PROPOSED ELECTRICAL LINE OF 2×400 KV FROM ARIES SUBSTATION NEAR KENHARDT TO UPINGTON SUBSTATION NEAR UPINGTON (145 KM LINE).

FLOODLINE REPORT

COMPILED FOR
VOMBE PTY LTD ON BEHALF OF ESKOM HOLDINGS SOC LTD

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COMPILED BY
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SOLUTION FOR SUSTAINABLE DEVELOPMENT

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1. INTRODUCTION AND BACKGROUND.

1.1 Background information

Flood line determination or study forms part of the specialist studies required for the proposed construction of the Eskom powelines 400kv and 132 kv that traverse from Aries Substation near Kenhardt to Upington Substation in the Northern Cape Province of South Africa, See Figure 1.1. these lines will cross over the Orange river before they connect to the Upington Substation.

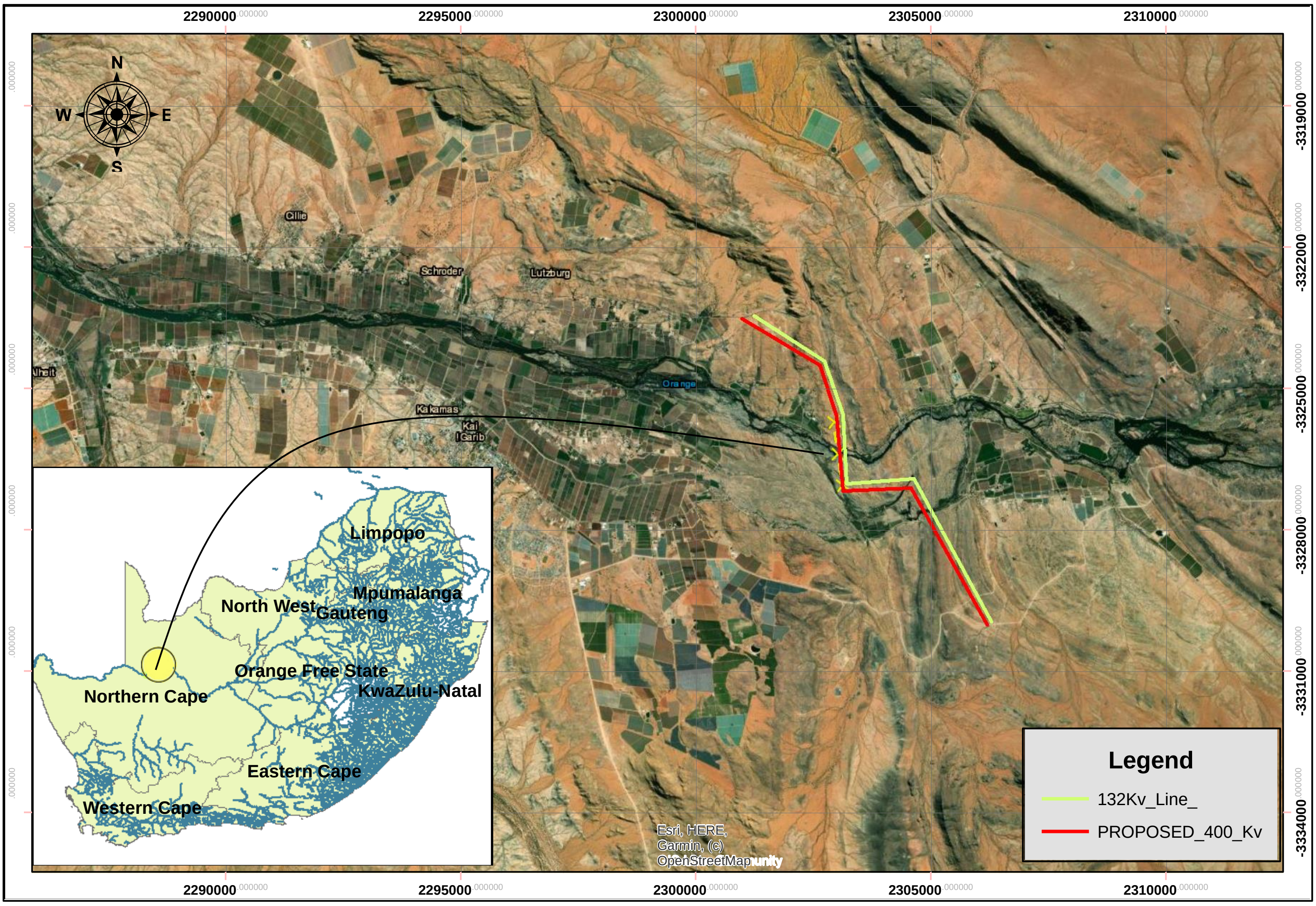


Figure 1.1: Locality Plan of the study area.

1.2 Legal Framework

It should be noted that the specialist studies for any activities which trigger EIA regulation listing notices does not require the further studies to be conducted, rather the screening tool report gives a hint on which further studies are required. This is based on the impact which the activities pose on the environment which are undertaken.

In this case the proposed powerlines will cross over the Orange River. National Water Act regulation with regards to water uses might be considered. Furthermore, the proposed activity will be undertaken, in this regard crossing the significant river. Damage to infrastructure may occur if floods occur. It is necessary to determine the flood potential along the proposed route.

Part 3: Information on bloodlines, floods, and droughts (National Water Act 36 of 1998). Part 3 requires certain information relating to j700Ls, droughts and potential risks to be made available to the public. Township layout plans must indicate a specific floodline. Water management institutions must use tie most appropriate means to inform the public about anticipated floods, droughts t r risks posed by water quality, the failure of any dam or any other waterworks or my other related matter. The Minister may establish early warning systems to anticipate such events.
Section 144 of this act mainly refers to undertaking flood assessment for the development of the township.

1.3 Purpose of the study.

A 100-year flood is a flood event that has a 1% probability of occurring in any given year. The 100-year flood is also referred to as the 1% flood, since its annual exceedance probability is 1%, or as having a return interval of 100-years. The 100-year flood is generally expressed as a flow rate (m^3/s). Based on the expected 100-year flood flow rate in a given stream or river, the flood's water level can be mapped as an area of inundation. The purpose of the study is to identify the potential flood return in year 1:100 yr and demarcate areas that may be impacted along the Orange river, such areas will be pertaining to the powerlines crossing the river. Such information will enable the developer to execute mitigation measures with regard to how best can the powerline not to be impacted by such natural disaster

2. DESCRIPTION OF THE STUDY AREA.

2.1 Locality

The proposed site is located near the town of Kakamas in the Northern Cape Province, see Figure 2.1. the ain land uses in the area is agriculture (crops) and Orange River is used for irrigation.

