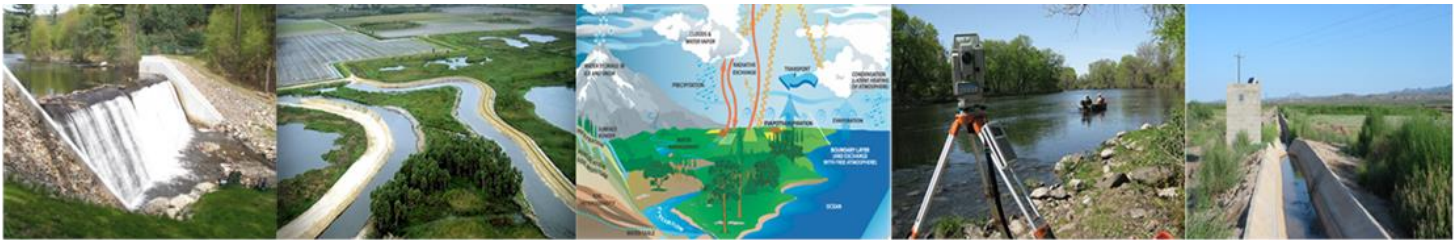
Floodline Determination for the Proposed Prospecting Right Application for Niara Minerals (Pty) Ltd

Report

Version – Draft

22 July 2025

Client Reference: Niara Minerals – Floodlines



Floodline Determination of the Prospecting Right Application for Niara Minerals (Pty) Ltd

Report

DOCUMENT VERIFICATION

TITLE: Floodline Determination for Niara Minerals (Pty) Ltd – Floodlines			
Report Number		**25_0625**	
Date		**22 July 2025**	
Report Version		**Draft**	
Verification	**Name**	**Signature**	**Date**
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SPECIALIST DETAILS AND DECLARATION

Specialist Details

Sbongiseni Mazibuko is a hydrologist focusing on surface water hydrological specialisation. Sbongiseni has – over the past ten years – worked on numerous projects for a variety of clients ranging from mining, agriculture, and public entities, which included hydrological assessments, water balances, stormwater planning and management, floodlines modelling, catchment yield assessments and water conservation and water demand management plans.

Declaration

This report has been prepared independently of any influence or prejudice from any parties.

I, *Sbongiseni Christian Mazibuko*, declare that –

- I act as the independent specialist in this application,
- I regard the information and data contained in this report to be accurate and correct as per the provision of data from the client,
- I do not have any vested interest (i.e., business, financial, personal, or other) in the project other than remuneration for the professional work performed and
- I conducted the work relating to the project objectively in line with my profession and regulatory body and within the confines of the applicable legislation.

Mr. Sbongiseni Christian Mazibuko

MSc Hydrology, (*Pr.Sci.Nat.* reg number: 011204)

EXECUTIVE SUMMARY

Altra Watch (Pty) Ltd was appointed by Niara Minerals to conduct a floodlines determination study for the proposed Prospecting Rights Application for coal, pseudo-coal and torbanite/oil shale in the Sihlengeni area located within Abaqulusi Local Municipality in KwaZulu-Natal Province of South Africa. The prospecting rights area covers about 9 hactres (ha) of land and covers Remaining Extent of Isihlengeni No. 689; the Remaining Extent of Demoina No. 830; Portions 4 and 5 of Wonderfontein No. 560; Portion 5 of Mariantha No. 845; Portion 1 of Weltevrede No. 540; the Remaining Extent and Portion 1 of Wagendrift No. 541; the Remaining Extent and Portion 1 of Ongemaakt No. 301; the Remaining Extent, Portion 1, and Portion 2 of Zalflager No. 525; Portion 8 of Frischgewaagd No. 401; Portion 1 of Misty Valley No. 831; Portions 0, 1, 3, 4, and 6 of Overmars Rust No. 518; and Portions 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, and Spitzkop No. 70 properties. The area is in the headwater reaches of the Mkuze and Black Mfolozi Rivers of the Pongola-Mtamvuna Water Management Area (WMA).

