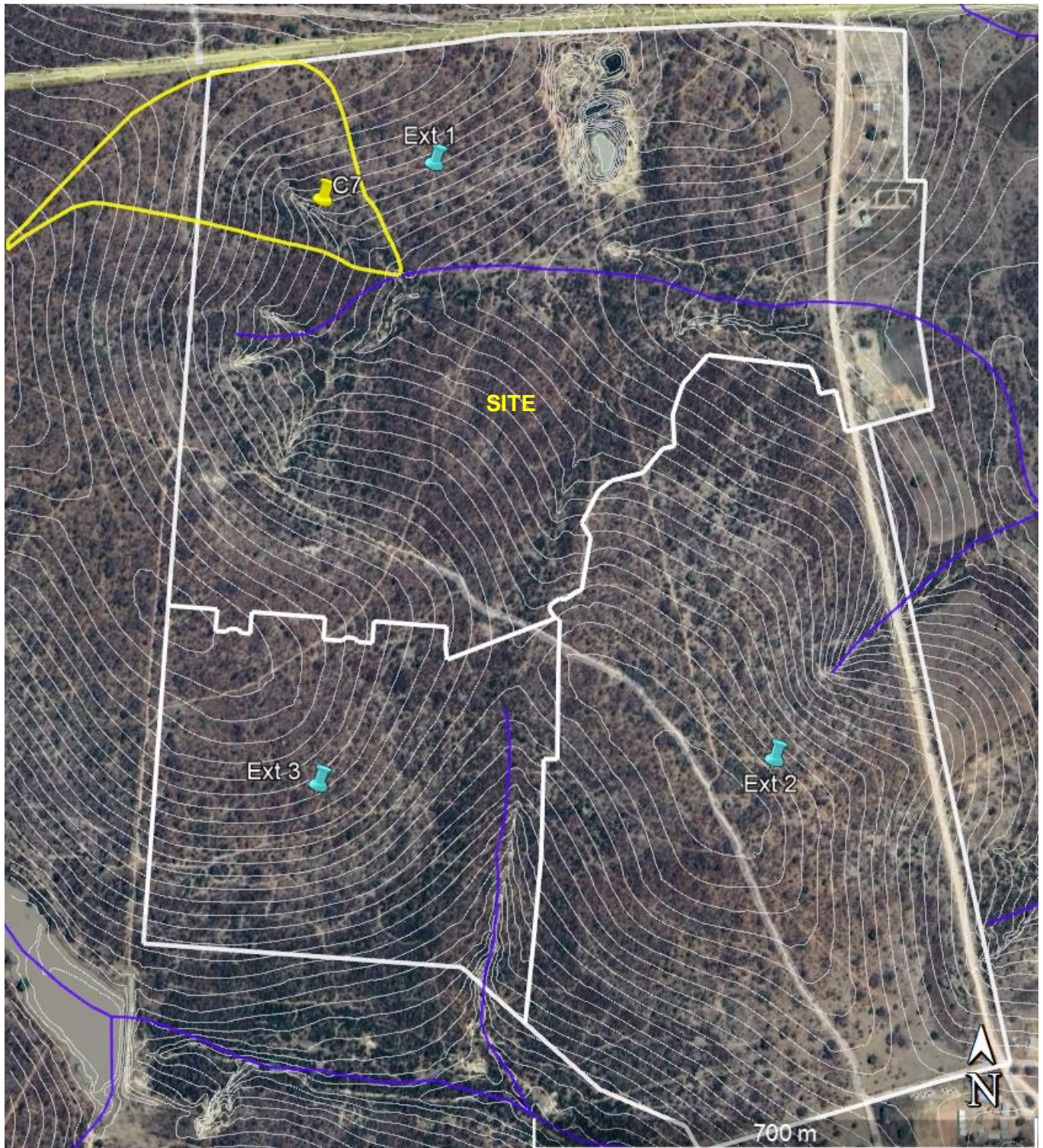


Figure 23 Catchment C7 (yellow line boundary)

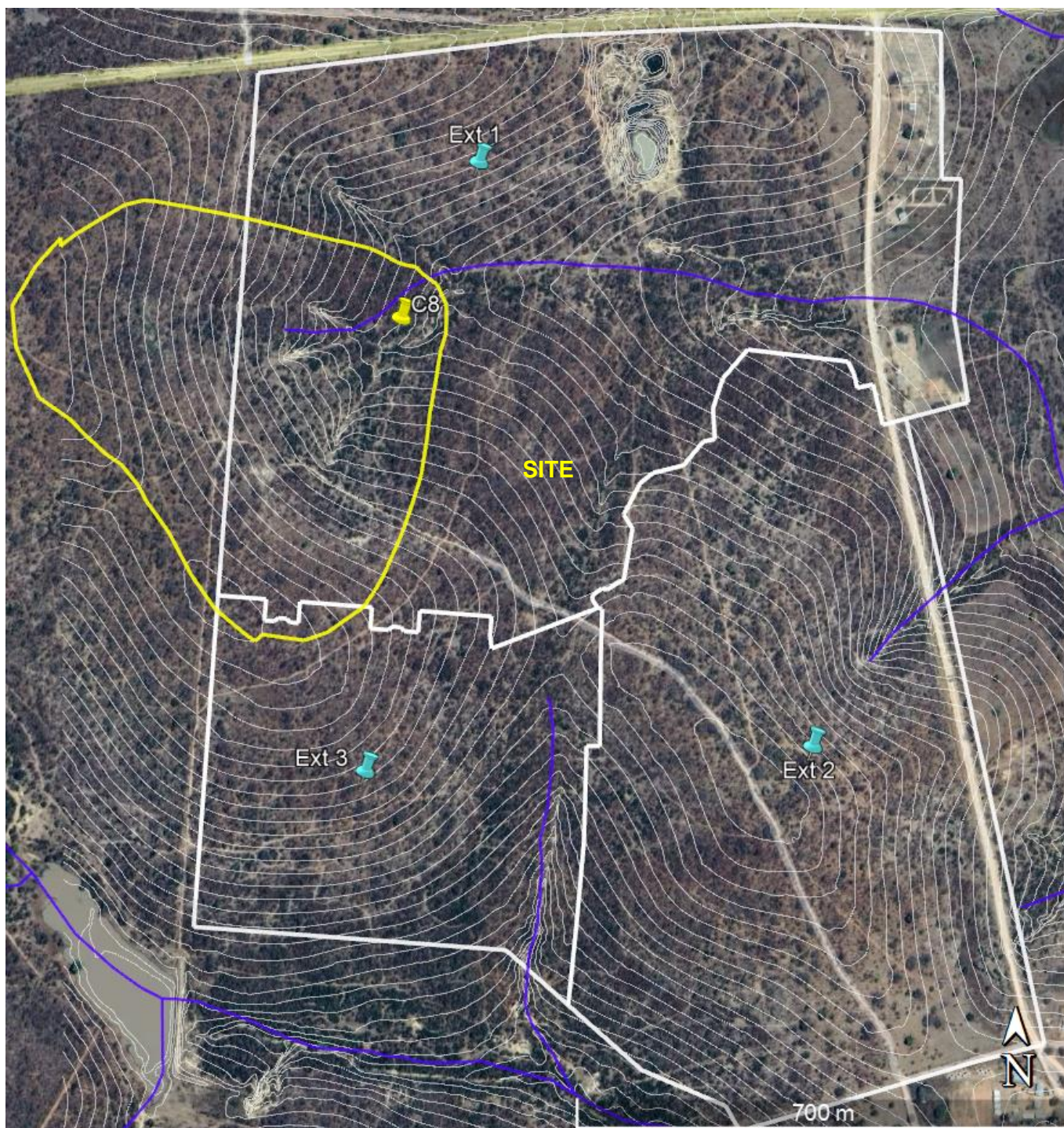


Figure 24 Catchment C8 (yellow line boundary)

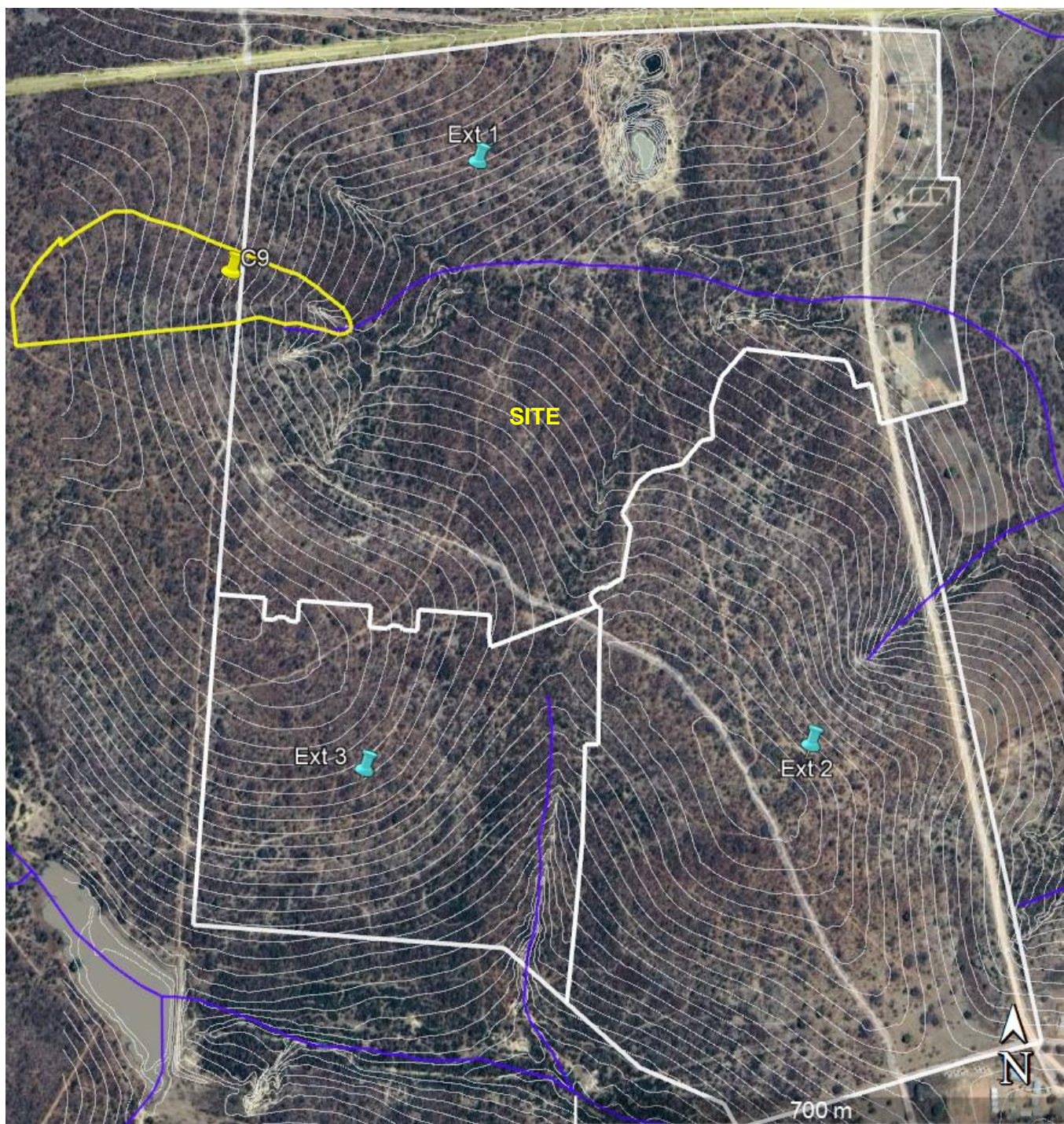


Figure 25 Catchment C9 (yellow line boundary)

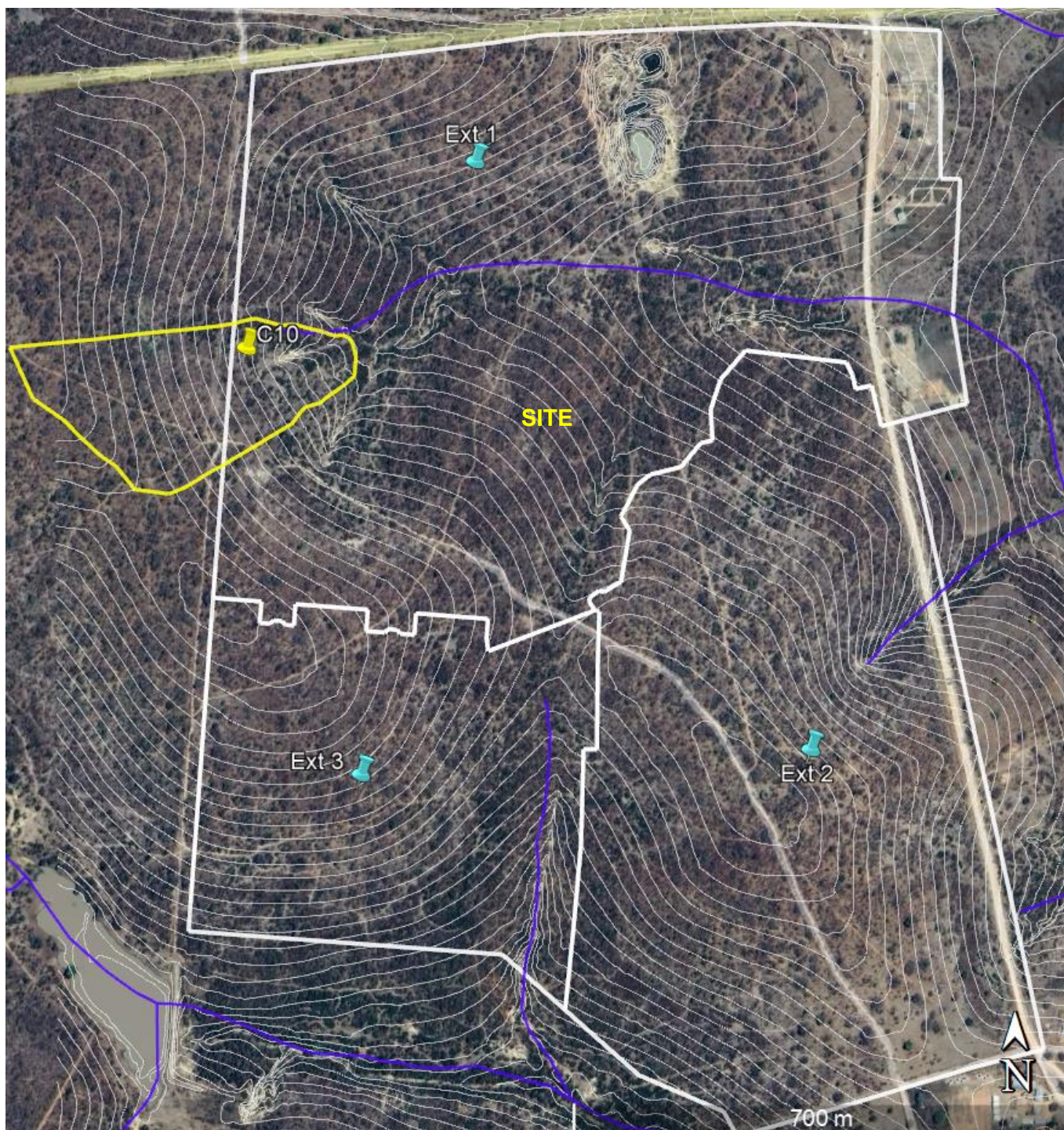


Figure 26 Catchment C10 (yellow line boundary)