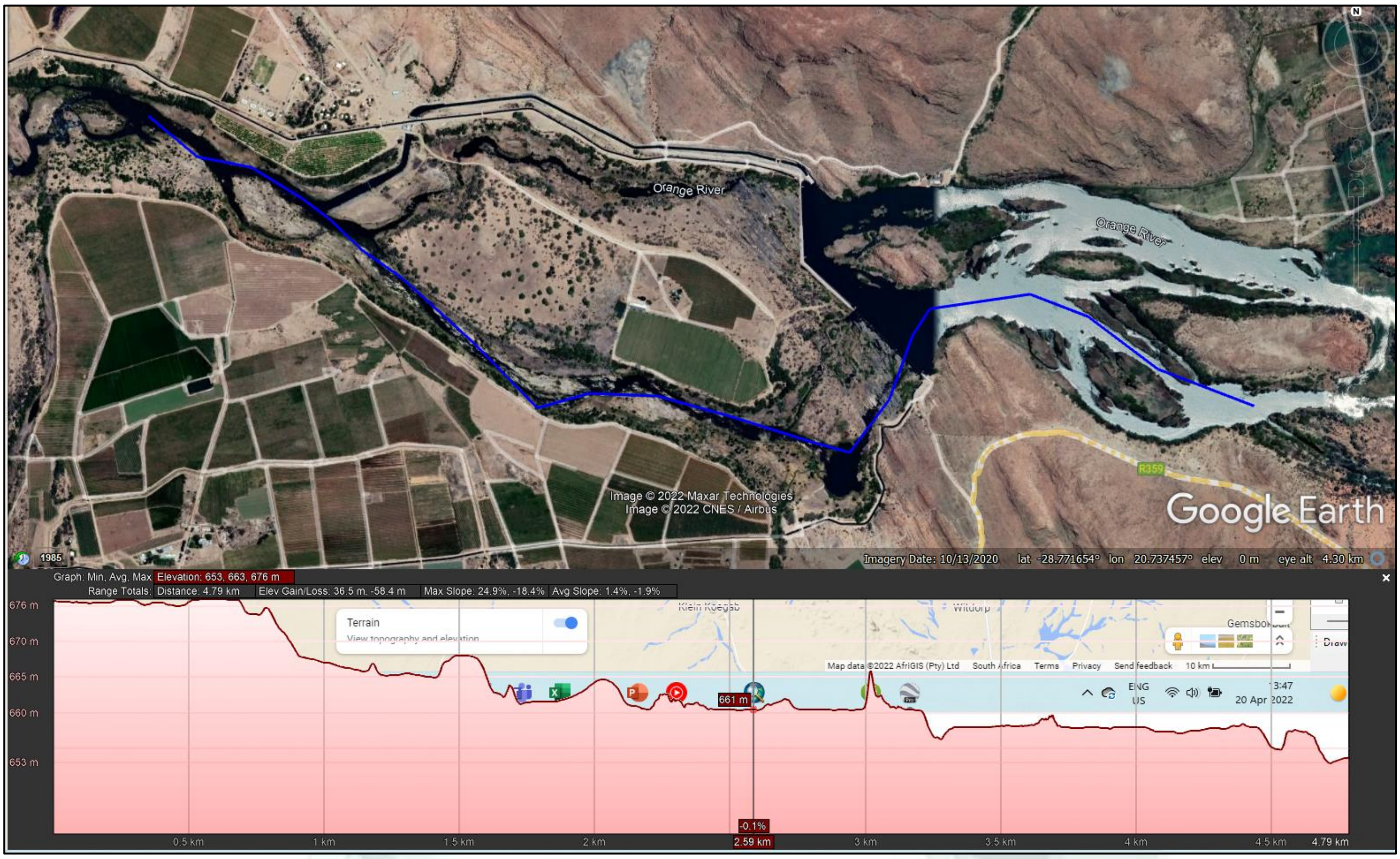
Figure 2.1: Location of the study area.