These main rivers drain their waters with tributaries, with a potential flooding risk resulting from peak flood volumes of various return periods. As part of the exploration process, establishing baseline conditions of the area before commencing with any possible developments, such as those associated with mineral exploration, requires that the 1:50 and 1:100-yr floodlines be determined and mapped. This aims to ensure that relevant regulations, legislation and guidelines relating to mineral exploration are adhered to. Part of these include the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA), the National Water Act (Act 36 of 1998), General Notice (GN704) and the Department of Water and Sanitation (DWS) Best Practice Guidelines (BPGs) which are all aimed at ensuring that the water resources are protected through regulating the mining-related activities next to the river courses. Therefore, this study aimed to determine the 1:50 and 1:100-yr floodlines for the main tributaries and rivers covering the Niara Minerals Prospecting Rights Area. Results from this study aim to provide specialist inputs required for the Basic Assessment Report (BAR) required in terms of the Mineral and Petroleum regulations and the Environmental Impact Assessment (EIA) required in terms of the National Environmental Management Act (NEMA) Act 107 of 1998.

Located in the high-lying areas of about 1 450 metres above mean sea level (mamsl) in the Upper Mkuze and Black Mfolozi Rivers, the prospecting rights area spans across four quaternary catchments of the Pongola-Mtamvuna Water Management Area. The area has steep hilltops with undulating hills that generate runoff into the deep-incised valleys. Dense natural and forest plantations cover most headwater reaches, while the valleys have grasslands on well-developed soils. The area's Mean Annual Precipitation (MAP) ranges between 789 mm and 1 100 mm, which spatially varies where headwaters receive more rainfall than the low-lying areas.

Five drainage areas were delineated to model the main rivers and tributaries in the prospecting rights area. Modelled river geometric data were derived from a 5 m contour data, while Manning's n values for the riparian zones were derived using the combination of the information derived during the site visit, 2022 Land Use and Land Cover and visual assessment of the 2025 satellite imagery retrieved via Google Earth Pro. Using deterministic and empirical methods, peak flow volumes were computed for the 1:50 and 1:100-yr recurring flood events due to the limitations of the observed stream flow gauge and data in the areas of interest. Results show that most methods presented the expected peak flows within a similar magnitude range, with the exception of the Standard Design Flood (SDF) method, which provided higher estimates for higher return period events. Probably statistical fits of various methods used to compute the peak flow volumes guided the selection of the conservative values for routing floodwater through HEC-RAS version 6.7.

The 1:50 and 1:100-yr flood peaks were simulated through a 1D hydraulic model to map the inundation extents of flood waters. Results show that relatively flat floodplain zones result in larger inundation extents. This is partly related to the spatial scale of the topographic data used to represent the river geometry.

LIST OF ACRONYMS

ALOS	Advanced Land Observing Satellite
BPGs	Best Practice Guidelines
DSM	Digital Simulation Model
HEC-RAS	Hydrologic Engineering Center - River Analysis System
JAXA	Japanese Aerospace Exploration Agency
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MPRD	Mineral and Petroleum Resources Development Act
NEMA	National Environmental Management Act
NWA	National Water Act
QGIS	Quantum Geographical Information System
RM	Rational Method
SAWS	South African Weather Station
SDF	Standard Design Flood
WR2012	2012 South African Water Resources Study

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1 INTRODUCTION

1.1 Background

Niara Minerals (Pty) Ltd appointed Altra Watech (Pty) Ltd to undertake floodline determination for Prospecting Rights Application by Niara Minerals in Sihlengeleni, KwaZulu-Natal Province of South Africa (Figure 1-1). This area covers various farm portions, namely the Remaining Extent of Isihlengeni No. 689; the Remaining Extent of Demoina No. 830; Portions 4 and 5 of Wonderfontein No. 560; Portion 5 of Mariantha No. 845; Portion 1 of Weltevrede No. 540; the Remaining Extent and Portion 1 of Wagendrift No. 541; the Remaining Extent and Portion 1 of Ongemaakt No. 301; the Remaining Extent, Portion 1, and Portion 2 of Zalflager No. 525; Portion 8 of Frischgewaagd No. 401; Portion 1 of Misty Valley No. 831; Portions 0, 1, 3, 4, and 6 of Overmars Rust No. 518; and Portions 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, and Spitzkop No. 70 properties.