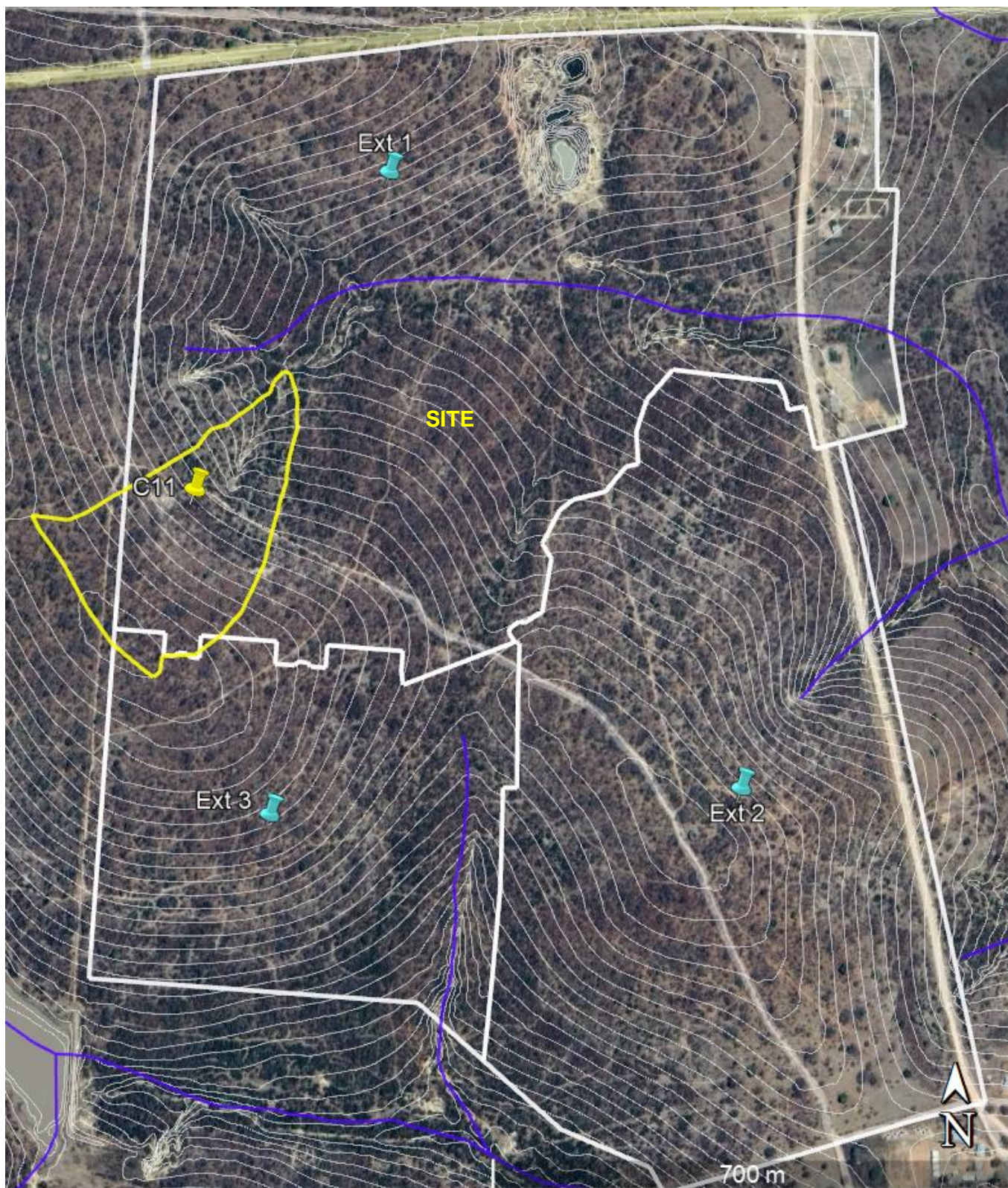


Figure 27 Catchment C11 (yellow line boundary)

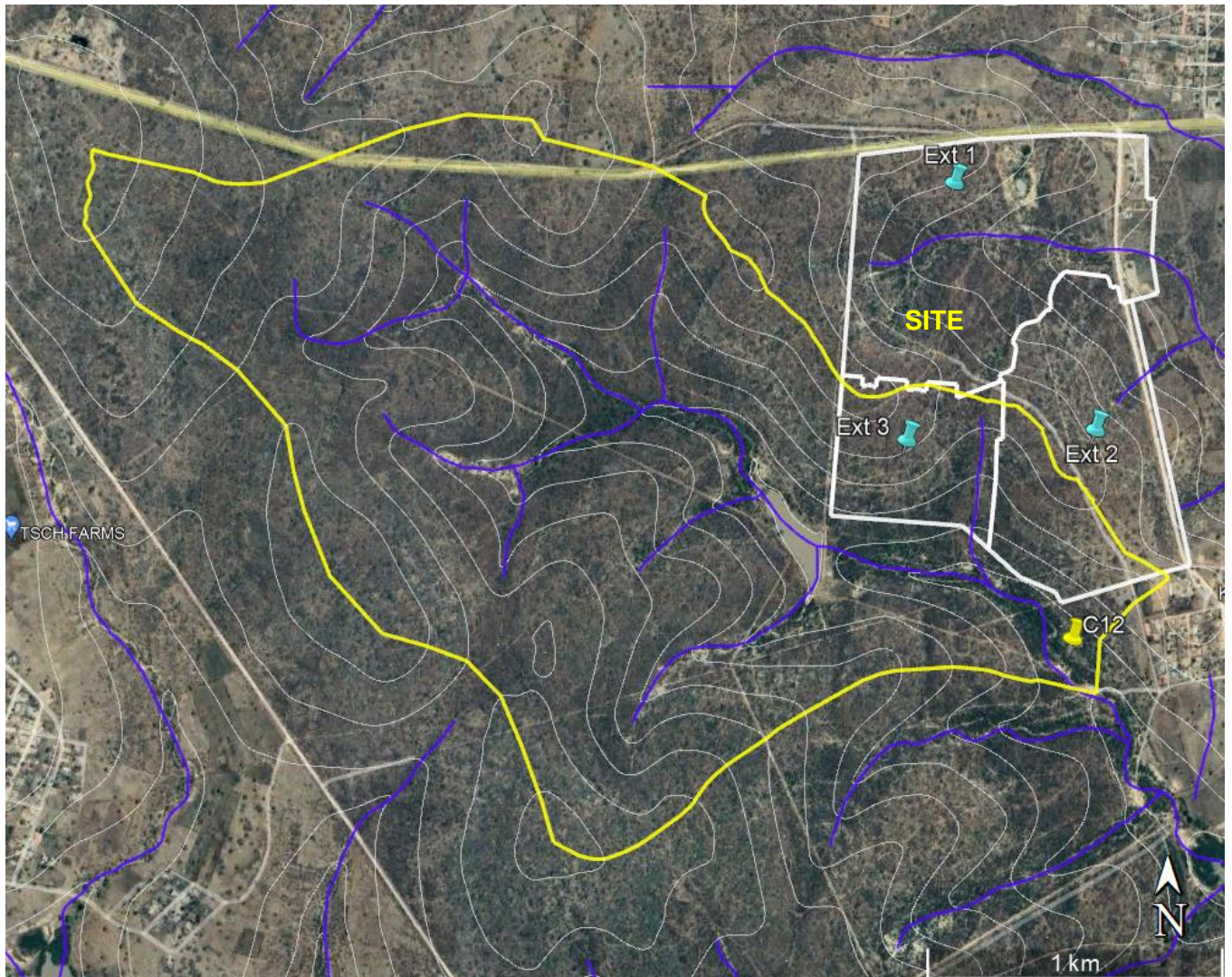


Figure 28 Catchment C12 (yellow line boundary)

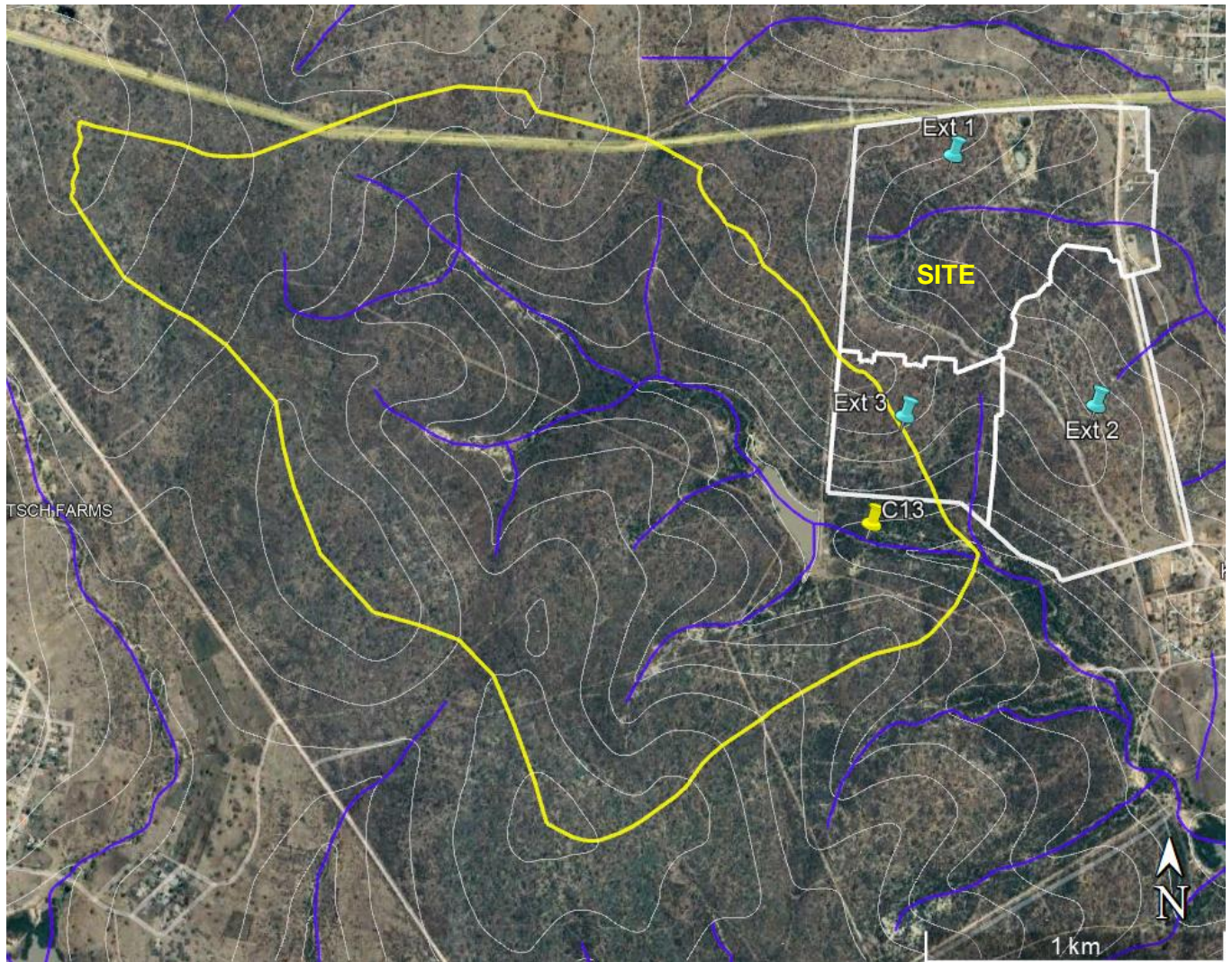


Figure 29 Catchment C13 (yellow line boundary)

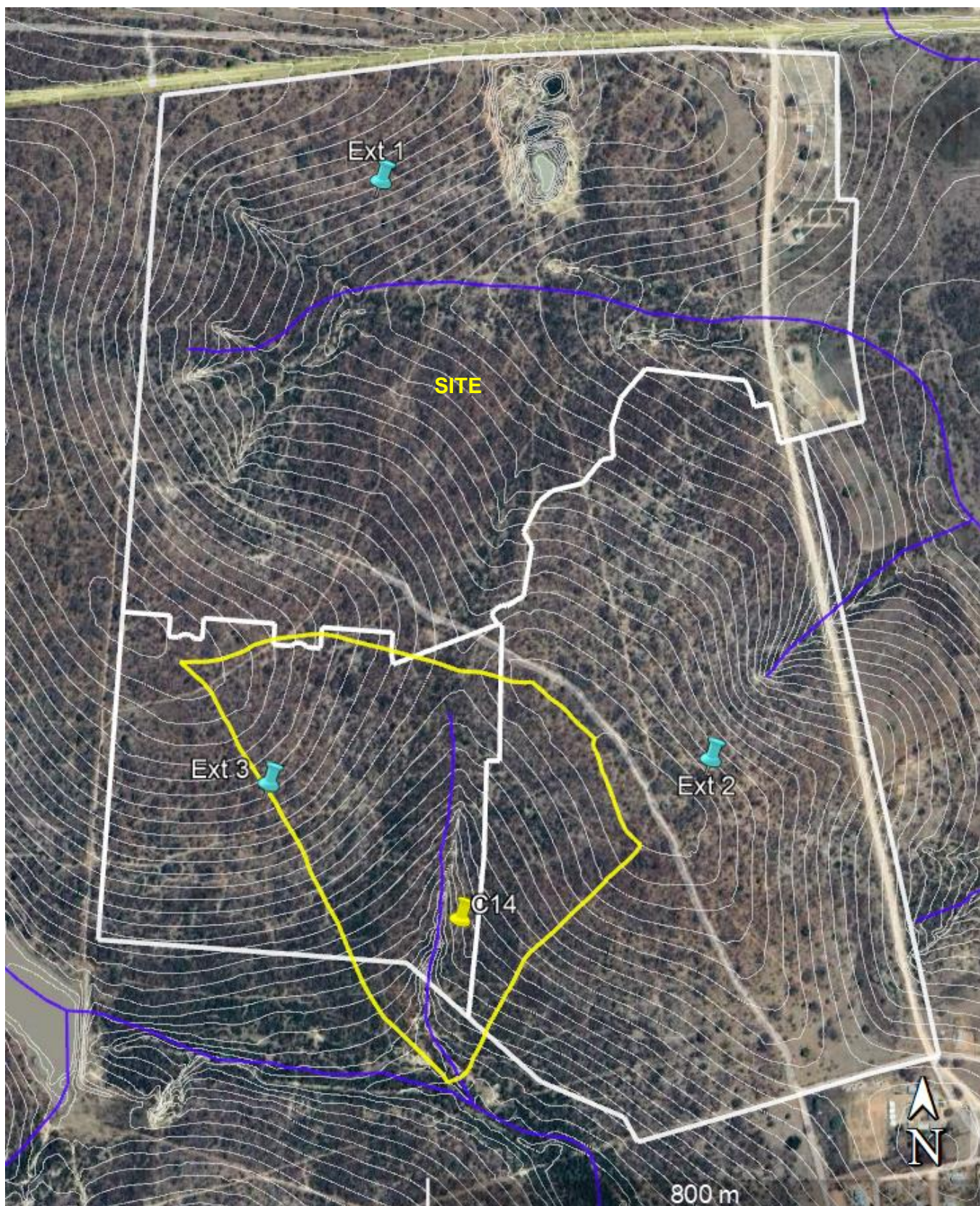


Figure 30 Catchment C14 (yellow line boundary)

Table 4 Catchment Characteristic

Characteristic	Rural	Urban	Lakes	Total
	Distribution	Distribution	Distribution	
Catchment	%	%	%	(%)
Stream 1	100%	0%	0%	100.0%
Stream 2	100%	0%	0%	100.0%
Stream 3	100%	0%	0%	100.0%
Stream 4	100%	0%	0%	100.0%
Stream 5	100%	0%	0%	100.0%
Stream 6	100%	0%	0%	100.0%
Stream 7	100%	0%	0%	100.0%
Stream 8	100%	0%	0%	100.0%
Stream 9	100%	0%	0%	100.0%
Stream 10	100%	0%	0%	100.0%
Stream 11	100%	0%	0%	100.0%
Stream 12	99%	0%	1%	100.0%
Stream 13	99%	0%	1%	100.0%
Stream 14	100%	0%	0%	100.0%

Table 5 Rural area - Surface slope

Rural area - Surface slope	Lakes and pans (<3%)	Flat area (3 to 10%)	Hilly (10 to 30%)	Steep areas (>30%)	Total
	Distribution	Distribution	Distribution	Distribution	
Catchment	(%)	(%)	(%)	(%)	(%)
Stream 1	16%	77%	7%	0%	100.0%
Stream 2	18%	80%	2%	0%	100.0%
Stream 3	16%	83%	1%	0%	100.0%
Stream 4	25%	61%	12%	2%	100.0%
Stream 5	11%	89%	0%	0%	100.0%
Stream 6	18%	81%	1%	0%	100.0%
Stream 7	25%	74%	1%	0%	100.0%
Stream 8	11%	87%	2%	0%	100.0%
Stream 9	6%	92%	2%	0%	100.0%
Stream 10	10%	88%	2%	0%	100.0%
Stream 11	20%	79%	1%	0%	100.0%
Stream 12	27%	73%	0%	0%	100.0%
Stream 13	28%	72%	0%	0%	100.0%
Stream 14	9%	88%	3%	0%	100.0%

Table 6 Rural area – Permeability

Rural area - Permeability	Very permeable	Permeable	Semi-permeable	Impermeable	Total
	Distribution	Distribution	Distribution	Distribution	
Catchment	(%)	(%)	(%)	(%)	(%)
Stream 1	0%	100%	0%	0%	100.0%
Stream 2	0%	100%	0%	0%	100.0%
Stream 3	0%	100%	0%	0%	100.0%
Stream 4	0%	100%	0%	0%	100.0%
Stream 5	0%	100%	0%	0%	100.0%
Stream 6	0%	100%	0%	0%	100.0%
Stream 7	0%	100%	0%	0%	100.0%
Stream 8	0%	100%	0%	0%	100.0%
Stream 9	0%	100%	0%	0%	100.0%
Stream 10	0%	100%	0%	0%	100.0%
Stream 11	0%	100%	0%	0%	100.0%
Stream 12	30%	70%	0%	0%	100.0%
Stream 13	34%	66%	0%	0%	100.0%
Stream 14	0%	100%	0%	0%	100.0%