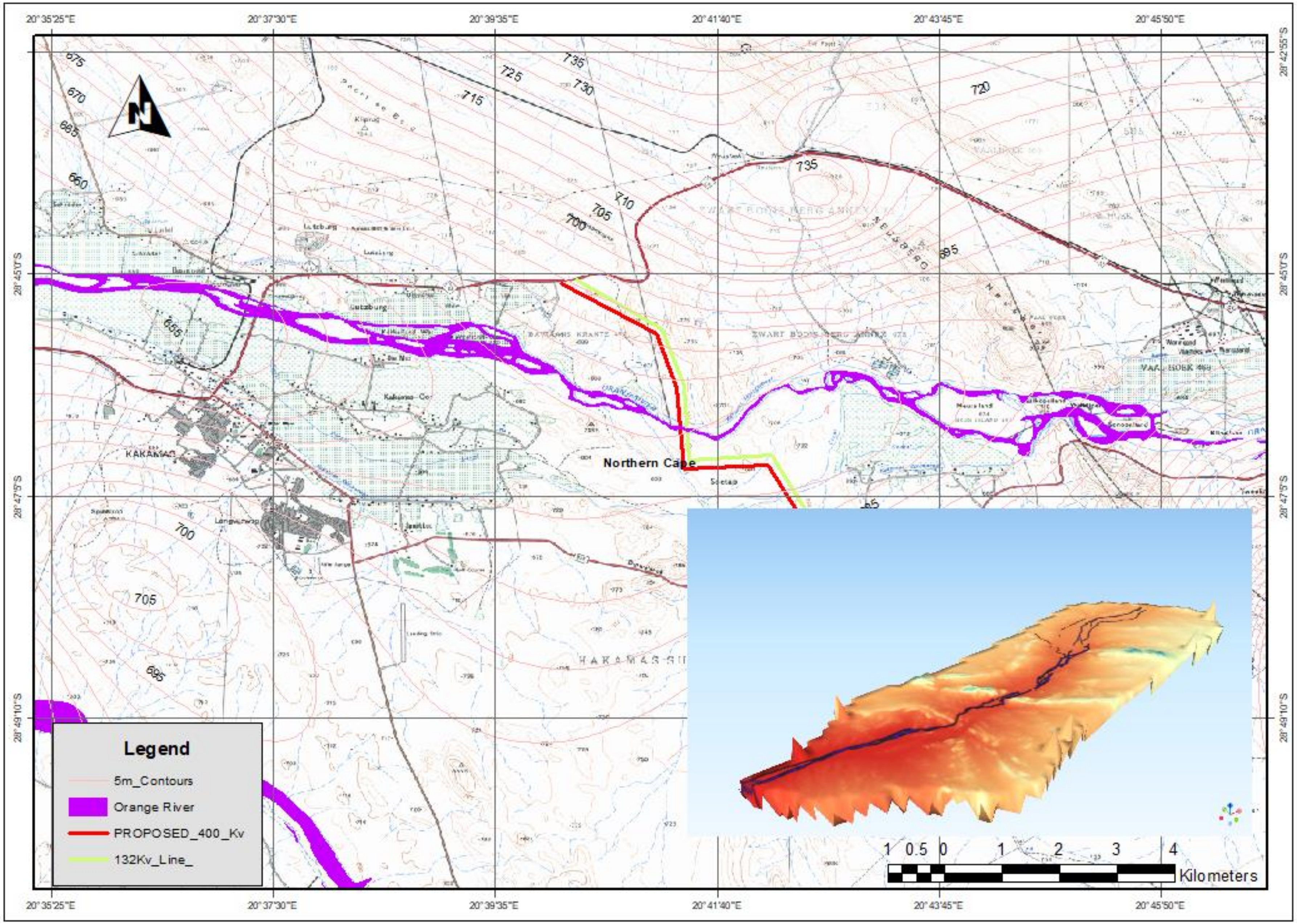
2.2 Physiographic Setting

Physiography will be described in terms topography and hydrological setting of the area.

2.2.1 Topography.

The topographic profile along the Orange River is shown in Figure 2.2. the profile has been derived from google earth. The proposed crossing area has an approximate altitude of 650masl. The site is bounded by the mountainous topography at the east with the river cutting across two koppies which has the elevation of approximately 770masl. See Figure 2.3.





20°35'25"E
20°37'30"E
20°39'35"E
20°41'40"E
20°43'45"E
20°45'50"E
28°42'55"S
28°45'0"S
28°47'5"S
28°49'10"S
KAKAMAS
Northern Cape
Legend
5m_Contours
Orange River
PROPOSED_400_Kv
132Kv_Line_
1 0.5 0 1 2 3 4
Kilometers

Figure 2.2: Topographic plan for the study area.

2.2.2 Hydrology

The proposed site is located in the lower Orange River Water Management area. The Orange River basin is one of the largest river basins south of the Zambezi with a catchment area of approximately 0.9 million km^2 The mean annual precipitation (MAP) in the Orange River Basin vary from as high as 1 200mm in the Lesotho Highlands to less than 50mm in the Richtersveld and parts of Namibia in the Lower Orange where the Orange River forms the border between the RSA and Namibia. Rainfall data are possibly the most important data used in a hydrological analysis, as it forms the basis of the runoff generated in each sub-catchment. It is therefore essential that rainfall data are checked and infilled properly before being used in subsequent phases of the hydrological process. The quaternary catchments are indicated in figure 2.3. the sub catchments play an important role with regards to understanding areas where water is being collected including the flow directions.