These properties traverse several quaternary catchments of the upper Mkuze and Black Mfolozi River Basins, which form part of the larger Pongola-Mtamvuna Water Management Area (WMA). These quaternaries drain tributaries and rivers across the prospecting area, which have a flood risk to any potential developments within the area. The infrastructure might be at risk of flooding from this tributary. Therefore, this report constitutes the floodline assessment study required to evaluate the flood risk posed by the tributaries within the prospecting rights area resulting from 1:50 and 1:100-year return periods. Results from this study will provide specialist input for the prospecting rights application in terms of the Mineral and Petroleum Resources Development Act (Act 28 of 2002 as amended) and Basic Assessment Report (BAR) application required as per the regulation of in terms of the National Environmental Management Act (Act 107 of 1998) (NEMA).

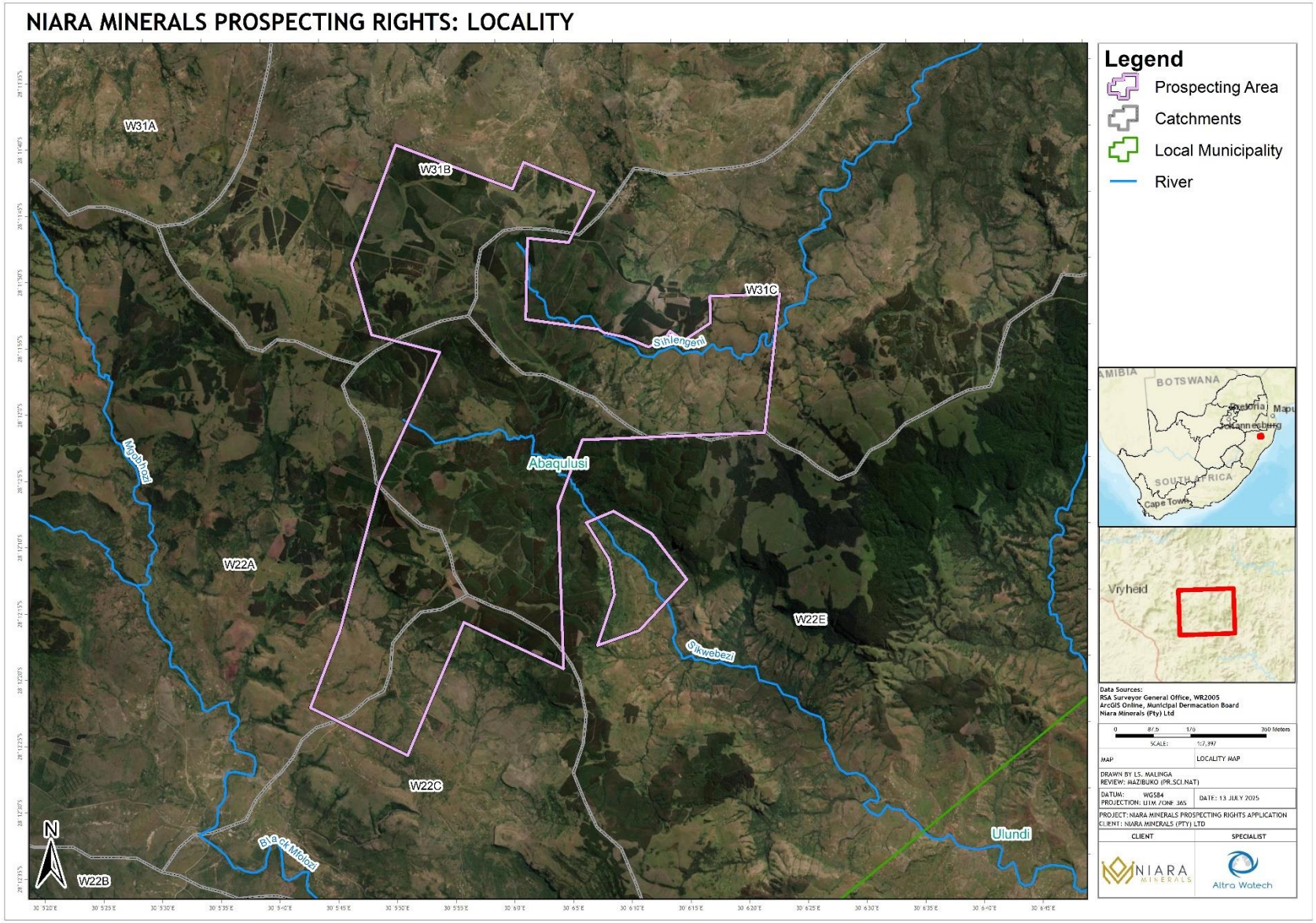

Figure 1-1: Study locality and the surrounding properties

2 SCOPE OF WORK

The scope of work for the water balance study is defined as follows:

1. Site Visit and Desktop Review:
    - A site walk-over to identify catchment features,
    - Data collection, preparation and conceptualisation, and
    - Review of the relevant legislation and guidelines.
2. Baseline Hydrology:
    - Delineation of all drainage areas of the modelled river section and characterisation of the physiographic setting,
    - Hydroclimatic characterisation through the calculation of the design rainfall, and
    - Deriving drainage characteristics and calculating the peak flow volumes (1:50 and 1:100-year return period events).
3. Floodline Modelling:
    - Preparation of river geometric data using topographical data, and
    - Flood line modelling using 1D HEC-RAS hydraulic software (US Army Corps of Engineers, 2025).
4. Reporting:
    - A report deliverable that presents the detailed results of the activities mentioned above and the recommendations will be made based on the study's findings.

3 METHODOLOGY

3.1 Site Visit and Desktop Study