Table 7 Rural area - Vegetation

Rural area - Vegetation	Thick bush & forests	Light bush & cultivated land	Grasslands	Bare	Total
	Distribution	Distribution	Distribution	Distribution	
Catchment					(%)
Stream 1	12%	77%	5%	6%	100.0%
Stream 2	17%	68%	7%	8%	100.0%
Stream 3	16%	69%	7%	8%	100.0%
Stream 4	7%	56%	5%	32%	100.0%
Stream 5	14%	72%	6%	8%	100.0%
Stream 6	13%	76%	6%	5%	100.0%
Stream 7	12%	79%	5%	4%	100.0%
Stream 8	15%	77%	4%	4%	100.0%
Stream 9	16%	78%	3%	3%	100.0%
Stream 10	12%	79%	5%	4%	100.0%
Stream 11	14%	78%	4%	4%	100.0%
Stream 12	18%	69%	5%	8%	100.0%
Stream 13	20%	68%	5%	7%	100.0%
Stream 14	14%	79%	3%	4%	100.0%

Table 8 Run-off factors

Catchment	Run-off factor			
	Rural (C _R)	Urban (C _U)	Lakes (C _L)	Combined (C)
Stream 1	0.274	0	0	0.274
Stream 2	0.271	0	0	0.271
Stream 3	0.272	0	0	0.272
Stream 4	0.325	0	0	0.325
Stream 5	0.274	0	0	0.274
Stream 6	0.267	0	0	0.267
Stream 7	0.262	0	0	0.262
Stream 8	0.266	0	0	0.266
Stream 9	0.266	0	0	0.266
Stream 10	0.270	0	0	0.270
Stream 11	0.262	0	0	0.262
Stream 12	0.251	0	0	0.248
Stream 13	0.245	0	0	0.243
Stream 14	0.268	0	0	0.268

Table 9 Hydrological input data

Catchment	Catchment Area (km ²)	Longest water course (km)	Height difference 1085 method (m)	Days thunder was heard (No.)	Area Dolomite (%)	Mean Annual Precipitation (mm)	SDF Basin no. (No.)
Stream 1	0.105	0.486	20.2	27	0	805	29
Stream 2	0.837	1.418	28.3	27	0	805	29
Stream 3	0.649	1.185	27.2	27	0	805	29
Stream 4	0.108	0.813	20.7	27	0	805	29
Stream 5	0.112	0.843	19.4	27	0	805	29
Stream 6	0.478	1.052	25.1	27	0	805	29
Stream 7	0.079	0.514	14.2	27	0	805	29
Stream 8	0.256	0.552	18.6	27	0	805	29
Stream 9	0.054	0.426	16.0	27	0	805	29
Stream 10	0.073	0.405	14.9	27	1	805	29
Stream 11	0.069	0.437	6.4	27	2	805	29
Stream 12	4.497	4.201	44.4	27	3	805	29
Stream 13	3.980	3.635	42.7	27	4	805	29
Stream 14	0.220	0.911	22.3	27	5	805	29

Table 10 Catchment characteristics

Catchment Site	Catchment area (km ²)	Longest water course, L (km)	Height difference along 10-85 slope (m)	Average slope S _{av} (m/m)	Time of concentration, T _c (hours)	% Slope	MAP (mm)	Run-off factor C
Stream 1	0.105	0.486	20.2	0.05535242	0.115909498	5.54%	805	0.274
Stream 2	0.837	1.418	28.3	0.02658235	0.350807416	2.66%	805	0.271
Stream 3	0.649	1.185	27.2	0.03064247	0.289299564	3.06%	805	0.272
Stream 4	0.108	0.813	20.7	0.03395680	0.208067629	3.40%	805	0.325
Stream 5	0.112	0.843	19.4	0.03074989	0.222134963	3.07%	805	0.274
Stream 6	0.478	1.052	25.1	0.03174033	0.260422509	3.17%	805	0.267
Stream 7	0.079	0.514	14.2	0.03675408	0.141834052	3.68%	805	0.262
Stream 8	0.256	0.552	18.6	0.04492630	0.138544277	4.49%	805	0.266
Stream 9	0.054	0.426	16.0	0.05017264	0.108723237	5.02%	805	0.266
Stream 10	0.073	0.405	14.9	0.04897770	0.105569054	4.90%	805	0.27
Stream 11	0.069	0.437	6.4	0.01951499	0.159602409	1.95%	805	0.262
Stream 12	4.497	4.201	44.4	0.01408753	1.033696173	1.41%	805	0.248
Stream 13	3.980	3.635	42.7	0.01565062	0.888046987	1.57%	805	0.243
Stream 14	0.220	0.911	22.3	0.03267004	0.230549493	3.27%	805	0.268

Flood magnitudes

The flood magnitudes from the 1:2 return up to 1:100 return floods are presented in the Tables below.

Table 11 Estimated stormwater flow (m³/s)

Return	Rational method						Alternative rational method					
	1:2	1:5	1:10	1:20	1:50	1:100	1:2	1:5	1:10	1:20	1:50	1:100
Catchment												
Stream 1	0.68	0.98	1.32	1.72	2.36	3.06	0.68	1.23	1.71	2.23	2.95	3.58
Stream 2	3.40	4.93	6.63	8.66	11.87	15.36	3.06	5.51	7.66	10.02	13.24	16.05
Stream 3	2.91	4.23	5.68	7.43	10.18	13.18	2.68	4.82	6.69	8.75	11.57	14.03
Stream 4	0.67	0.98	1.31	1.71	2.35	3.05	0.64	1.15	1.60	2.09	2.77	3.36
Stream 5	0.57	0.83	1.12	1.46	2.00	2.59	0.54	0.97	1.35	1.77	2.34	2.83
Stream 6	2.22	3.22	4.32	5.65	7.75	10.03	2.06	3.70	5.15	6.73	8.90	10.79
Stream 7	0.46	0.66	0.89	1.16	1.60	2.07	0.45	0.82	1.13	1.48	1.96	2.38
Stream 8	1.51	2.20	2.95	3.86	5.29	6.85	1.51	2.71	3.77	4.93	6.52	7.91
Stream 9	0.34	0.50	0.67	0.87	1.20	1.55	0.35	0.62	0.87	1.13	1.50	1.82
Stream 10	0.47	0.69	0.93	1.21	1.66	2.15	0.48	0.87	1.20	1.57	2.08	2.52
Stream 11	0.38	0.56	0.75	0.98	1.34	1.73	0.38	0.68	0.94	1.23	1.62	1.97
Stream 12	8.44	12.24	16.44	21.45	29.35	37.91	7.19	12.94	17.98	23.52	31.09	37.70
Stream 13	8.15	11.82	15.86	20.70	28.32	36.59	6.96	12.52	17.40	22.77	30.09	36.49
Stream 14	1.08	1.57	2.11	2.75	3.78	4.89	1.02	1.83	2.54	3.33	4.40	5.33

Table 12 Estimated stormwater flow (m³/s)

Return	Standard design flood method					
	1:2	1:5	1:10	1:20	1:50	1:100
Catchment						
Stream 1	0.35	1.08	1.74	2.50	3.61	4.54
Stream 2	1.57	4.88	7.92	11.33	16.38	20.61
Stream 3	1.37	4.26	6.90	9.87	14.27	17.96
Stream 4	0.27	0.85	1.38	1.98	2.86	3.60
Stream 5	0.27	0.85	1.38	1.98	2.86	3.60
Stream 6	1.07	3.33	5.41	7.73	11.19	14.07
Stream 7	0.24	0.75	1.21	1.74	2.51	3.16
Stream 8	0.79	2.45	3.97	5.68	8.22	10.34
Stream 9	0.18	0.57	0.92	1.31	1.90	2.39
Stream 10	0.25	0.77	1.25	1.79	2.59	3.26
Stream 11	0.20	0.62	1.01	1.44	2.08	2.62
Stream 12	4.04	12.55	20.34	29.10	42.10	52.96
Stream 13	3.99	12.40	20.10	28.76	41.60	52.34
Stream 14	0.53	1.64	2.66	3.81	5.51	6.93

The applications and limitation of flood calculation methods are shown in the table below.

Table 13 Applications and limitation of flood calculation methods

Method	Recommended maximum area (km ²)	Return period of floods that could be determined
Statistical method	No limitation (larger areas)	1:2 to 1:200
Rational method	Usually less than 15km ²	1:2 to 1:200
Unit Hydrograph method	15km ² to 5,000km ²	1:2 to 1:100
Standard Design Flood method	No limitation	1:2 to 1:200
SCS-SA method	Less than 30km ²	1:2 to 1:100
Empirical methods	No limitation (larger areas)	1:10 to 1:100

Flood magnitudes for the 1:100-year floods

The Rational, Alternative Rational (AR), and Standard Design Flood (SDF) methods were used to select the flood peak.

The flow results were similar, therefore, the method with the highest magnitude of the peak flow was used for the 1:100 return flood for a sub-catchment.

The selected maximum peak flow is shown in the table below.

Table 14 Catchment generated estimated 1:100 peak flow

Stream 1	Catchment, estimated 100year peak flow =	4.54	m ³ /s
Stream 2	Catchment, estimated 100year peak flow =	20.61	m ³ /s
Stream 3	Catchment, estimated 100year peak flow =	17.96	m ³ /s
Stream 4	Catchment, estimated 100year peak flow =	3.60	m ³ /s
Stream 5	Catchment, estimated 100year peak flow =	3.60	m ³ /s
Stream 6	Catchment, estimated 100year peak flow =	14.07	m ³ /s
Stream 7	Catchment, estimated 100year peak flow =	3.16	m ³ /s
Stream 8	Catchment, estimated 100year peak flow =	10.34	m ³ /s
Stream 9	Catchment, estimated 100year peak flow =	2.39	m ³ /s
Stream 10	Catchment, estimated 100year peak flow =	3.26	m ³ /s
Stream 11	Catchment, estimated 100year peak flow =	2.62	m ³ /s
Stream 12	Catchment, estimated 100year peak flow =	52.96	m ³ /s
Stream 13	Catchment, estimated 100year peak flow =	52.34	m ³ /s
Stream 14	Catchment, estimated 100year peak flow =	6.93	m ³ /s

The estimated 1:100 stream flow is listed in the table below.

Table 15 Stream 1:100 return peak flow estimates

Stream - Reach	Flow (m³/s)
Stream 1	4.54
Stream 2	20.61
Stream 3	17.96
Stream 4	3.60
Stream 5	3.60
Stream 6	14.07
Stream 7	3.16
Stream 8	10.34
Stream 9	2.39
Stream 10	3.26
Stream 11	2.62
Stream 12	52.96
Stream 13	52.34
Stream 14	6.93

2.2 Flood line Modelling

The HEC-RAS model was used to determine the flood line during the event of a flood for any return period, and in this case the 1:100-year floods were modelled.

2.2.1 Cross section profile

Cross sectional data was generated using GIS and CAD software, as well as the lidar 0.5m contour lines that were obtained from the Bushbuckridge Local Municipality. Sections shown in Annexure 5 were used to approximate the geometry for the river.

2.2.2 Flood profiles

Annexure 4 shows the longitudinal profile for the 1:100 return peak flow.

3.0 CONCLUSION

The determination of the 1:100 return period floodlines was undertaken for the site of the proposed development. The results of this determination provide an indication as to the extent of the areas that will be inundated by the 1:100 return design flood.

It is recommended that a buffer zone of 20m should be provided between the 1:100 flood line and any proposed development.

The lateral extent of the 1:100 return flood line is shown in Annexure 2. These flood lines have also been provided as Gauss Conform WGS84 LO31 coordinated CAD dwg softcopy files.

4.0 REFERENCES

- Smithers J.C. and Schulze R.E. (2002): Drainage rainfall and flood estimation in South Africa, WRC project KS/1060.
- The South African National Roads Agency Limited (2013): Drainage manual, 6th Edition.

ANNEXURE 1: FLOODLINE CERTIFICATE



Branch Offices
Polokwane, Limpopo

DALIMEDE PROJECTS (PTY) LTD
No. 11 Pierre street,
IT Park RentCo Building, Office 6,
Bendor, Polokwane, South Africa, 0699
Tel: 015 291 0775, Cell: 079 368 8414,
E-mail: admin@dalimede.com

Reg. No: 2014 / 233383 / 07

FLOOD LINE CERTIFICATE

Dalimede Projects (PTY) LTD was appointed by Real Development Planning Company to undertake floodline assessment relating to the proposed township development situated for Greater Seville Ext 1 on the Remainder of Portion 2 and Portion 3 of the Farm Seville 224 KU, Mpumalanga Province.

This will entail to delineate the 1:100 return flood line.

Site: *Remainder of Portion 2 and Portion 3 of the Farm Seville 224 KU, Mpumalanga Province*

Township Name: *Greater Seville Ext 1*

Co-ordinates: *24°39'17.10"S 31°24'20.76"E*

Municipality: *Bushbuckridge Local Municipality*

In terms of section 114 of the National Water Act, Act 36 of 1998 the above-mentioned property is affected by flood water within the 1:100 period from the stream / river as indicated in the floodline report. Development must be done outside of the floodline.

It is recommended that a buffer zone of 20m should be provided between the 1:100 flood line and any proposed development.

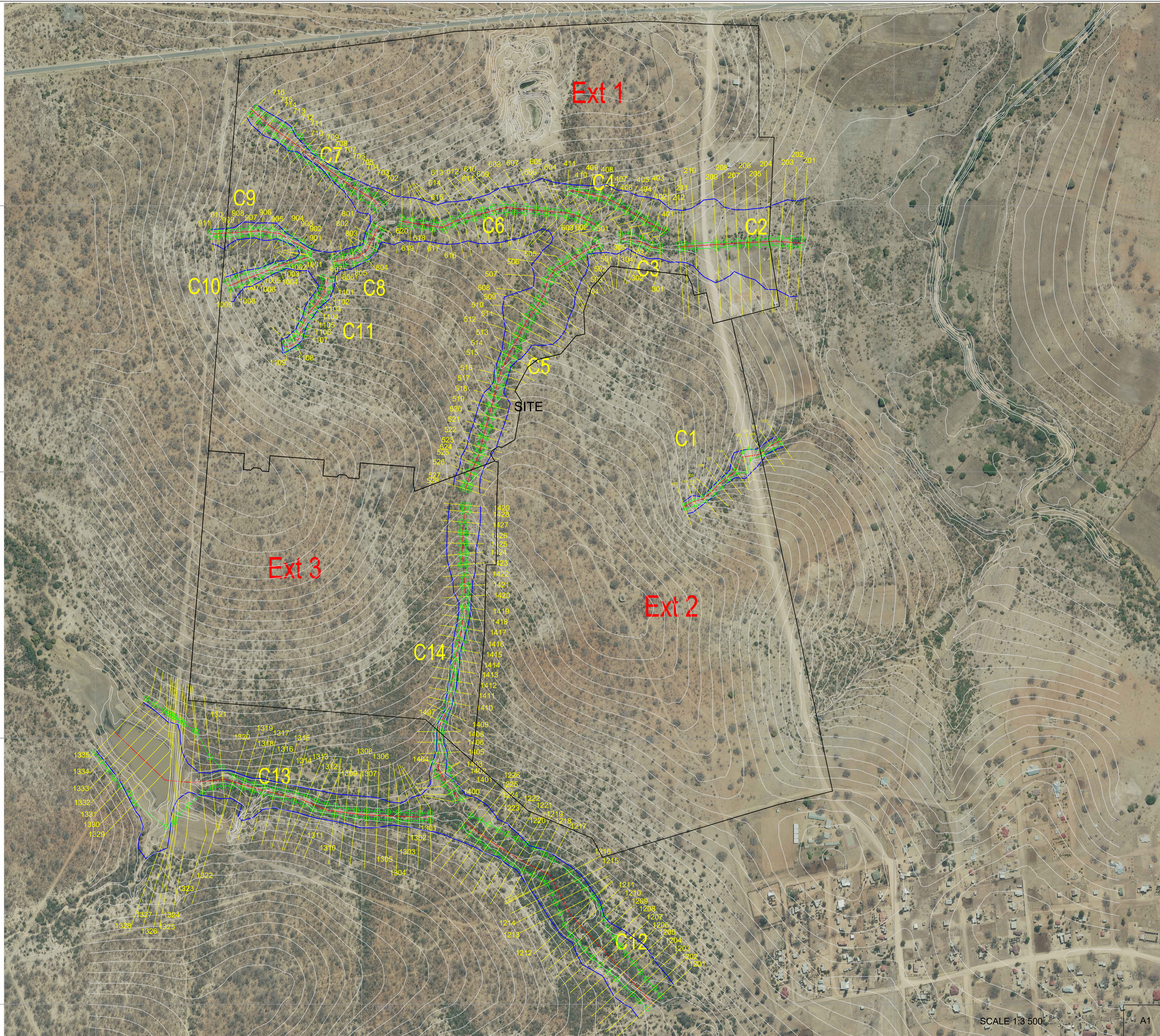
Thus, done and signed in Polokwane..... on this day 2022 / 11 / 14.....