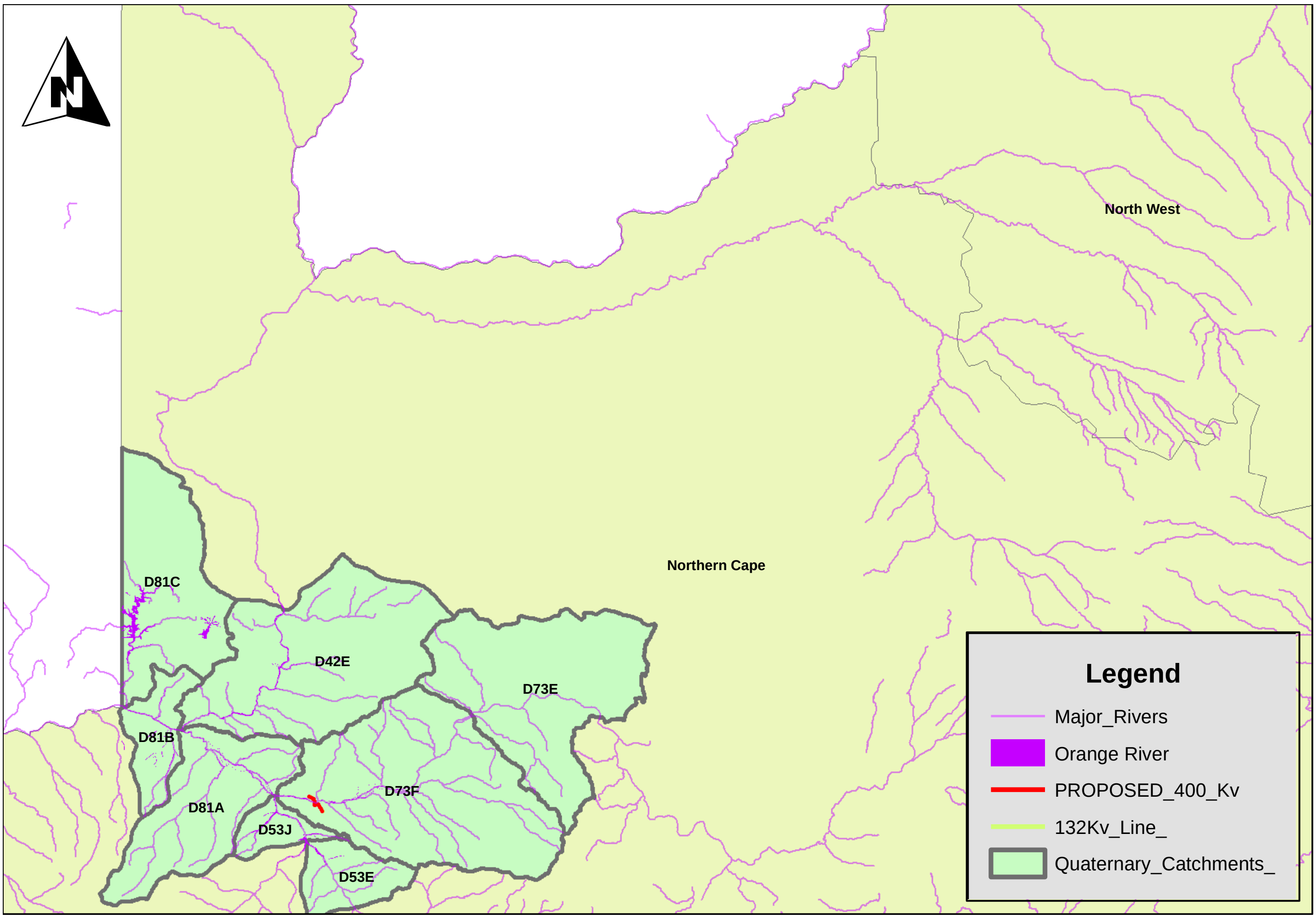


Figure 2.3: Lower Orange River Basin quaternary catchments

3. ASSESMENT METHODOLOGY

The 100-year flood is also referred to as the 1% flood, since its annual exceedance probability is 1%, or as having a return interval of 100-years. The 100-year flood is generally expressed as a flow rate (m^3/s). Based on the expected 100-year flood flow rate in a given stream or river, the flood's water level can be mapped as an area of inundation. The resulting floodplain map is referred to as the 100-year floodplain, which may be very important in how close to the stream buildings or other activities are allowed.
A common misconception exists that a 100-year flood is likely to occur only once every 100 years. In fact, statistically, there is an approximately **63.4 %** chance of **one or more** 100-year floods occurring in any given 100-year period. The **Probability** (***P_e***) of one or more of a specifically sized flood occurring during any return interval, exceeding the specifically sized flood severity, can be expressed as:

$$P_e = 1 - \left[1 - \left(\frac{1}{T}\right)\right]^n$$

…where ***Pe*** is the probability, **T** is the return interval of a given storm (e.g. 100-year, 50-year, 20-year, etc.), and ***n*** is the number of years. The exceedance probability Pe is also described as the natural, inherent, or hydraulic risk of failure when, e.g. when referring to dams, bridges, etc. However, the expected value of the number of 100-year floods occurring in any 100-year period is 1. In other words, 100-year floods have a 1% chance of occurring in any given year (Pe = 0.01), 10-year floods have a 10% chance of occurring in any given year (Pe = 0.1), 50-year floods have a 2% chance of occurring in any given year (Pe = 0.02), etc. The percent chance of an x-year flood occurring in a single year can be calculated by dividing 100 by x.

The determination of flood lines is done in two steps,

- modelling a succession of "design storms", each of them with a specific duration (1 hour, 2 hours, 24-hours, etc.) and producing a particular discharge in m^3/s and,
- routing the highest discharge produced in Step 1 through cross sections across representative reaches of the river/streams at the study area, which then assigns an elevation on each side of the centreline of the stream to which the floodwaters would rise at that particular cross section. This is done using HEC-RAS Modelling software. The flood lines are then drawn using these elevations at the cross sections as guides. The flood lines indicate the area that will be inundated during a 100-year flood event at the study area.

3.1 Hec Ras Modelling 1D Flow Inundation

3.1.1 Digital terrain creation

The initial step is to create the digital terrain model derived from SRTM data. This is created using RAS Mapper. See Figure 3.1. it should be noted the DTM shows two distinctive rivers, the Orange River on north flowing east west direction and Hartbees River flowing southeast to northwest direction. The latter river joins the Orange river just west of the proposed area of crossing, see Figure 3.2.