A site visit was conducted on the 30th of June 2025, to characterise the topographic, soils and land cover characteristics as well as the riparian areas along the main tributaries modelled in this study. Observations made during this visit were essential in helping to set Manning's values, which are essential in representing the friction of flood waters across the modelled river reach, and in identifying factors affecting runoff generation. Applicable guidelines relating to floodline assessment for mineral exploration were evaluated and applied in the context of this study. Hydrometeorological data representing the study site were collected and analysed to formulate a baseline understanding of local hydroclimatic regimes. Satellite imagery retrieved via Google Earth Pro was used to derive land catchment characteristics that describe the existing conditions, which could affect the calculation of the peak flow volumes.

3.2 Baseline Hydrology

Baseline hydrometeorological data for the study area were obtained from the Water Resources Study WR2012 database (Bailey and Pitman, 2015) and the Daily Rainfall Data Extraction Utility (Lynch, 2004). These estimated the Mean Annual Precipitation (MAP) of the study site and the design rainfall used to determine the catchment's peak flow volumes. A 30 m Digital Simulation Model (DSM) data derived from Advanced Land Observing Satellite (ALOS) (JAXA, 2018) data was used to delineate the overall catchments draining modelled rivers of the study site. Delineation results were also used to derive physical characteristics of the catchment that affect the calculation of peak flows and floods. These characteristics included the catchment area, river network and slopes. A 5 m contour data from the Surveyor General Office was extracted to develop a Digital Simulation Model (DSM) to define the river channel and route the flood waters in the 1D hydraulic model through HEC-RAS.

3.3 Peak Flow Calculation

The appropriate methodology to calculate peak flows depends on the size of the catchment and hydrological data (e.g., stream flow) for a particular catchment. The methods used to calculate the peak discharge values are associated with the small to medium catchments. Methodologies for using the Rational Method (RM), Alternative Rational Method (RM2), Standard Design Flood (SDF), Unit Hydrograph (UH) and Midgley and Pitman (MIPI) Methods are explained in the South African Drainage Manual (SANRAL, 2013). The peak flow volumes for the 1:50 and 1:100-year return periods were calculated for the delineated drainage areas based on the deterministic and empirical methods because no stream flow gauges are available.