Signature: 

Engineer: Litmos Mthunzi
Pr Tech Eng




Pr no.: ECSA 201770075.....

ANNEXURE 2: FLOODLINE DELINEATION



NOTES

KEY

-  FLOODLINE
-  CROSS SECTION
-  STREAM / RIVER

REVISIONS

REV	DATE	SIGN	DESCRIPTION
0

CLIENT

Bushbuckridge Local Municipality
 R533 Graskop Main Road
 Bushbuckridge
 1280



Tel: 013 065 0814

CONSULTANT



Dalimede Projects (PTY) LTD
 No. 11 Pierre street, IT Park RentCo Building, Office 6,
 Bendor, Polokwane, South Africa, 0699

Tel: 015 291 0775, Cell: 079 368 8414,
 E-mail: admin@dalimede.com
 GPS; Lat: -23.894692 Long: 29.479758

DRAWING STATUS

FOR INFORMATION

PROJECT TITLE

Proposed township development situated on a portion of portion 1, 2 and 3 of the farm Seville 224 KU, Mpumalanga Province

PROJECT LOCATION

The proposed township is situated in 145km north of Mbombela along the R40, in Mpumalanga Province, South Africa. GPS coordinates of site are 24°39'30.99"S 31°24'34.87"E.

DRAWING DESCRIPTION

FLOODLINE DELINEATION 1:100 RETURN PERIOD

SCALE	DATE	DESIGNED	DRAWN	CHECKED
As Shown	Sept 2022	LM	AK	CM

DRAWING No. SEVILLE/FL/01	REVISION B
-------------------------------------	----------------------

SCALE 1:3 500 A1

ANNEXURE 3: HEC-RAS PROGRAMME MODELLING RESULTS

HEC-RAS Plan: Current mode River: Stream C1 Reach: 1 Profile: 1:100yr

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
1	112	1:100yr	4.54	406.62	406.88	406.88	406.95	0.030796	1.42	4.53	32.09	0.97
1	111	1:100yr	4.54	404.65	405.05	405.05	405.16	0.028075	1.58	3.41	15.72	0.96
1	110	1:100yr	4.54	402.27	402.76	402.76	402.90	0.030404	1.67	2.74	10.27	1.00
1	109	1:100yr	4.54	400.93	401.39	401.39	401.53	0.028716	1.67	2.82	10.62	0.98
1	108	1:100yr	4.54	399.80	400.26	400.26	400.40	0.028527	1.70	2.88	10.69	0.98
1	107	1:100yr	4.54	398.88	399.31	399.31	399.46	0.026947	1.71	2.82	10.79	0.96
1	106	1:100yr	4.54	398.07	398.85		398.88	0.002176	0.76	7.47	17.96	0.31
1	105	1:100yr	4.54	398.00	398.87	398.65	398.87	0.000037	0.12	43.98	67.84	0.04
1	104.5		Culvert									
1	104	1:100yr	4.54	395.88	396.40	396.40	396.66	0.025898	2.23	2.04	9.90	1.01
1	103	1:100yr	4.54	395.20	395.78		395.87	0.015503	1.40	3.58	11.53	0.74
1	102	1:100yr	4.54	394.77	395.34	395.34	395.46	0.027696	1.62	3.16	13.52	0.96
1	101	1:100yr	4.54	394.09	394.57	394.57	394.69	0.030008	1.66	3.06	12.44	0.99

HEC-RAS Plan: Current mode River: Stream C2 Reach: 2 Profile: 1:100

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
2	212	1:100	20.61	394.67	395.58		395.65	0.006737	1.49	24.07	74.86	0.55
2	211	1:100	20.61	394.55	395.58		395.60	0.002314	0.95	37.53	85.85	0.33
2	210	1:100	20.61	394.31	395.39	395.39	395.49	0.018394	1.83	20.11	92.90	0.79
2	209.5		Culvert									
2	209	1:100	20.61	393.79	395.34	395.34	395.41	0.014304	1.55	26.25	152.60	0.66
2	208	1:100	20.61	393.50	393.96		394.02	0.016343	1.63	22.68	97.30	0.79
2	207	1:100	20.61	393.21	393.61		393.67	0.019203	1.58	21.47	92.07	0.83
2	206	1:100	20.61	392.91	393.28		393.33	0.015064	1.37	23.38	94.38	0.73
2	205	1:100	20.61	392.61	392.95		393.00	0.017443	1.41	23.24	105.74	0.78
2	204	1:100	20.61	392.30	392.63		392.67	0.014887	1.27	25.41	114.25	0.72
2	203	1:100	20.61	392.00	392.27		392.32	0.021428	1.37	23.10	117.81	0.84
2	202	1:100	20.61	391.57	391.83		391.87	0.023805	1.33	23.48	131.90	0.86
2	201	1:100	20.61	391.15	391.36	391.32	391.40	0.023014	1.08	25.36	151.81	0.81

HEC-RAS Plan: Current mode River: Stream C3 Reach: 3 Profile: 1:100

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
3	305	1:100	17.96	396.15	397.41	397.23	397.49	0.010885	1.37	15.83	40.63	0.65
3	304	1:100	17.96	396.00	396.86	396.86	397.16	0.022888	2.45	7.59	13.08	0.99
3	303	1:100	17.96	395.99	396.69		396.78	0.007700	1.45	16.12	41.28	0.58
3	302	1:100	17.96	395.71	396.45		396.58	0.012184	1.80	14.67	45.07	0.72
3	301	1:100	17.96	395.12	396.06	396.06	396.30	0.019022	2.27	9.73	26.77	0.90

HEC-RAS Plan: Current mode River: Stream C4 Reach: 4 Profile: 1:100

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
4	411	1:100	3.60	399.00	399.40	399.31	399.44	0.009975	1.01	4.06	18.00	0.58
4	410	1:100	3.60	398.79	399.08	399.06	399.16	0.021609	1.26	3.13	17.05	0.82
4	409	1:100	3.60	398.50	398.95		398.97	0.004468	0.75	5.47	21.90	0.40
4	408	1:100	3.60	398.20	398.55	398.54	398.63	0.022331	1.24	3.22	21.12	0.83
4	407	1:100	3.60	397.91	398.16		398.21	0.018693	1.08	4.02	26.50	0.75
4	406	1:100	3.60	397.62	397.90		397.93	0.011059	0.90	5.85	43.88	0.59
4	405	1:100	3.60	397.34	397.58	397.57	397.63	0.020765	1.13	4.53	37.61	0.79
4	404	1:100	3.60	397.05	397.26	397.21	397.28	0.014272	0.84	6.33	54.78	0.63
4	403	1:100	3.60	396.66	396.83	396.83	396.87	0.031344	1.18	4.70	50.13	0.93
4	402	1:100	3.60	396.26	396.45		396.47	0.012317	0.82	6.78	52.48	0.60
4	401	1:100	3.60	395.80	395.98	395.98	396.03	0.045182	1.27	3.94	39.45	1.09

HEC-RAS Plan: Current mode River: Stream C5 Reach: 5 Profile: 1:100

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)	
5	528	1:100	3.60	414.15	414.47		414.51	0.011296	0.97	4.93	30.61	0.60
5	527	1:100	3.60	414.03	414.30	414.28	414.35	0.021085	1.13	4.14	30.29	0.79
5	526	1:100	3.60	413.69	413.95		414.00	0.014303	1.00	4.12	22.81	0.66
5	525	1:100	3.60	413.34	413.64		413.70	0.016315	1.08	3.89	23.90	0.71
5	524	1:100	3.60	412.99	413.20	413.20	413.26	0.030014	1.25	3.66	28.10	0.93
5	523	1:100	3.60	412.64	412.87	412.85	412.92	0.022120	1.16	3.92	27.49	0.81
5	522	1:100	3.60	412.11	412.34	412.34	412.41	0.030580	1.24	3.75	31.71	0.93
5	521	1:100	3.60	411.54	411.75	411.75	411.81	0.029016	1.19	3.79	30.70	0.90
5	520	1:100	3.60	410.95	411.15	411.15	411.21	0.031471	1.19	3.78	33.16	0.93
5	519	1:100	3.60	410.22	410.43	410.43	410.50	0.031073	1.23	3.43	26.99	0.94
5	518	1:100	3.60	409.44	409.69	409.69	409.77	0.032769	1.28	3.09	20.88	0.96
5	517	1:100	3.60	408.28	408.59	408.59	408.69	0.035069	1.39	2.59	13.37	1.01
5	516	1:100	3.60	407.42	407.81	407.81	407.93	0.033384	1.51	2.38	10.48	1.01
5	515	1:100	3.60	406.79	407.15	407.13	407.24	0.023827	1.27	2.84	12.89	0.85
5	514	1:100	3.60	406.28	406.68	406.66	406.76	0.023432	1.24	2.93	14.08	0.84
5	513	1:100	3.60	405.86	406.27		406.31	0.020695	0.99	3.95	22.75	0.76
5	512	1:100	3.60	405.57	405.92	405.88	405.96	0.014633	0.95	4.43	28.13	0.66
5	511	1:100	3.60	405.27	405.59	405.55	405.64	0.017730	1.01	4.17	35.63	0.72
5	510	1:100	3.60	404.93	405.05	405.05	405.09	0.046466	1.01	4.95	71.38	1.04
5	509	1:100	3.60	404.23	404.35	404.34	404.37	0.027949	0.84	6.10	78.09	0.82
5	508	1:100	3.60	403.43	403.51	403.51	403.55	0.062169	0.68	4.18	47.94	1.05
5	507	1:100	3.60	401.97	402.03	401.99	402.05	0.023744	0.31	5.53	48.95	0.60
5	506	1:100	3.60	401.36	401.50	401.49	401.52	0.034020	0.98	5.55	71.86	0.92
5	505	1:100	3.60	400.70	400.83	400.80	400.86	0.029184	0.65	4.64	37.48	0.78
5	504	1:100	3.60	400.12	400.28		400.31	0.026708	0.84	4.90	43.78	0.80
5	503	1:100	3.60	399.44	399.61	399.61	399.66	0.040286	1.20	3.86	36.49	1.03
5	502	1:100	3.60	397.99	398.31	398.31	398.43	0.031361	1.56	2.34	9.99	0.99
5	501	1:100	3.60	396.99	397.72		397.72	0.000867	0.46	8.96	18.44	0.19

HEC-RAS Plan: Current mode River: Stream C6 Reach: 6 Profile: 1:100

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)	
6	620	1:100	14.07	405.09	405.60	405.59	405.70	0.017717	1.64	12.78	57.57	0.82
6	619	1:100	14.07	404.97	405.26		405.31	0.019740	1.19	14.12	60.99	0.78
6	618	1:100	14.07	404.60	404.84		404.90	0.022227	1.24	14.51	69.00	0.83
6	617	1:100	14.07	404.20	404.53		404.57	0.012356	1.15	17.23	68.66	0.65
6	616	1:100	14.07	403.74	404.16	404.16	404.26	0.021851	1.66	12.59	67.83	0.88
6	615	1:100	14.07	403.31	403.73		403.81	0.018666	1.55	13.82	62.64	0.82
6	614	1:100	14.07	402.91	403.35	403.31	403.44	0.017920	1.61	12.35	48.54	0.82
6	613	1:100	14.07	402.57	403.00		403.08	0.018032	1.55	13.72	63.04	0.81
6	612	1:100	14.07	402.23	402.62	402.59	402.70	0.019847	1.53	13.77	62.75	0.84
6	611	1:100	14.07	401.89	402.26		402.33	0.017104	1.46	14.25	61.59	0.78
6	610	1:100	14.07	401.61	402.00		402.05	0.011014	1.22	18.03	81.53	0.63
6	609	1:100	14.07	401.35	401.75		401.81	0.013739	1.37	16.61	79.42	0.71
6	608	1:100	14.07	401.08	401.38		401.45	0.025182	1.50	14.37	77.40	0.91
6	607	1:100	14.07	400.73	400.91		400.96	0.023398	1.04	15.00	79.05	0.81
6	606	1:100	14.07	400.34	400.46	400.41	400.51	0.021247	0.74	14.31	74.32	0.71
6	605	1:100	14.07	399.95	400.10		400.15	0.015562	0.76	14.29	62.58	0.64
6	604	1:100	14.07	399.53	399.85		399.89	0.010717	1.04	16.91	65.58	0.60
6	603	1:100	14.07	399.12	399.46	399.45	399.56	0.027106	1.75	11.97	54.59	0.97
6	602	1:100	14.07	398.59	398.95	398.92	399.04	0.024619	1.72	11.89	48.14	0.93
6	601	1:100	14.07	398.04	398.35	398.35	398.45	0.035153	1.86	11.14	54.00	1.09

HEC-RAS Plan: Current mode River: Stream C7 Reach: 7 Profile: 1:100

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)	
7	716	1:100	3.16	418.65	418.77	418.77	418.81	0.040682	1.06	4.12	51.66	1.00
7	715	1:100	3.16	417.77	417.90	417.90	417.94	0.035786	1.01	4.08	49.20	0.94
7	714	1:100	3.16	416.77	416.90	416.90	416.95	0.046545	1.03	3.62	43.52	1.04
7	713	1:100	3.16	415.71	415.86	415.86	415.92	0.036268	1.02	3.35	36.16	0.95
7	712	1:100	3.16	414.62	414.77	414.77	414.82	0.039924	1.05	3.20	30.62	0.99
7	711	1:100	3.16	413.18	413.39	413.39	413.46	0.038016	1.19	2.66	18.92	1.00
7	710	1:100	3.16	411.58	411.95	411.95	412.07	0.033020	1.53	2.06	8.78	1.01
7	709	1:100	3.16	410.40	410.88	410.88	411.04	0.031315	1.72	1.83	6.17	1.01
7	708	1:100	3.16	409.80	410.23		410.30	0.014343	1.20	2.64	8.67	0.69
7	707	1:100	3.16	409.49	410.01		410.05	0.010291	0.94	3.36	12.41	0.58
7	706	1:100	3.16	409.19	409.60	409.60	409.70	0.035179	1.39	2.27	11.72	1.01
7	705	1:100	3.16	408.79	409.10		409.15	0.020480	1.04	3.03	16.18	0.77
7	704	1:100	3.16	408.23	408.54	408.54	408.61	0.037181	1.23	2.59	18.38	1.00
7	703	1:100	3.16	407.64	407.85	407.84	407.91	0.028741	1.09	3.06	23.75	0.88
7	702	1:100	3.16	407.00	407.19	407.19	407.25	0.037292	1.13	3.04	25.76	0.98
7	701	1:100	3.16	405.75	406.23		406.24	0.002345	0.52	6.23	20.43	0.29

HEC-RAS Plan: Current mode River: Stream C8 Reach: 8 Profile: 1:100

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
8	807	1:100	10.34	407.73	408.15	408.13	408.27	0.025947	1.70	7.41	29.01	0.95
8	806	1:100	10.34	407.13	407.64	407.64	407.80	0.028989	1.77	6.15	21.59	1.00
8	805	1:100	10.34	406.56	407.12	407.09	407.24	0.022185	1.50	7.03	24.65	0.87
8	804	1:100	10.34	406.03	406.56	406.56	406.72	0.030124	1.73	5.98	19.85	1.01
8	803	1:100	10.34	405.65	406.26		406.32	0.008561	1.11	9.29	23.21	0.56
8	802	1:100	10.34	405.31	405.96		406.08	0.016113	1.58	6.55	16.12	0.78
8	801	1:100	10.34	405.00	405.94		405.96	0.002103	0.75	18.73	54.59	0.30

HEC-RAS Plan: Current mode River: Stream C9 Reach: 9 Profile: 1:100

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
9	911	1:100	2.39	418.10	418.25	418.25	418.30	0.042134	1.16	2.84	33.08	1.03
9	910	1:100	2.39	417.41	417.57	417.57	417.62	0.043233	1.15	2.63	27.40	1.04
9	909	1:100	2.39	416.42	416.60	416.60	416.66	0.042663	1.15	2.50	23.68	1.04
9	908	1:100	2.39	415.61	415.80	415.80	415.85	0.032475	1.05	2.67	24.37	0.92
9	907	1:100	2.39	414.89	415.06	415.06	415.12	0.036350	1.12	2.43	22.32	0.97
9	906	1:100	2.39	413.96	414.15	414.15	414.22	0.036856	1.15	2.22	17.88	0.98
9	905	1:100	2.39	413.06	413.21	413.21	413.26	0.037735	1.06	2.79	29.89	0.97
9	904	1:100	2.39	411.35	411.64	411.64	411.72	0.037346	1.27	1.88	11.68	1.01
9	903	1:100	2.39	410.00	410.35	410.32	410.44	0.023545	1.32	1.82	7.53	0.86
9	902	1:100	2.39	409.44	409.77	409.77	409.86	0.036179	1.35	1.78	9.85	1.01
9	901	1:100	2.39	408.85	409.20		409.23	0.008590	0.85	3.29	14.46	0.53