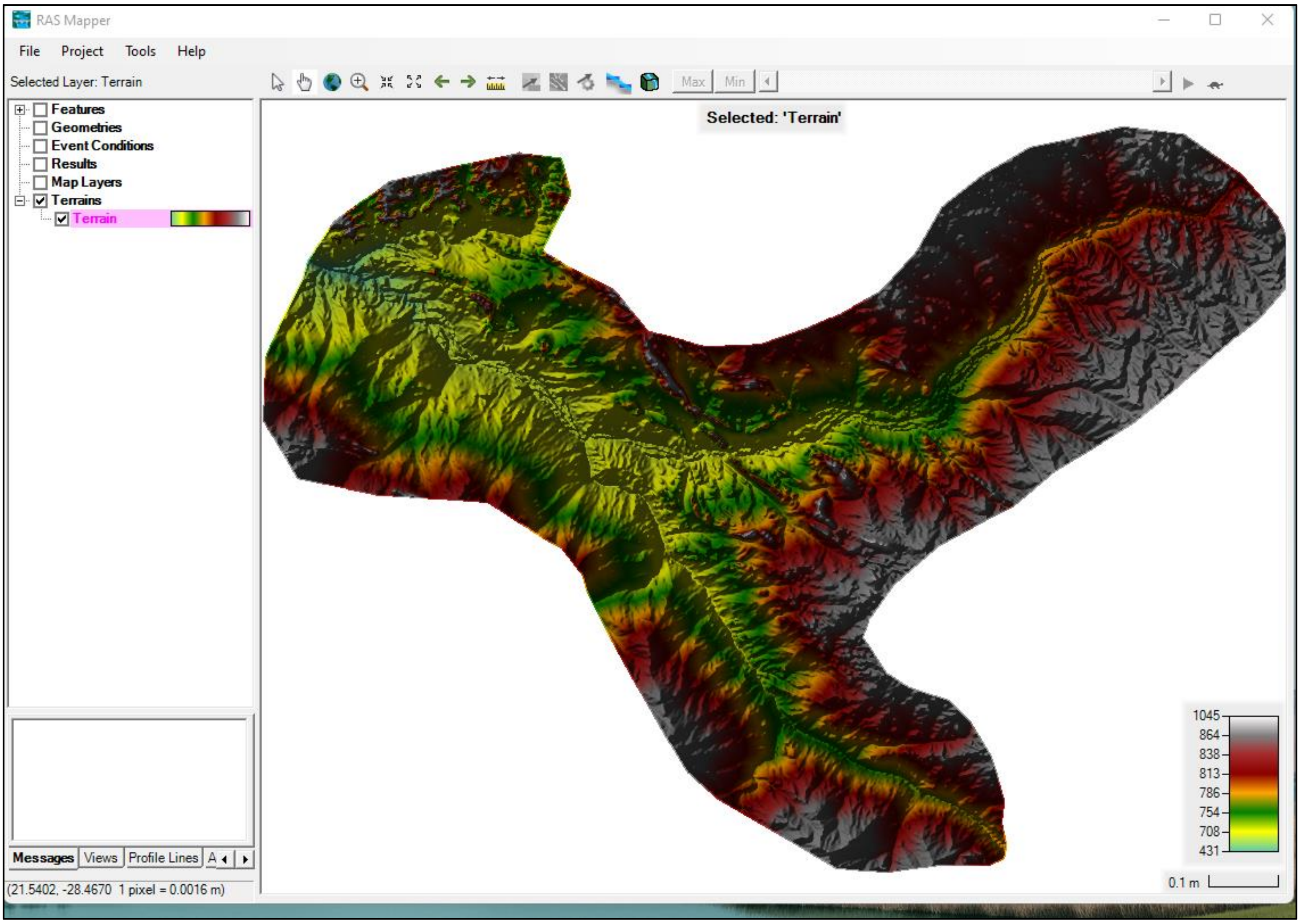


Figure 3.1. DTM for the study area.

The DTM show the elevations of the surface, hence the Orange River and the Hartbees are at the elevation ranging from 780 to 430 masl.

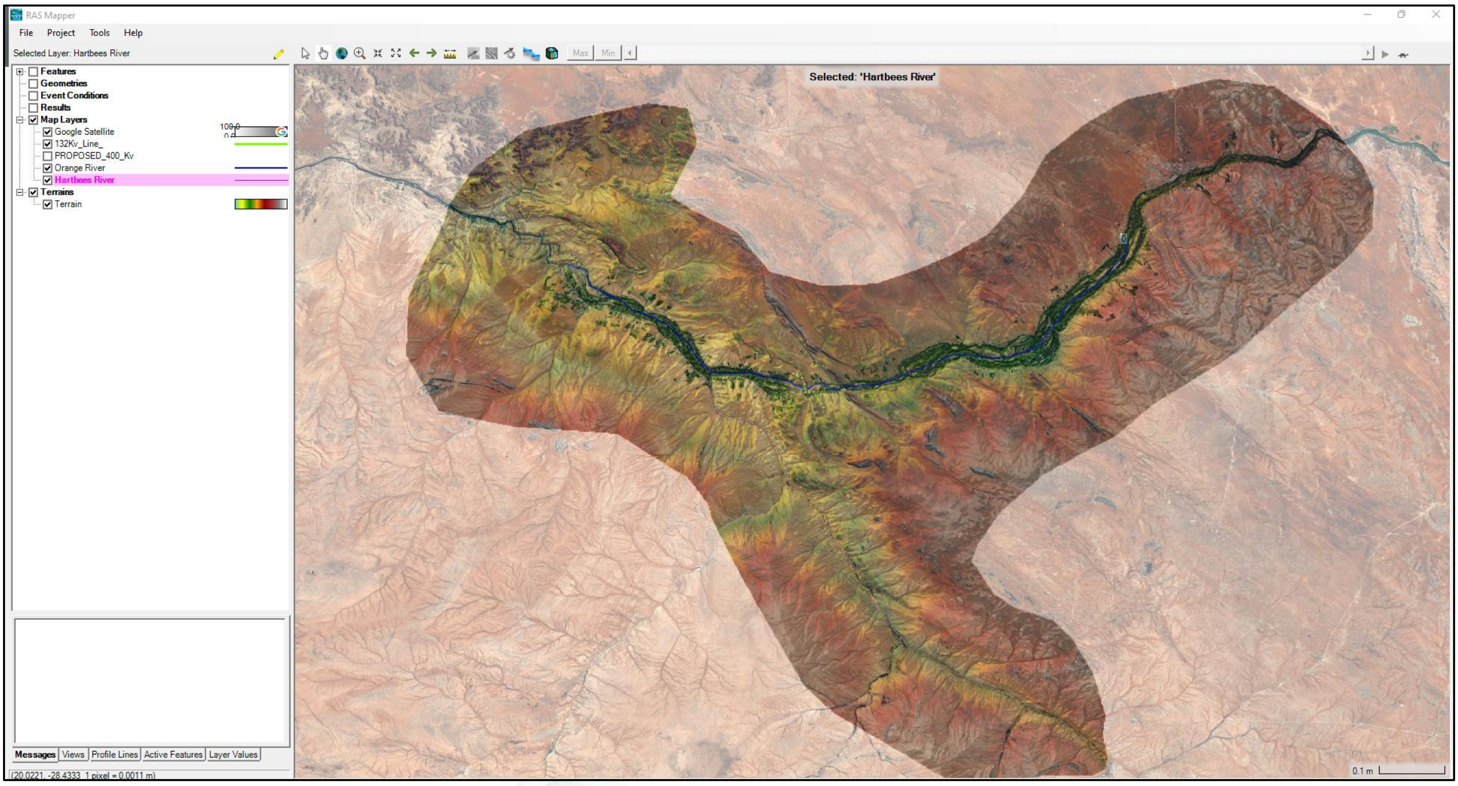


Figure 3.2: Super imposed DTM on satellite imagery showing the two main Rivers

3.1.2 River Profile and station

The geometry data for the river banks and stream flow direction are indicated as Figure 3.3.

3.1.3 Flow data

The flow data has been obtained from the river station data as recorded by the department of water and sanitation. The information that has been used for peak flow modelling was from the river station D8H014 Orange River @ Blouputs. Table 3.1 and Table 1.2 for the flow data used for flood modelling.