3.3.1 Rational and Alternative Methods

The equation for calculating peak flows using the Rational Method (RM) is based on a runoff coefficient, the catchment's average rainfall intensity and the catchment's effective area (recommended for small catchments less than 15 km^2) that contributes largely to runoff generation after the heavy storm's rainfall has exceeded infiltration. The deterministic RM equation is given by $Q = CiA$ where Q is peak flow volume (m^3/s), *c* is a dimensionless runoff coefficient, *i* is the catchment average rainfall intensity (mm/hr) and *A* is the effective catchment area (m^2). All catchment factors influencing rainfall-runoff relations after a storm event are defined and represented by the runoff coefficient (c). The calibration of the runoff coefficients for the drainage area is guided by an understanding of the effective runoff-generating processes, soil and land cover attributes derived from various sources, as well as catchment physical surveys of the site linked with the prevalent rainfall regimes of the areas.

These factors are accumulated to account for (i) slope, (ii) soil permeability and (iii) vegetation cover type of the catchment based on (1) rural, (2) urban, and (3) lakes setting. Steeper slopes affect the generation of more runoff than flat, gentle slopes. The permeability of soils are classified into (i) very permeable with high infiltration rates resulting in less runoff (Group A), (ii) permeable with moderate infiltration rates generating moderate runoff (Group B), (iii) Group C soils are semi-permeable with low infiltration and immoderate to high runoff and (iv) impermeable soils with very low infiltration rates resulting in higher runoff (Group D). Dense forest, dense bush and wood (Group A), thin bush and cultivated land (Group B), grassland (Group C) and bare surfaces (Group D) result in less, moderately low, moderately high and very high runoff volumes, respectively.

Design rainfall depths are one of the critical inputs into the alternative RM in the computation of the rainfall intensity. The storm rainfall depths for different time durations (up to 24 hours) of varying return periods were obtained from the Design Rainfall Estimation (DRE) program for this study (Smithers and Schulze, 2003). The determination of the catchments' applicable average design rainfall intensity was undertaken by the time of concentration, point rainfall intensity, and average rainfall intensity of the study area.

Table 3-1: Calibration guide for runoff coefficients for the Rational Method (source: SANRAL, 2013)

Rural (C_1)					Urban (C_2)	
Component	Classification	Mean annual rainfall (mm)			Use	Factor
		< 600	600 - 900	> 900		
Surface slope (C_s)	Vleis and pans (<3%)	0,01	0,03	0,05	*Lawns*	
	Flat areas (3 to 10%)	0,06	0,08	0,11	- Sandy, flat (<2%)	0,05 – 0,10
	Hilly (10 to 30%)	0,12	0,16	0,20	- Sandy, steep (>7%)	0,15 – 0,20
	Steep areas (>30%)	0,22	0,26	0,30	- Heavy soil, flat (<2%)	0,13 – 0,17
					- Heavy soil, steep (>7%)	0,25 – 0,35
Permeability (C_p)	Very permeable	0,03	0,04	0,05	*Residential areas*	
	Permeable	0,06	0,08	0,10	- Houses	0,30 – 0,50
	Semi-permeable	0,12	0,16	0,20	- Flats	0,50 – 0,70
	Impermeable	0,21	0,26	0,30		
					Industry	
					- Light industry	0,50 – 0,80
Vegetation (C_v)	Thick bush and plantation	0,03	0,04	0,05	- Heavy industry	0,60 – 0,90
	Light bush and farm lands	0,07	0,11	0,15	*Business*	
					- City centre	0,70 – 0,95
	Grasslands	0,17	0,21	0,25	- Suburban	0,50 – 0,70
	No vegetation	0,26	0,28	0,30	- Streets	0,70 – 0,95
					- Maximum flood	1,00