HEC-RAS Plan: Current mode River: Stream C10 Reach: 10 Profile: 1:100

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)	
10	1009	1:100	3.26	417.30	417.45	417.45	417.50	0.035425	1.10	3.76	39.29	0.96
10	1008	1:100	3.26	416.14	416.29	416.29	416.35	0.040958	1.13	3.42	33.10	1.02
10	1007	1:100	3.26	414.95	415.14	415.14	415.20	0.032875	1.11	3.43	32.91	0.93
10	1006	1:100	3.26	412.99	413.37	413.37	413.48	0.033991	1.48	2.20	10.07	1.01
10	1005	1:100	3.26	411.23	411.78	411.78	411.94	0.030684	1.77	1.84	5.91	1.01
10	1004	1:100	3.26	410.65	411.13		411.20	0.014640	1.17	2.82	10.51	0.70
10	1003	1:100	3.26	410.24	410.71	410.69	410.81	0.025538	1.41	2.32	9.23	0.90
10	1002	1:100	3.26	409.69	410.12	410.12	410.23	0.034301	1.44	2.28	11.71	1.01
10	1001	1:100	3.26	408.96	409.30		409.36	0.016013	1.12	3.41	17.50	0.71

HEC-RAS Plan: Current mode River: Stream C11 Reach: 11 Profile: 1:100

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)	
11	1109	1:100	2.62	415.17	415.20	415.20	415.26	0.068942	0.33	2.29	17.88	0.91
11	1108	1:100	2.62	413.74	414.00	414.00	414.07	0.031757	1.23	2.40	18.00	0.94
11	1107	1:100	2.62	412.36	412.75	412.75	412.86	0.033537	1.49	1.76	7.90	1.01
11	1106	1:100	2.62	411.44	411.82	411.82	411.93	0.032905	1.45	1.80	8.27	1.00
11	1105	1:100	2.62	410.83	411.29		411.37	0.023633	1.26	2.08	9.22	0.85
11	1104	1:100	2.62	410.34	410.70	410.70	410.79	0.036726	1.29	2.03	12.13	1.01
11	1103	1:100	2.62	409.81	410.06	410.05	410.12	0.029001	1.13	2.36	15.51	0.89
11	1102	1:100	2.62	409.15	409.39	409.39	409.47	0.037238	1.20	2.21	16.14	1.00
11	1101	1:100	2.62	408.57	408.95		408.98	0.008866	0.78	3.79	19.44	0.52

HEC-RAS Plan: Current mode River: Stream C12 Reach: 12 Profile: 1:100yr

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
12	1226	1:100yr	52.96	397.00	398.24		398.34	0.005454	1.53	42.07	71.35	0.49
12	1225	1:100yr	52.96	397.00	398.22		398.26	0.002001	1.04	63.31	74.39	0.31
12	1224	1:100yr	52.96	397.00	398.13		398.21	0.003499	1.27	46.60	59.49	0.40
12	1223	1:100yr	52.96	396.99	397.93		398.08	0.011204	1.77	32.00	53.11	0.67
12	1222	1:100yr	52.96	396.69	397.62		397.82	0.015834	1.97	27.93	50.89	0.78
12	1221	1:100yr	52.96	396.13	397.52		397.62	0.005335	1.39	38.69	49.46	0.47
12	1220	1:100yr	52.96	396.00	397.30		397.46	0.010934	1.75	30.20	41.76	0.66
12	1219	1:100yr	52.96	396.00	396.94	396.86	397.17	0.018845	2.15	24.87	41.56	0.85
12	1218	1:100yr	52.96	396.00	396.71		396.84	0.012364	1.66	35.00	65.11	0.68
12	1217	1:100yr	52.96	395.86	396.55		396.63	0.007839	1.36	43.38	73.29	0.55
12	1216	1:100yr	52.96	395.85	396.43		396.50	0.006516	1.27	46.88	80.72	0.50
12	1215	1:100yr	52.96	395.48	396.32		396.38	0.005313	1.15	51.11	86.61	0.45
12	1214	1:100yr	52.96	395.32	396.23		396.28	0.004536	1.08	53.67	89.43	0.42
12	1213	1:100yr	52.96	395.15	396.16		396.20	0.002824	0.92	61.18	89.65	0.34
12	1212	1:100yr	52.96	394.86	396.14		396.16	0.001120	0.68	81.75	91.29	0.22
12	1211	1:100yr	52.96	394.35	396.13		396.15	0.000613	0.59	92.55	81.97	0.17
12	1210	1:100yr	52.96	394.00	396.10		396.13	0.000951	0.74	73.01	62.90	0.21
12	1209	1:100yr	52.96	394.00	396.09		396.11	0.000751	0.68	82.94	74.78	0.19
12	1208	1:100yr	52.96	394.00	396.06		396.09	0.001208	0.78	74.82	84.59	0.24
12	1207	1:100yr	52.96	394.22	396.00		396.05	0.003100	1.07	54.43	83.64	0.36
12	1206	1:100yr	52.96	394.00	395.92		395.99	0.003367	1.15	50.86	78.24	0.38
12	1205	1:100yr	52.96	394.01	395.84		395.91	0.004197	1.25	48.18	80.22	0.42
12	1204	1:100yr	52.96	394.00	395.72		395.81	0.005866	1.42	42.66	76.41	0.49
12	1203	1:100yr	52.96	394.00	395.42	395.38	395.61	0.017125	2.02	29.48	73.80	0.81
12	1202	1:100yr	52.96	394.00	395.16		395.32	0.011948	1.81	33.14	65.32	0.69
12	1201	1:100yr	52.96	393.85	395.01	394.78	395.12	0.007503	1.56	40.97	73.49	0.56

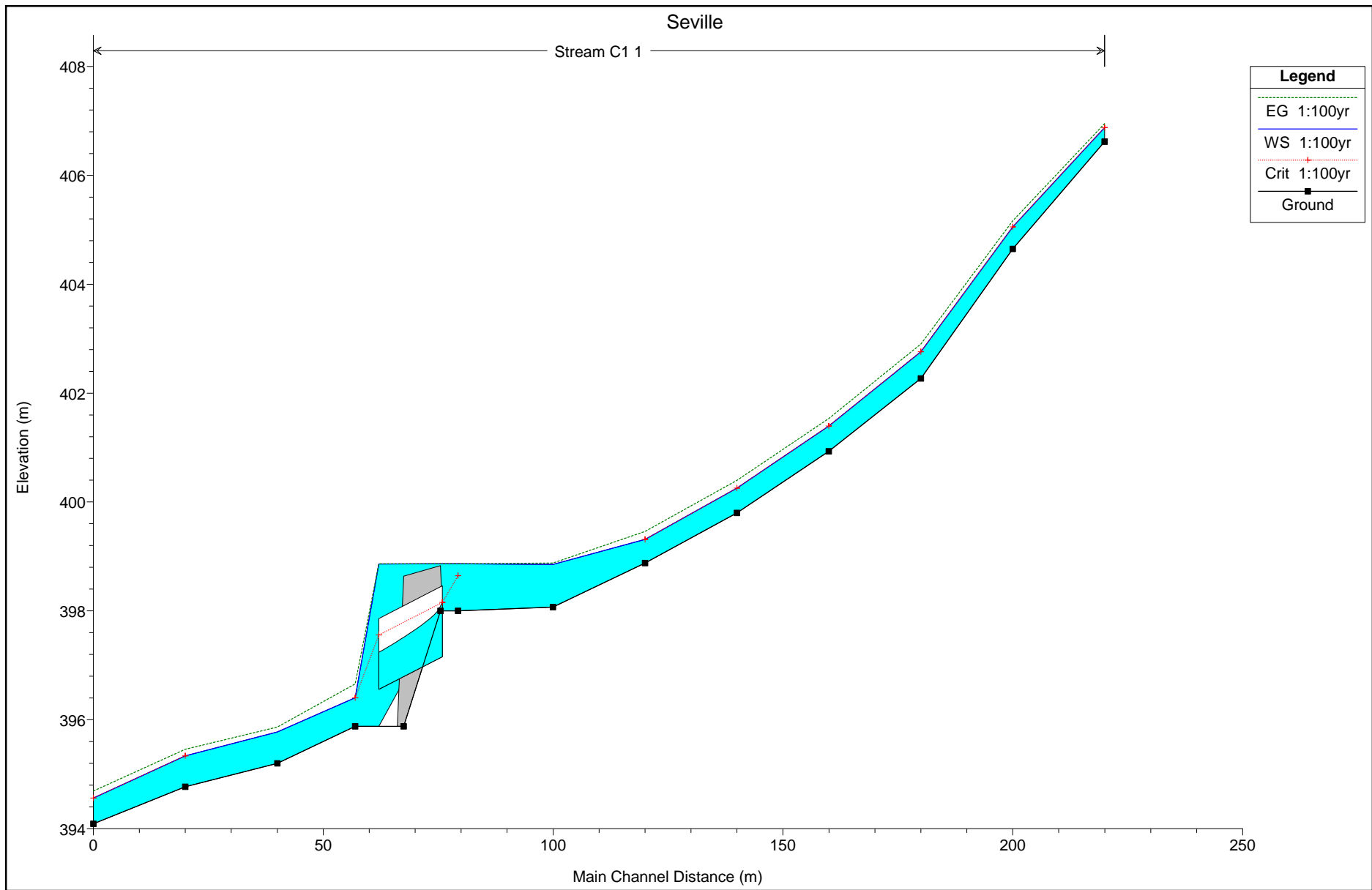
HEC-RAS Plan: Current mode River: Stream C13 Reach: 13 Profile: 1:100yr

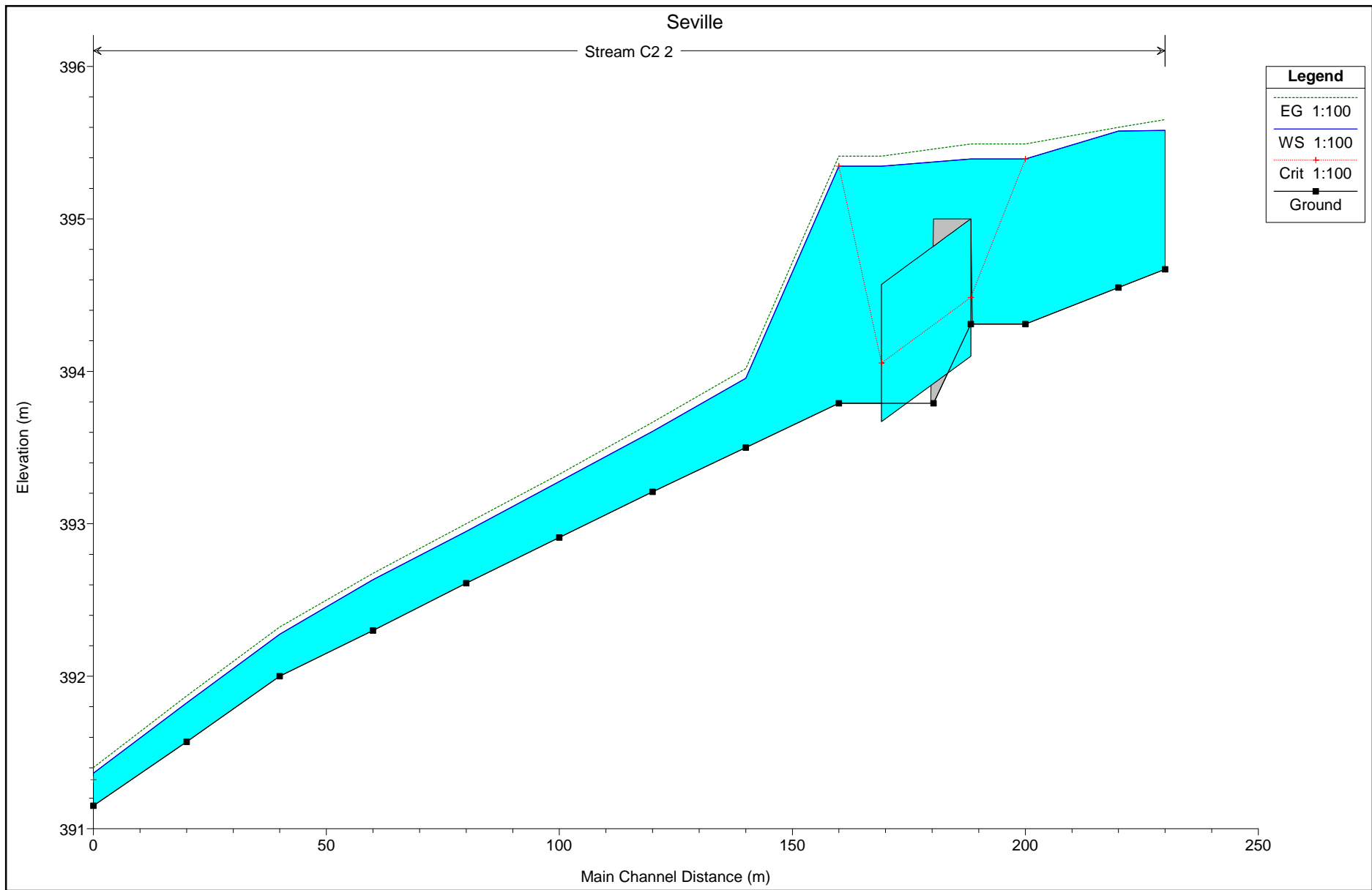
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
13	1335	1:100yr	52.34	403.00	405.55		405.56	0.000058	0.24	218.01	117.21	0.06
13	1334	1:100yr	52.34	403.00	405.55		405.55	0.000046	0.22	238.01	121.43	0.05
13	1333	1:100yr	52.34	403.00	405.55		405.55	0.000040	0.21	252.44	128.11	0.05
13	1332	1:100yr	52.34	403.00	405.55		405.55	0.000040	0.21	254.97	130.66	0.05
13	1331	1:100yr	52.34	403.00	405.55		405.55	0.000037	0.19	269.05	140.74	0.04
13	1330	1:100yr	52.34	403.00	405.55		405.55	0.000030	0.18	296.63	155.60	0.04
13	1329	1:100yr	52.34	403.00	405.55		405.55	0.000024	0.16	327.33	169.78	0.04
13	1328	1:100yr	52.34	403.00	405.55		405.55	0.000025	0.15	355.84	230.05	0.04
13	1327	1:100yr	52.34	405.01	405.40	405.40	405.53	0.034517	1.71	33.16	122.03	1.01
13	1326	1:100yr	52.34	404.19	404.76	404.76	404.94	0.032597	1.87	27.96	79.65	1.01
13	1325	1:100yr	52.34	402.72	403.35	403.35	403.56	0.030812	2.01	26.10	64.21	1.00
13	1324	1:100yr	52.34	400.90	402.10	402.10	402.39	0.027185	2.40	21.82	37.30	1.00
13	1323	1:100yr	52.34	400.00	401.53		401.68	0.008117	1.71	30.83	37.54	0.58
13	1322	1:100yr	52.34	400.00	401.33		401.50	0.008879	1.92	29.89	38.27	0.62
13	1321	1:100yr	52.34	399.99	401.20		401.34	0.006701	1.70	35.27	46.34	0.54
13	1320	1:100yr	52.34	399.73	401.01		401.19	0.008148	2.03	31.52	42.40	0.61
13	1319	1:100yr	52.34	399.41	400.83		401.02	0.009065	2.16	31.43	42.28	0.64
13	1318	1:100yr	52.34	399.08	400.85		400.90	0.002050	1.18	65.83	75.68	0.32
13	1317	1:100yr	52.34	398.00	400.85		400.87	0.000447	0.80	88.08	51.52	0.16
13	1316	1:100yr	52.34	398.19	400.77		400.85	0.001703	1.39	50.06	43.47	0.31
13	1315	1:100yr	52.34	398.54	400.69		400.80	0.002954	1.62	41.55	41.42	0.39
13	1314	1:100yr	52.34	398.88	400.60		400.73	0.004667	1.78	37.47	41.94	0.48
13	1313	1:100yr	52.34	399.00	400.50		400.64	0.004742	1.77	36.95	41.56	0.48
13	1312	1:100yr	52.34	399.00	400.41		400.54	0.004740	1.75	37.55	41.00	0.48
13	1311	1:100yr	52.34	398.95	400.29		400.44	0.005357	1.82	36.17	43.09	0.51
13	1310	1:100yr	52.34	398.80	400.15		400.32	0.006562	2.00	33.55	41.03	0.56
13	1309	1:100yr	52.34	398.66	400.06		400.19	0.005411	1.84	38.24	45.13	0.51
13	1308	1:100yr	52.34	398.51	399.97		400.08	0.004610	1.73	41.21	47.86	0.47
13	1307	1:100yr	52.34	398.37	399.88		399.99	0.004386	1.72	41.85	49.22	0.47
13	1306	1:100yr	52.34	398.22	399.73		399.89	0.005887	1.96	35.69	44.00	0.54
13	1305	1:100yr	52.34	398.08	399.33	399.33	399.68	0.017735	2.81	23.51	37.35	0.89
13	1304	1:100yr	52.34	397.81	398.87	398.87	399.23	0.019888	2.86	22.28	33.56	0.93
13	1303	1:100yr	52.34	397.42	398.68		398.88	0.009762	2.25	30.46	41.10	0.67
13	1302	1:100yr	52.34	397.04	398.63		398.73	0.004141	1.67	44.91	55.44	0.45
13	1301	1:100yr	52.34	397.00	398.56		398.65	0.003731	1.59	49.10	62.34	0.43