Table 3.1: average flows from year 2015 to 2022 (Source DWS)

Hydro		MAX	MAX	MAX	
Year	Date	Time	Level (m)	Flow (cumec)	Codes
2015	20141129	19:01	0.95	193.82	Q
2016	20160121	23:00	1.106	255.976	Q
2017	20170309	10:24	1.253	320.451	Q
2018	20180508	23:24	1.761	584.388	Q
2019	20190519	21:24	0.713	112.667	Q
2020	20200426	00:48	0.74	121.05	Q
2021	20210211	20:48	4.14	1612.4	A
2022	20211105	12:24	0.694	106.905	M
Explanation of codes:					
A ... Above Rating					
M ... Missing Data					
Q ... Data Not Audited					

Table 3.2. Flow data along the Orange River

D8H014 Orange River @ Blouputs					
Hydro		**MAX**	**MAX**	**MAX**	
Year	**Date**	**Time**	**Level (m)**	**Flow (cumec)**	
2015	**20141001**	**00:00**	**0.485**	**51.83**	
	20141129	19:01	0.95	193.82	Q
	20141201	00:00	0.823	148.126	Q
	20150130	18:00	0.631	88.659	Q
	20150217	22:36	0.56	69.746	Q
	20150331	21:36	0.683	103.627	Q
	20150403	07:48	0.685	104.22	
	20150530	18:36	0.698	108.107	Q
	20150626	23:24	0.781	134.226	Q
	20150705	09:36	0.657	96.027	Q
	20150802	14:24	0.655	95.452	Q
	20150920	23:00	0.709	111.444	Q
2016	**20151020**	**00:48**	**0.436**	**41.399**	**Q**
	20151130	05:36	0.477	50.055	Q
	20151201	01:24	0.478	50.275	Q
	20160121	23:00	1.106	255.976	Q

	20160201	20:12		0.739	120.735	Q
	20160325	16:00		0.505	56.387	Q
	20160419	22:00		0.635	89.777	Q
	20160523	19:48		1.008	216.153	Q
	20160601	00:00		0.418	37.847	Q
	20160728	15:00		0.368	28.875	Q
	20160829	19:12		0.449	44.062	Q
	20160926	19:36		0.452	44.687	Q
2017	**20161004**	**03:24**		**0.427**	**39.603**	**Q**
	20161108	17:24		0.325	22.457	Q
	20161207	23:24		0.392	33.007	Q
	20170111	19:12		0.578	74.367	Q
	20170228	23:48		0.778	133.245	Q
	20170309	10:24		1.253	320.451	Q
	20170412	21:48		0.574	73.329	Q
	20170515	17:00		0.368	28.875	Q
	20170620	21:36		0.361	27.736	Q
	20170724	18:48		0.422	38.623	Q
	20170828	09:00		0.439	42.006	Q
	20170925	12:36		0.436	41.399	Q
2018	**20171016**	**14:48**		**0.499**	**55.003**	**Q**
	20171127	17:24		0.501	55.463	Q
	20171227	07:00		0.512	58.021	Q
	20180101	16:48		0.48	50.718	Q
	20180216	22:48		0.512	58.021	Q
	20180301	00:00		0.436	41.399	Q
	20180430	23:59		1.526	454.421	Q
	20180508	23:24		1.761	584.388	Q
	20180608	18:12		0.681	103.035	Q
	20180701	23:24		0.708	111.139	Q
	20180820	17:48		0.488	52.504	
	20180916	22:36		0.546	66.233	
2019	20181001	00:00		0.483	51.384	
	20181114	16:00		0.434	40.997	
	20181218	15:12		0.462	46.801	
	20190101	02:36		0.464	47.229	
	20190211	15:24		0.534	63.283	
	20190301	00:48		0.36	27.575	Q
	20190421	11:00		0.297	19.346	Q
	20190519	21:24		0.713	112.667	Q
	20190612	20:00		0.705	110.225	Q
	20190705	00:24		0.442	42.618	Q
	20190820	11:48		0.517	59.2	Q
	20190916	16:24		0.561	69.999	Q

2020	**20191014**	**18:48**	**0.534**	**63.283**	**Q**
	20191128	10:00	0.64	91.184	Q
	20191208	22:12	0.533	63.04	Q
	20200109	00:48	0.533	63.04	Q
	20200227	14:00	0.658	96.315	Q
	20200326	16:48	0.624	86.714	Q
	20200426	00:48	0.74	121.05	Q
	20200511	10:48	0.578	74.367	Q
	20200604	18:36	0.395	33.548	Q
	20200713	17:24	0.41	36.32	Q
	20200823	17:24	0.423	38.818	Q
	20200914	11:24	0.438	41.803	Q
2021	**20201013**	**17:00**	**0.434**	**40.997**	**Q**
	20201126	08:38	0.61	82.878	Q
	20201216	05:53	0.672	100.384	Q
	20210131	23:36	2.321	979.355	Q
	20210211	20:48	4.14	1612.4	A
	20210301	01:24	2.394	1039.016	Q
	20210405	18:19	0.753	125.173	Q
	20210524	14:00	0.616	84.513	Q
	20210616	13:48	0.771	130.964	Q
	20210731	20:00	0.513	58.256	Q
	20210802	05:24	0.53	62.313	Q
	20210913	09:24	0.495	54.088	Q
2022	**20211031**	**06:36**	**0.604**	**81.253**	**Q**
Explanation of codes:					
A ... Above Rating					
Q ... Data Not Audited					

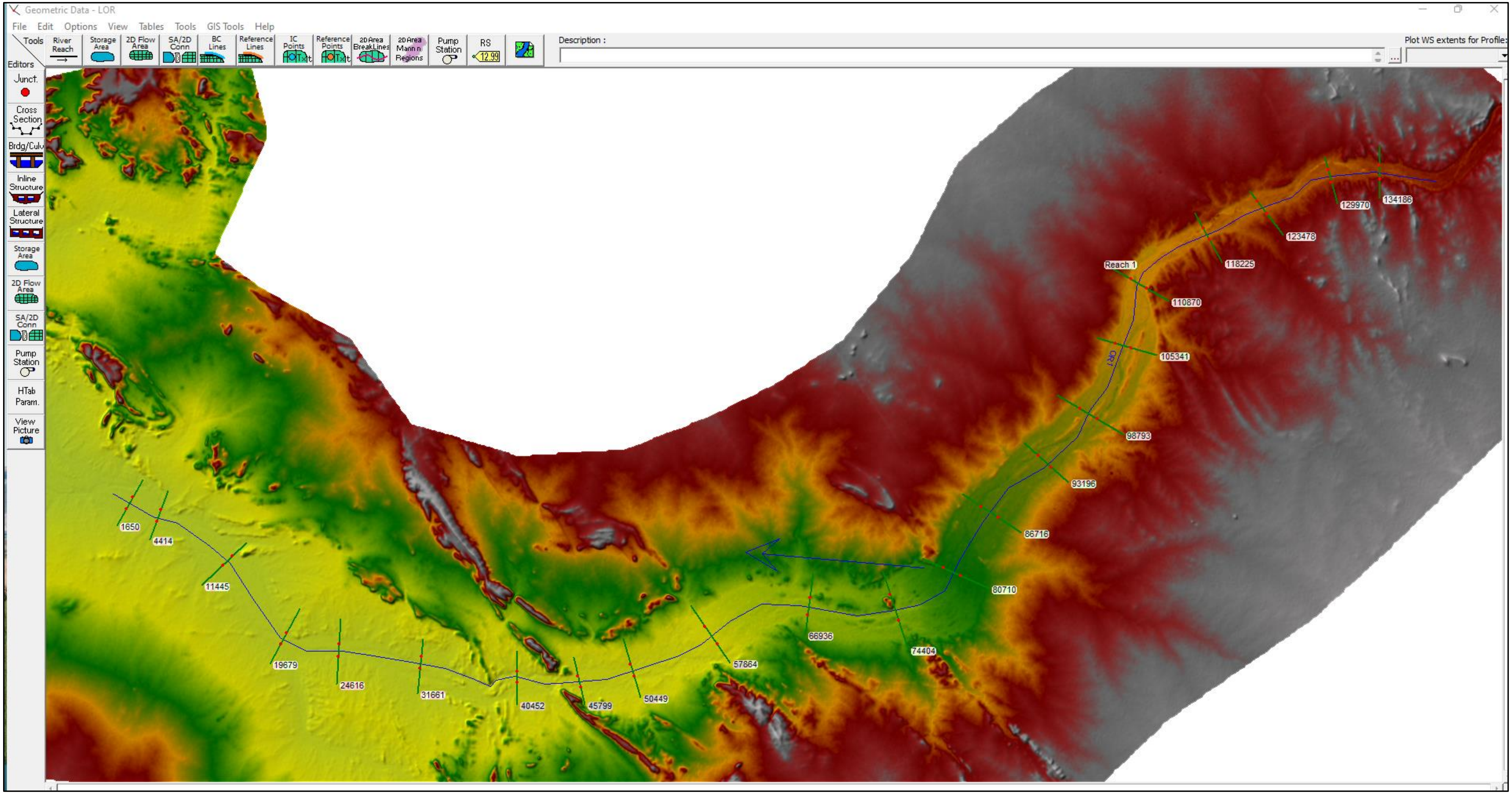


Figure 3.3: Geometric data showing the flow direction and the river station.

4. ONE DIMENSIONAL FLOW MODELING

The results of the flow model are indicated in the Figure 5.1. it should be noted that the flow data that has been to simulate the model has been obtained from the department of water and sanitation, hence some of the data was not audited as indicated in Table 3.1 and 3.2. the highest average flow peak was at a 1000m^3/s. The proposed crossing pint for the powerlines is between the river station 24616 and 45799. The simulation for 1:100 year flood shows no overflow or any risk of flood for the period modelled for.

5. CONCLUSION

The area simulated for 1:100 year flood line has shows little on no risk for flooding, however station or point 74404 show risk of flooding and it is located upstream of the proposed crossing. This may be due to an embankment or dam across that point. This is the only point that seems to pose risk of flooding.

6. REPORT PROVISION.

6.1 Study Limitations

The following are the limitation for the study. The assumptions are that the flow of the river is unsteady flow. Hence the variation in river profile indicates the elevation variation of approximately 300m. furthermore the model ignores the run-off from the storm or various season. Simulation is based on the flow data from the stations that are monitored by the Department of Water and Sanitation. Rainfall data for the area may vary from season to season. Furthermore, the Orange River flows from the Lesotho highlands where the average annual rainfall is approximately 1000mm in comparison to the Upington which has an average annual rainfall of less than 300mm. the other limitation is that the peak flow might increase when other dams upstream release more water which will then impact on the flow downstream, hence the proposed area is situated in the lower Orange River catchment.

While every effort is made during the simulation of the flood (1:100-year flood) note that All information and deductions contained in this report are dependent not only on access to the relevant information but also accuracy of the results generated by the HEC RAS 6.2 software.

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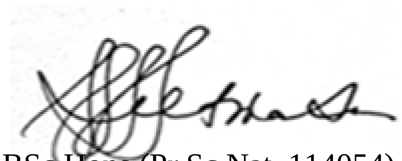
T Netsianda (Geologist)