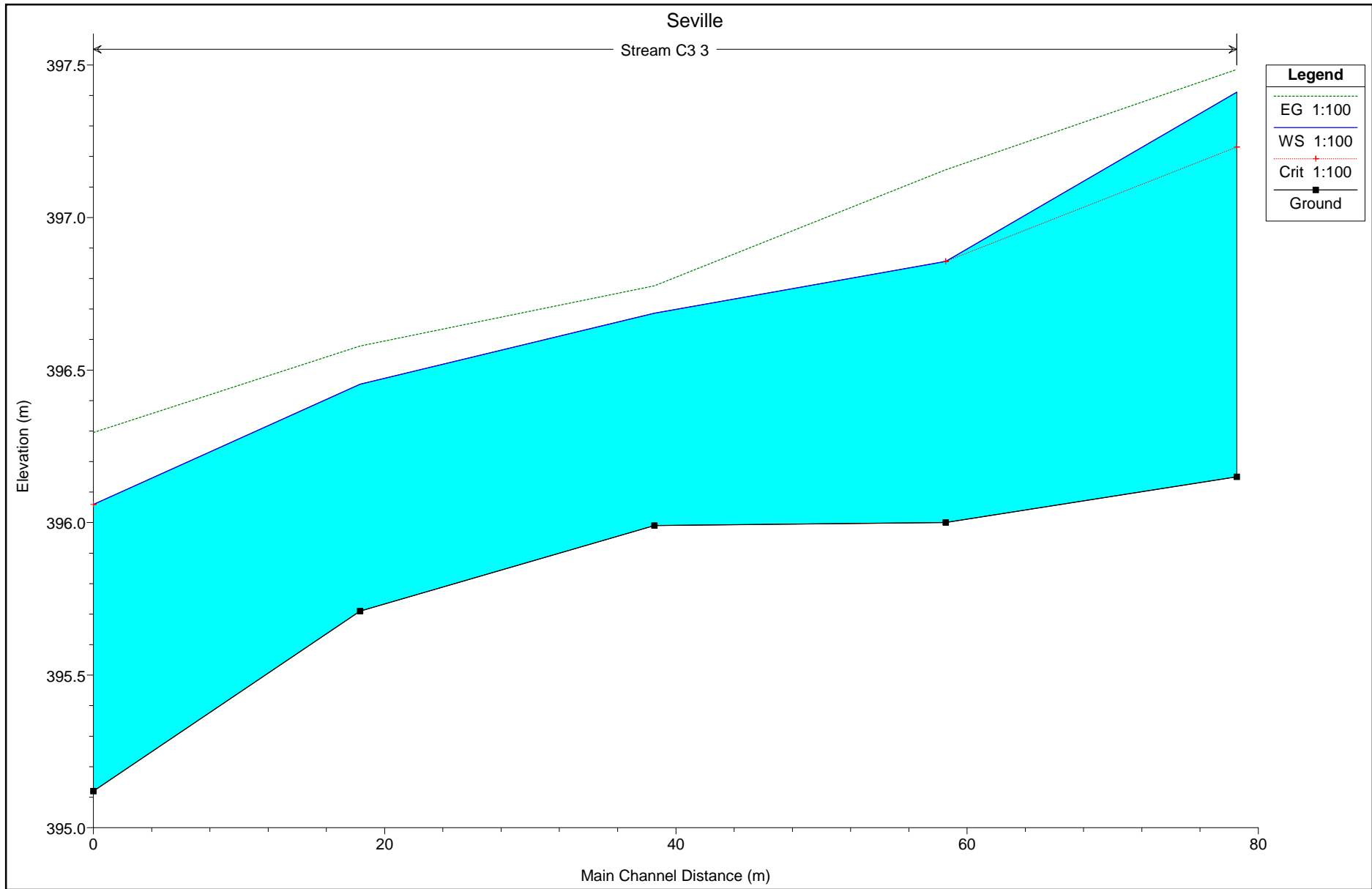
HEC-RAS Plan: Current mode River: Stream C14 Reach: 14 Profile: 1:100yr

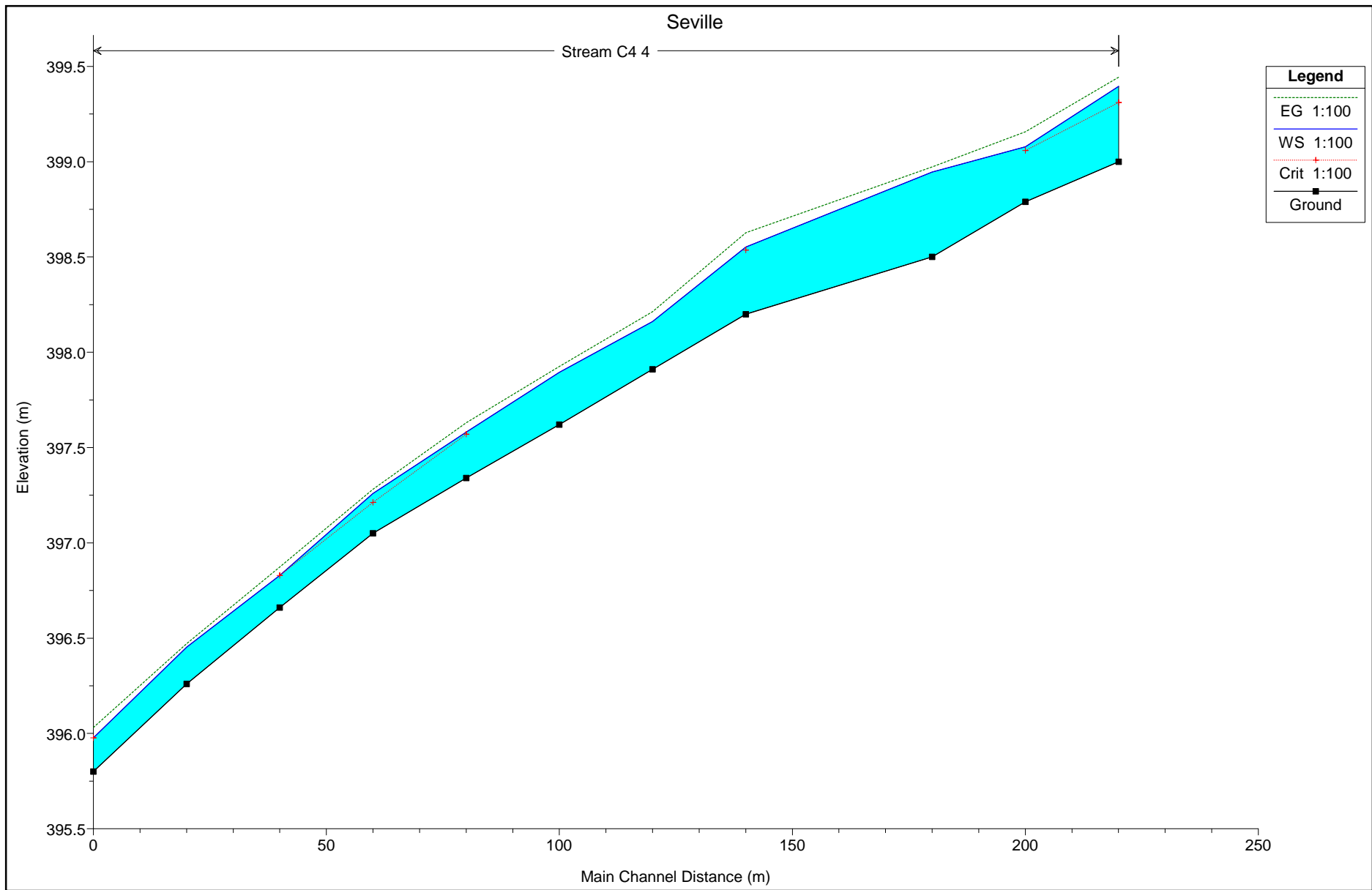
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
14	1429	1:100yr	6.93	414.13	414.51		414.56	0.015518	1.25	8.01	41.66	0.69
14	1428	1:100yr	6.93	413.96	414.27		414.33	0.023157	1.33	7.25	40.57	0.81
14	1427	1:100yr	6.93	413.55	413.89		413.94	0.016770	1.23	7.85	40.37	0.71
14	1426	1:100yr	6.93	413.13	413.41	413.41	413.49	0.032634	1.44	6.63	42.29	0.95
14	1425	1:100yr	6.93	412.62	412.90		412.95	0.022078	1.24	7.27	38.35	0.79
14	1424	1:100yr	6.93	412.06	412.36	412.35	412.44	0.029154	1.48	6.14	35.02	0.91
14	1423	1:100yr	6.93	411.42	411.73	411.73	411.83	0.032420	1.59	5.63	29.79	0.97
14	1422	1:100yr	6.93	410.71	411.02	411.02	411.13	0.031204	1.64	5.47	26.90	0.96
14	1421	1:100yr	6.93	409.85	410.23	410.23	410.36	0.029820	1.69	4.88	21.10	0.95
14	1420	1:100yr	6.93	408.95	409.37	409.37	409.50	0.027487	1.71	4.71	19.43	0.92
14	1419	1:100yr	6.93	407.27	407.92	407.90	408.07	0.026238	1.71	4.19	12.62	0.91
14	1418	1:100yr	6.93	406.53	407.32	407.32	407.49	0.031836	1.80	3.93	12.95	0.98
14	1417	1:100yr	6.93	405.99	406.49	406.46	406.62	0.022845	1.65	4.58	14.50	0.85
14	1416	1:100yr	6.93	405.33	405.93	405.93	406.10	0.029288	1.84	4.02	12.92	0.96
14	1415	1:100yr	6.93	404.58	405.16	405.16	405.33	0.030734	1.87	3.77	11.35	0.98
14	1414	1:100yr	6.93	403.62	404.24	404.24	404.42	0.031485	1.84	3.82	11.86	0.99
14	1413	1:100yr	6.93	402.78	403.42	403.38	403.57	0.023477	1.73	4.03	10.76	0.87
14	1412	1:100yr	6.93	402.31	403.15		403.24	0.011172	1.33	5.25	11.77	0.62
14	1411	1:100yr	6.93	401.74	402.65	402.65	402.87	0.033274	2.04	3.40	8.26	1.01
14	1410	1:100yr	6.93	401.00	401.80		401.93	0.016075	1.56	4.43	9.59	0.73
14	1409	1:100yr	6.93	400.60	401.27	401.27	401.49	0.029100	2.10	3.38	8.08	0.98
14	1408	1:100yr	6.93	400.00	400.67	400.63	400.83	0.023359	1.78	3.90	9.40	0.87
14	1407	1:100yr	6.93	399.58	400.12	400.12	400.30	0.030108	1.89	3.81	11.19	0.98
14	1406	1:100yr	6.93	399.00	399.79		399.87	0.009059	1.26	5.59	11.86	0.56
14	1405	1:100yr	6.93	399.00	399.65		399.71	0.006797	1.02	6.77	14.60	0.48
14	1404	1:100yr	6.93	398.99	399.43		399.51	0.016060	1.24	5.59	17.35	0.70
14	1403	1:100yr	6.93	398.53	398.94	398.94	399.06	0.030994	1.60	4.69	20.43	0.95
14	1402	1:100yr	6.93	398.00	398.58		398.63	0.006131	0.97	7.90	22.56	0.46
14	1401	1:100yr	6.93	397.97	398.48		398.51	0.005216	0.91	10.58	45.86	0.42
14	1400	1:100yr	6.93	397.85	398.46		398.46	0.000950	0.42	25.19	78.95	0.18

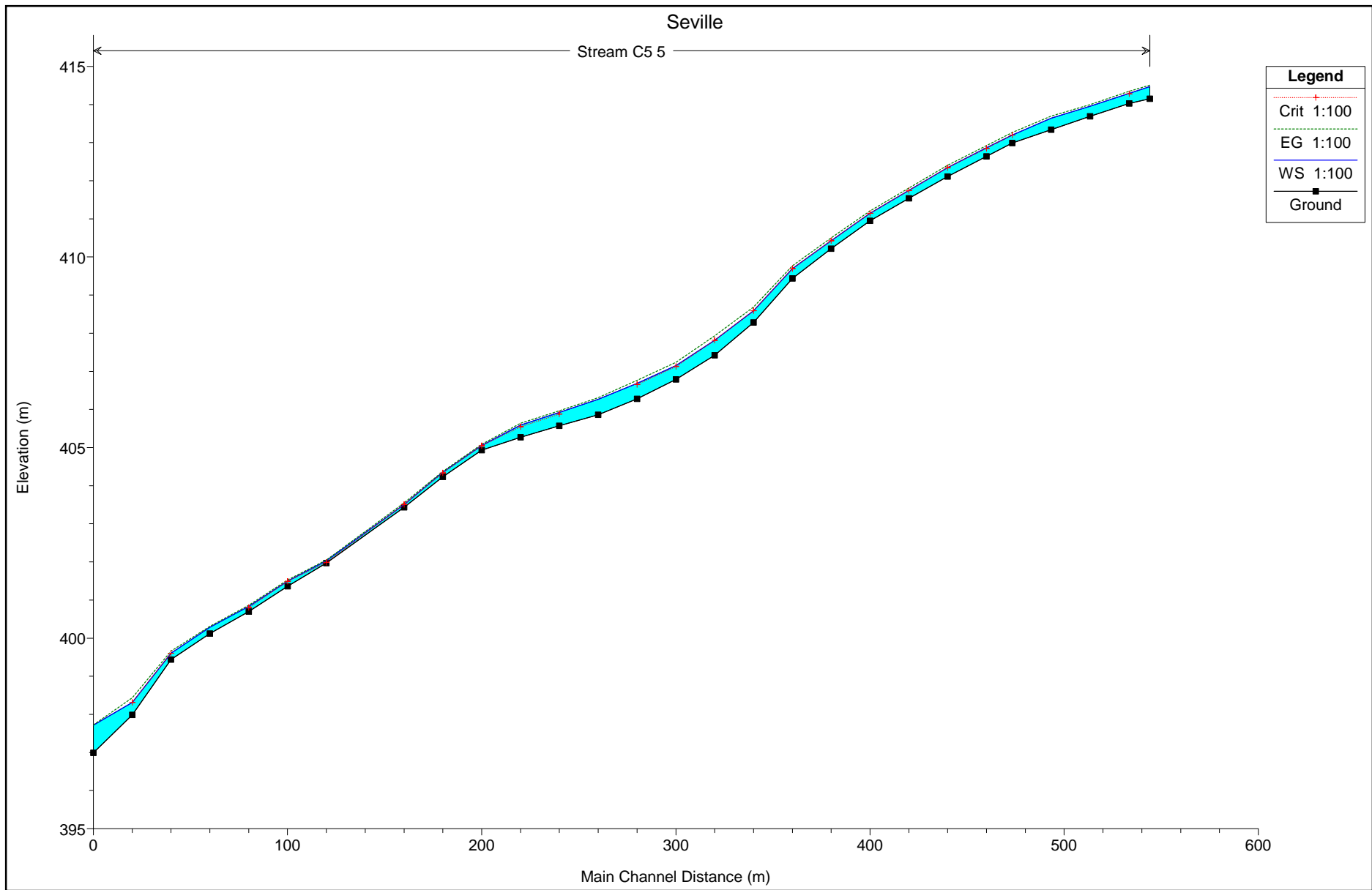
ANNEXURE 4: LONGITUDINAL FLOW PROFILE FOR THE FLOOD PEAK

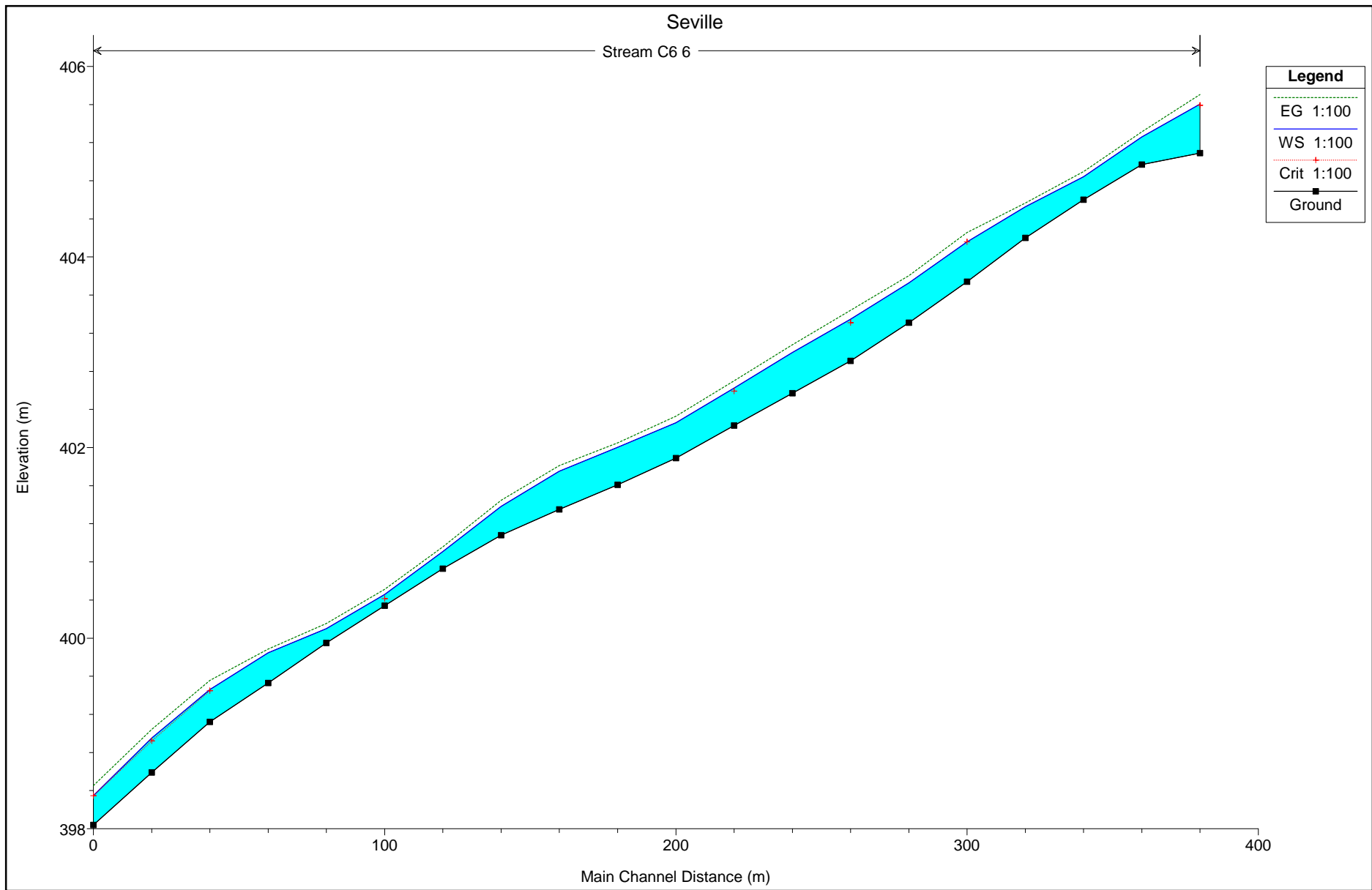


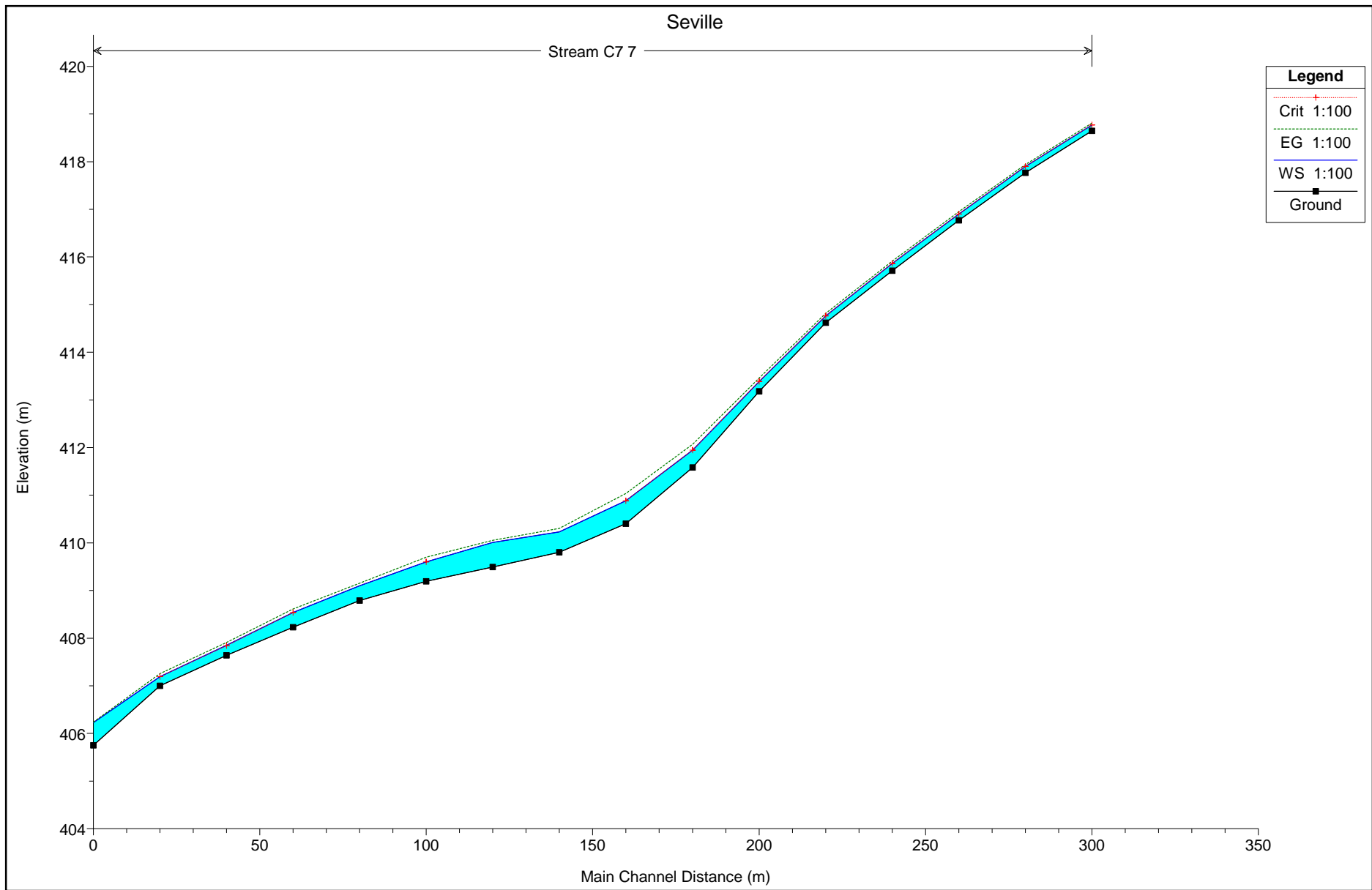


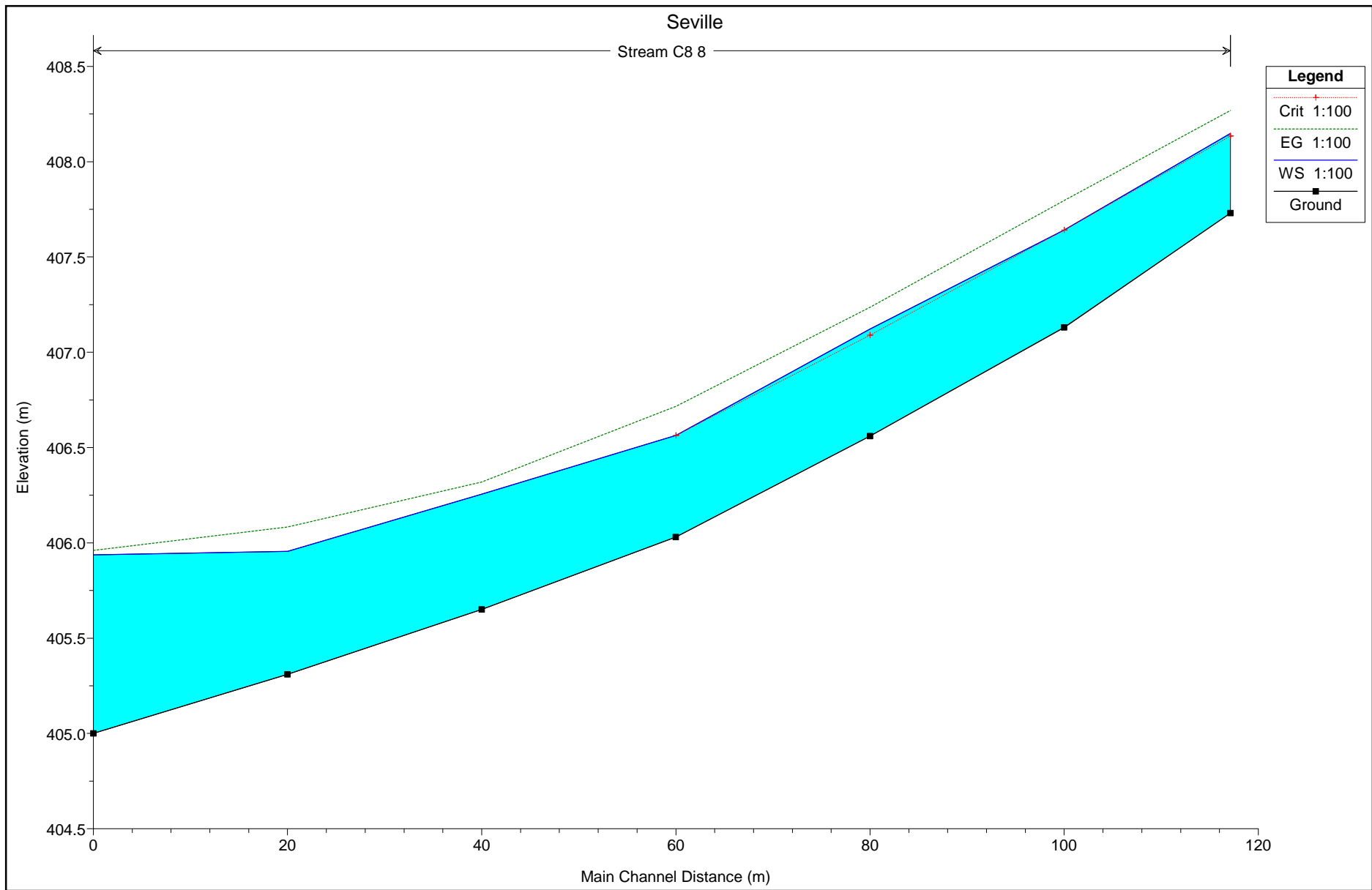


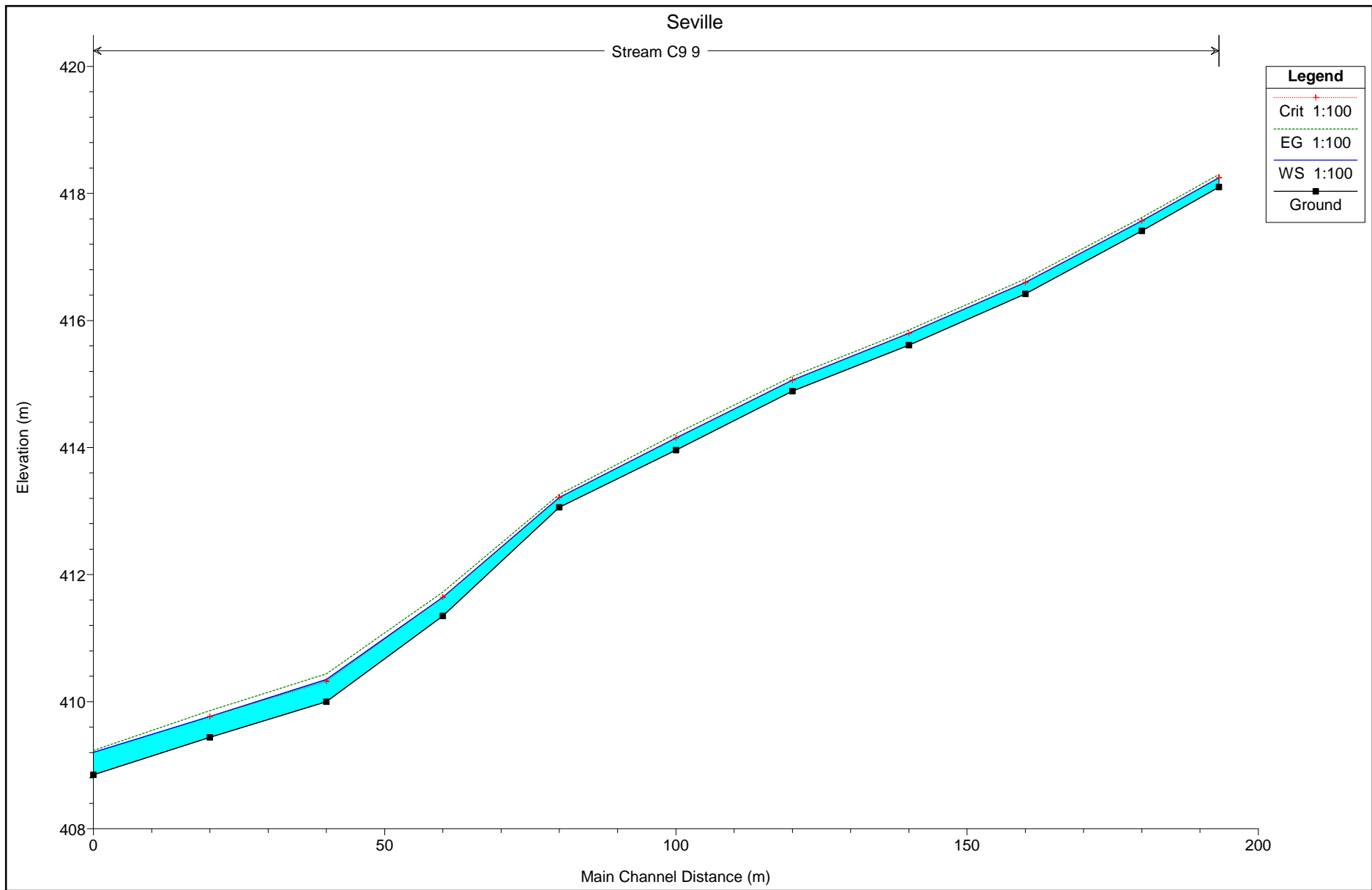