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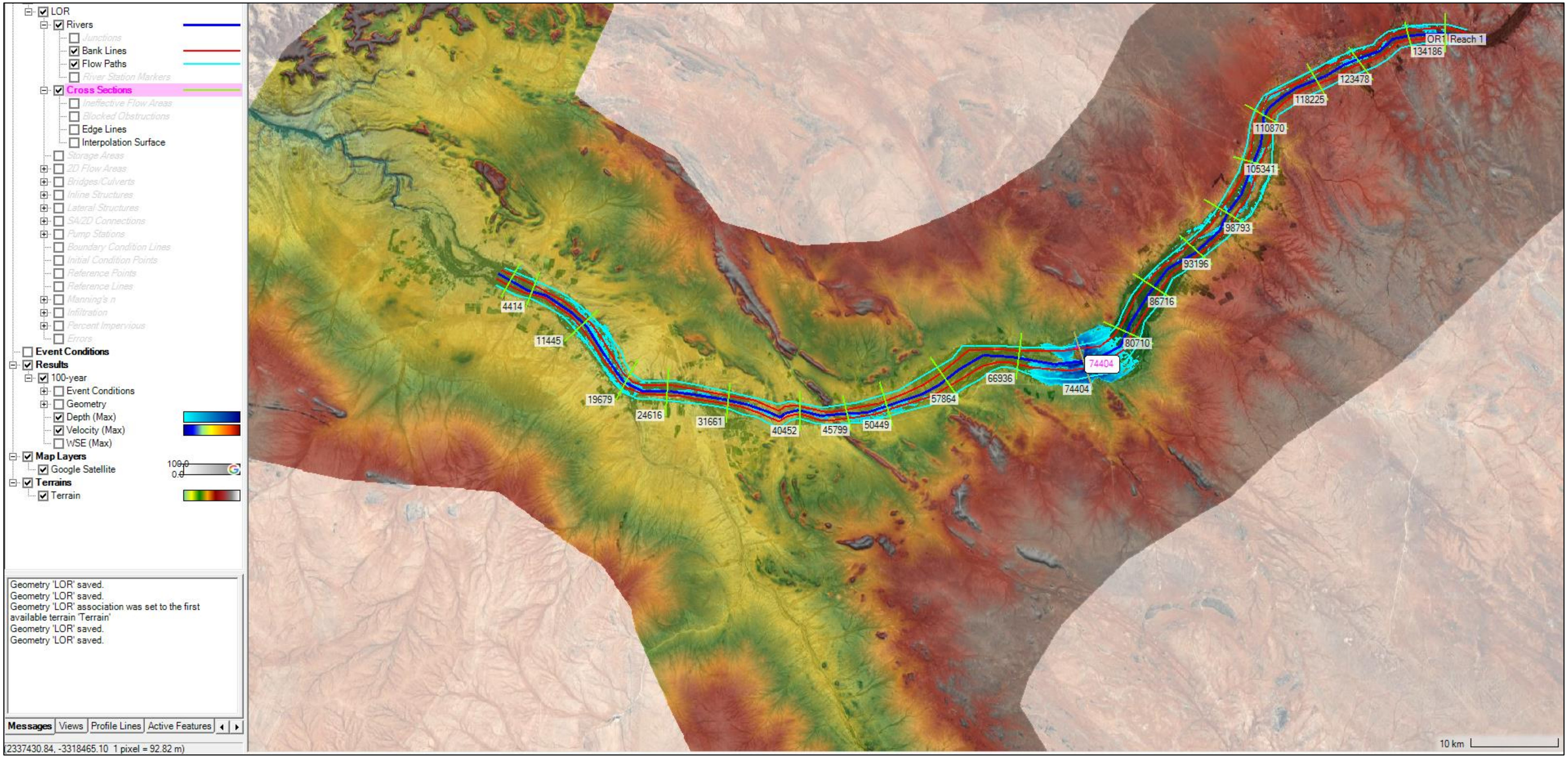

Figure 6.1: 1:100 year flood simulation model

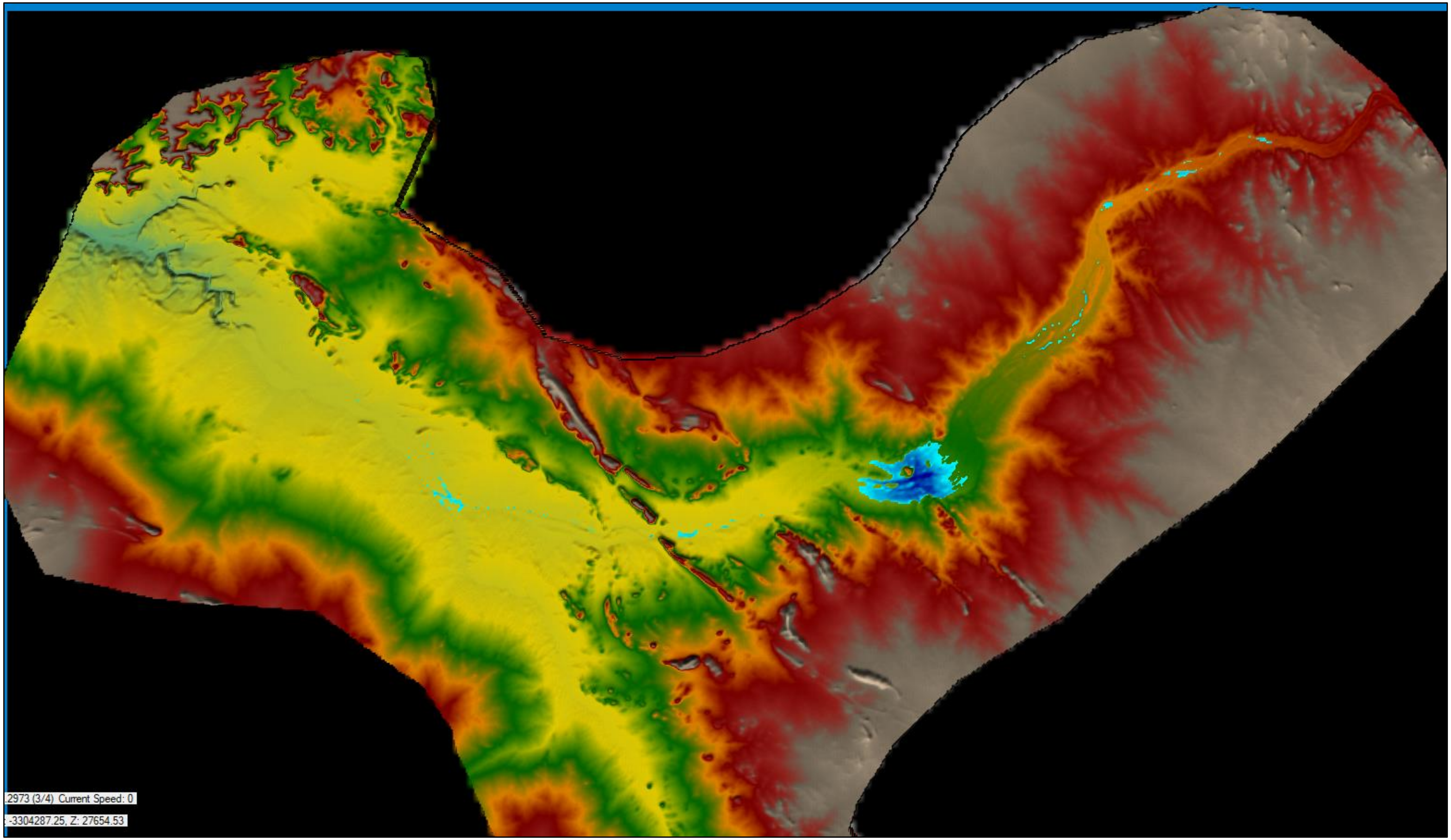

Figure 6.2: 3D View of the terrain model