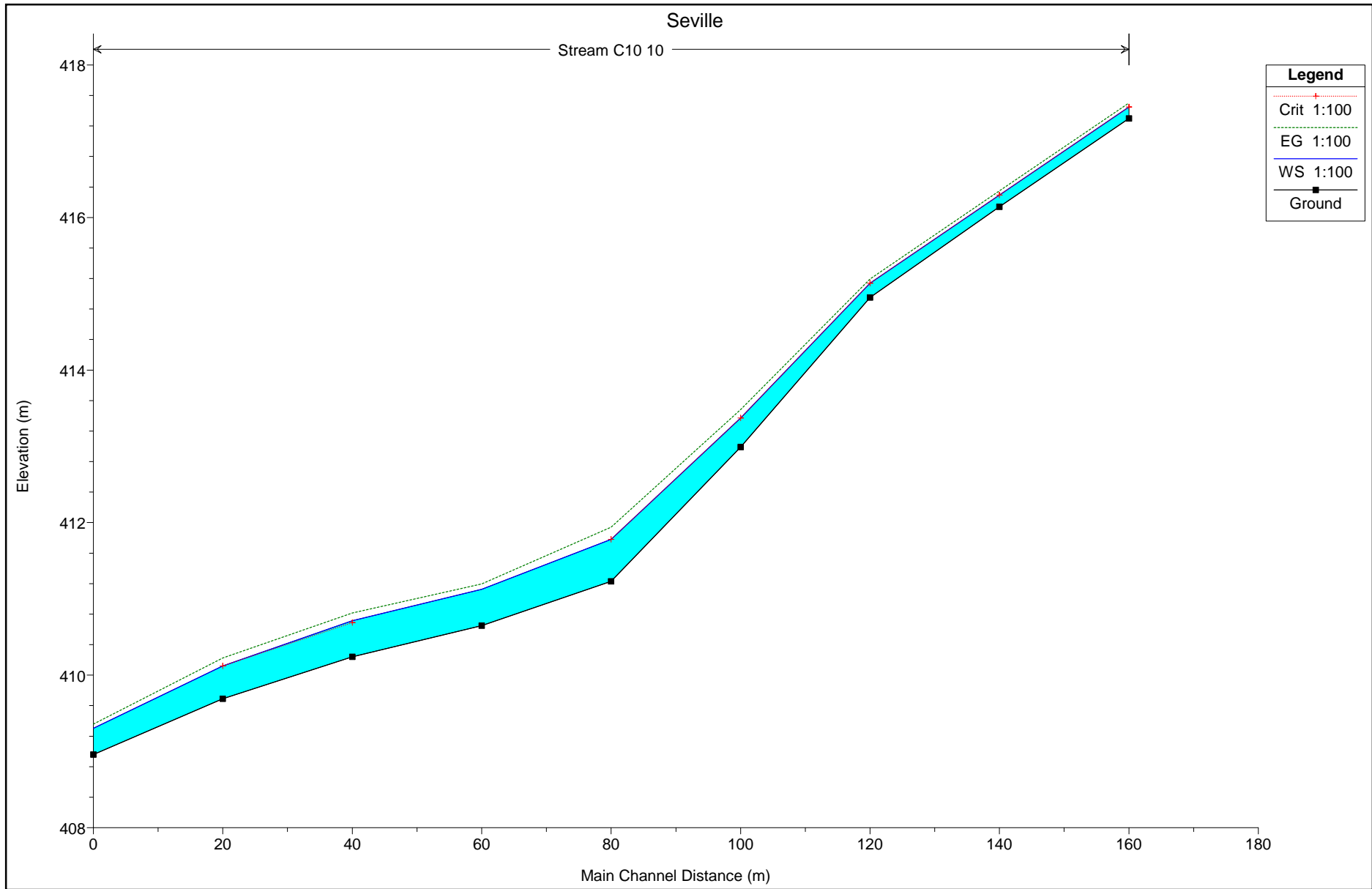


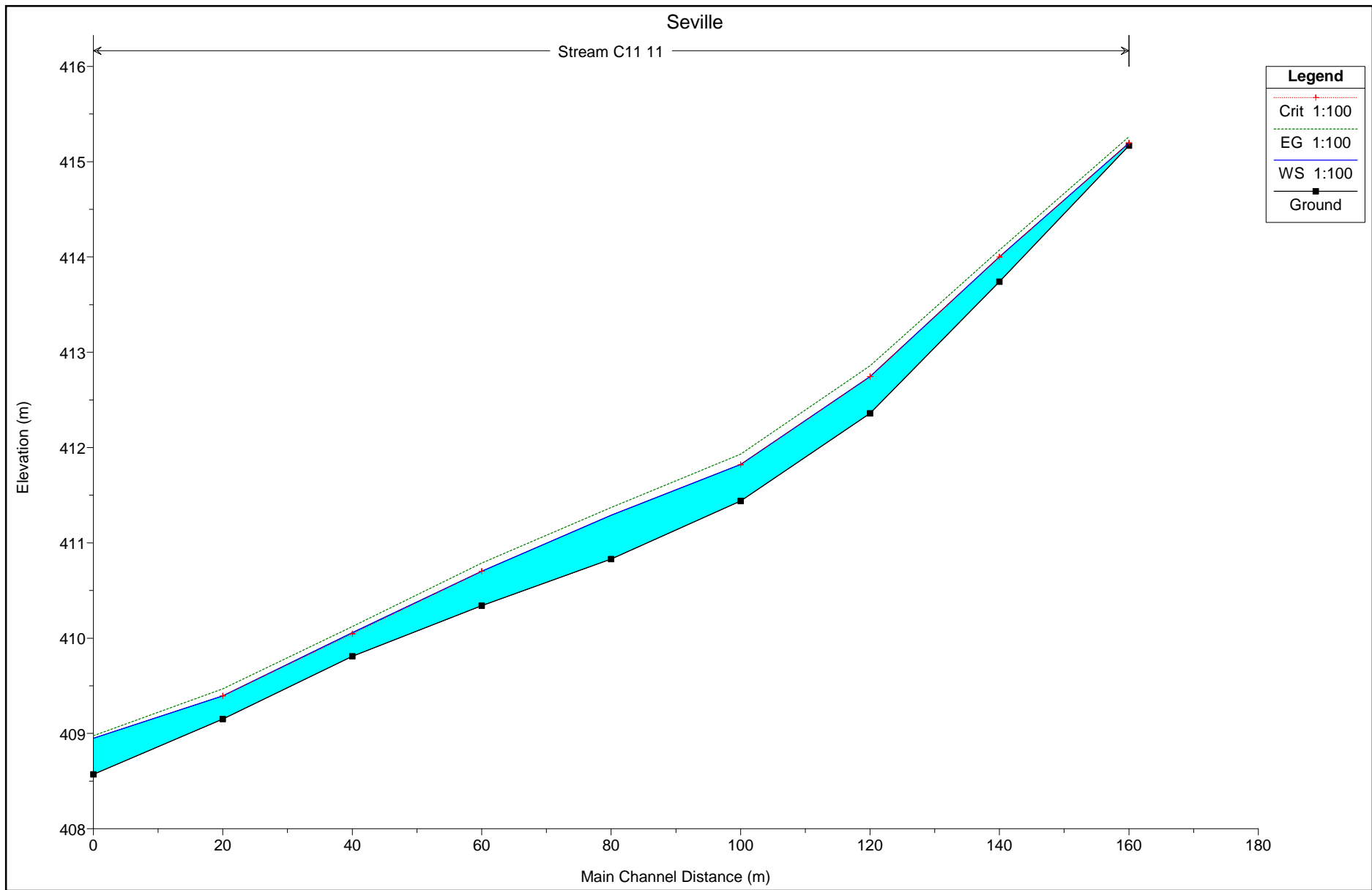


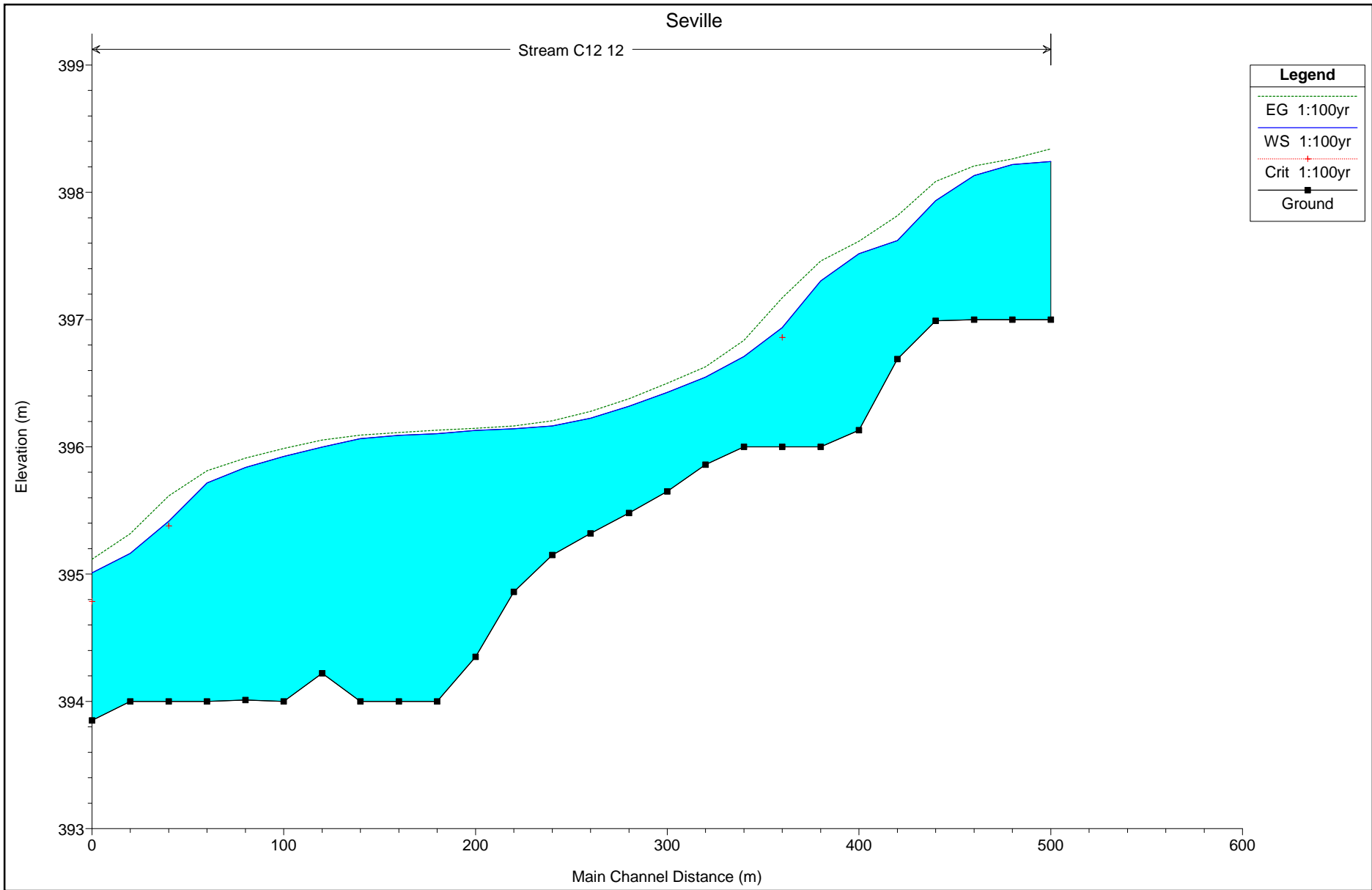


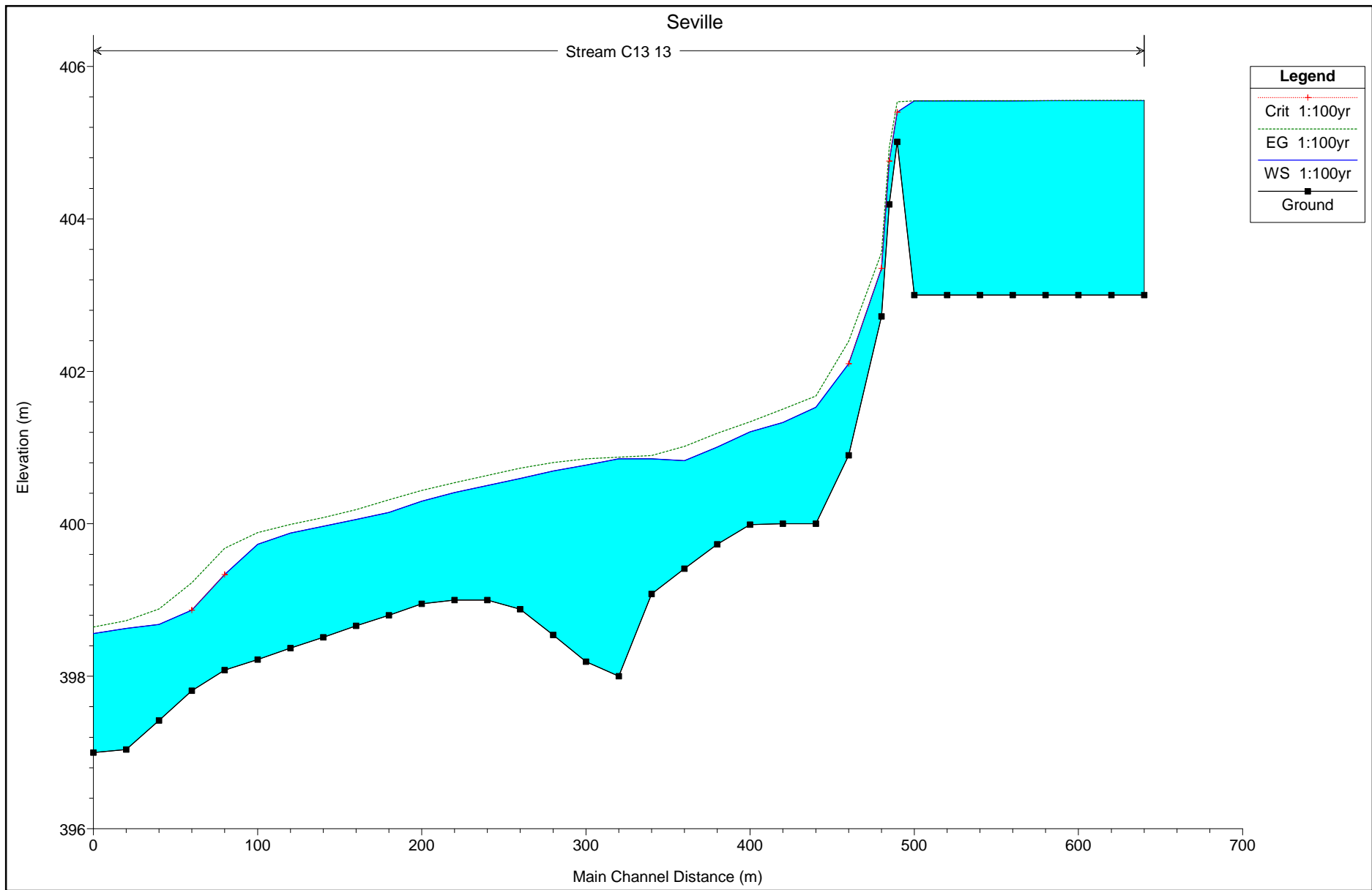


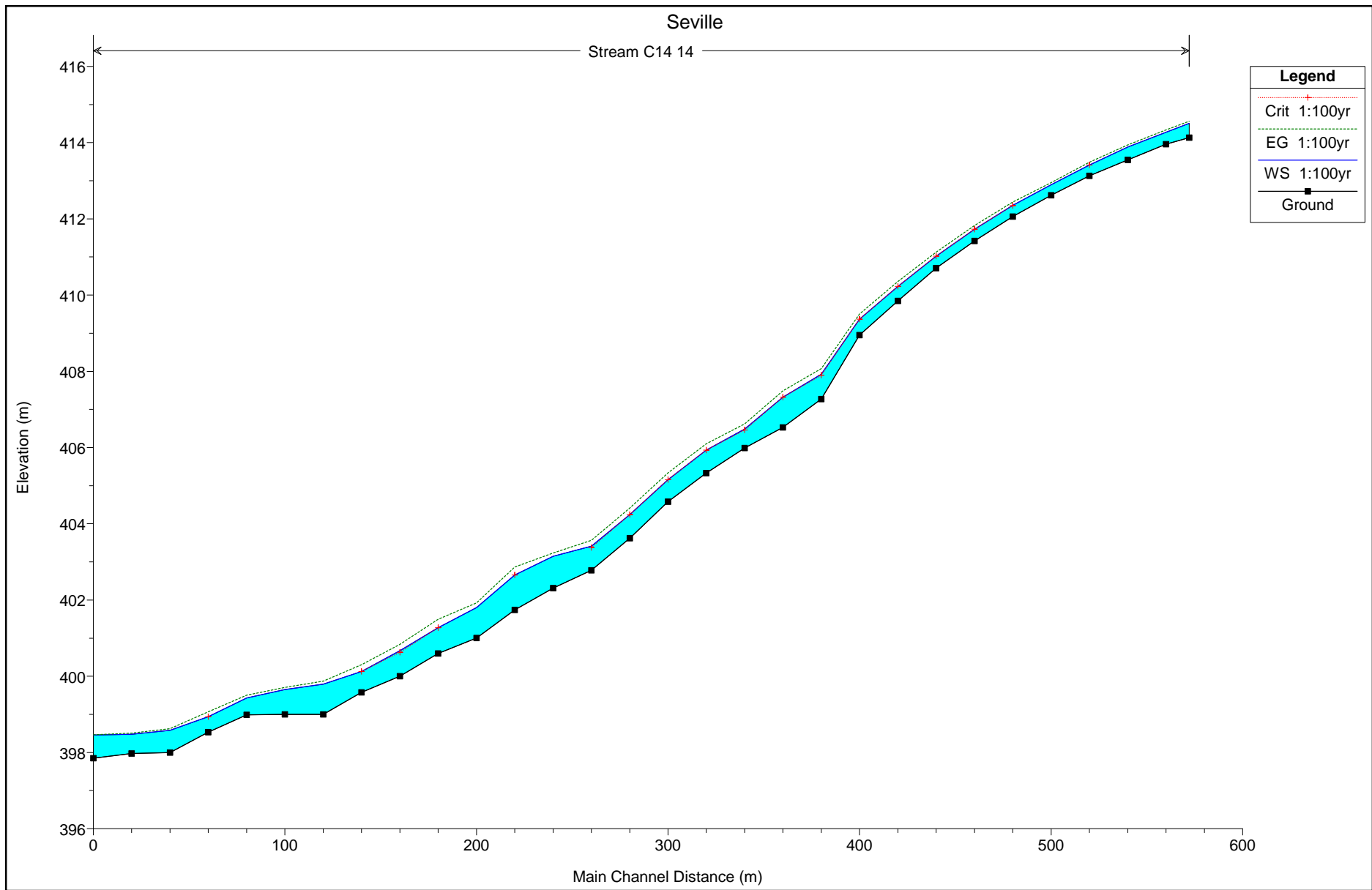












ANNEXURE 5: FLOW CROSS SECTIONS FOR THE FLOOD PEAK