Classification	Soil Factors		Vegetation Factors		Runoff Potential
	Soil Permeability	c-value	Vegetation Cover	c-value	
Group A	Very permeable	0.01 - 0.05	Forest, dense bush and wood	0.03 - 0.05	Very Low
Group B	Permeable	0.06 - 0.10	Thin bush and cultivated land	0.07 - 0.15	Moderlately Low
Group C	Semi-permeable	0.12 - 0.20	Grassland	0.17 - 0.25	Moderlately High
Group D	Impermeable	0.21 - 0.30	Bare surface (no vegetation)	0.26 - 0.30	Very High

3.3.2 Standard Design Flood Method

The SDF method is based on a calibrated discharge coefficient for a recurrence period of 2 to 100 years. Calibrated discharge parameters are based on historical data and were determined for 29 homogeneous basins in South Africa. The other inputs used in the SDF method for calculating the maximum discharge values of 1:50 and 1:100-yr are the catchment area, the length of the longest river course, the catchment height difference, the annual maximum rainfall, and the average days when thunder was heard.

3.3.3 Midgely and Pitman Method (MIPI)

The empirical method developed by Pitman and Midgley (1971) was initially derived from the original Synthetic Unit Hydrograph (SUH) and relates peak discharge to catchment size, slope, and distance from the drainage point to the centroid of the catchment (Campbell, 1986). The MIPI method uses 10-unit hydrographs for 10 zones in South Africa. The method does not consider overland flow as a component separate from streamflow, but only finds the total longest flow path.

3.4 Floodline Modelling and Floodline Delineation

Hydraulic parameters and the channel geometry of the modelled river sections were derived from spatial information obtained from a 5 m contour dataset. River cross-sections and flow paths were prepared using RAS Mapper software and provided as input to the HEC-RAS flood model through the use of HEC-RAS. Cross sections were drawn in key areas with sudden river flow direction and land cover changes. This standard practice ensures that the model accounts for these changes, mimicking where floodwater will be routed. Boundary conditions in the model were based on the assumption that the flood starts when the water level is at 0m depth of the river profile. A 1-D steady state flow regime was set for all drainage areas, which suggests that the peak flow volumes are assumed to be uniform throughout the river channel during the flood events. While this is not realistic from a flood routing conceptual perspective, limitations of a dynamic time series hydrograph allow for the implementation of this modelling approach.

Visual assessment of the 2025 satellite imagery retrieved through Google Earth Pro was used with the information derived during the site visit and the 2022 LULC to interpret the riparian zones for setting Manning's coefficient values (Chow, 1959) of the cross-sections in the hydraulic model for all modelled river sections. The roughness of the floodplain is used in hydraulic model calculations to account for the frictional impacts that topography, land cover and soils have on the flood routing patterns, thus enabling the assessment of the friction losses on flow velocities, discharge and cross-section flow area of a modelled river segment. Flood inundation extents were extracted after routing the chosen peak flow volume values for 1:50 and 1:100-year return events from the methods used. These extents were extracted in a polygon form, converted to polylines, and mapped through Geographic Information System (GIS) software for interpretation.

3.5 Assumptions and Limitations

The following constraints may have affected this hydrological assessment:

- The lack of stream flow data to set a 2D unsteady flow model could have limited a proper representation of the dynamics of flood water when routed in the model.
- The use of 5 m contour data might have limited proper representation of the river centreline, which is accumulating floodwaters and overtopping the river banks.
- No hydraulic structures, such as weirs or culverts, were considered in this assessment.
- The floodline areas modelled in this assessment should be interpreted cautiously, given the overall low-resolution elevation data utilised.

4 DESKTOP ASSESSMENT

The following sub-sections present the dataset and information obtained during the desktop phase of the hydrological assessment study.

4.1 Data Used

The following dataset and tools were used to derive the results of the study:

- **30m ALOS DSM and 5m contour data** – for drainage areas delineation and river geometry data used to route flood,
- **SAWS and WR2012 dataset** – defining hydrological regimes of the study site,
- **HEC-RAS v6.7 beta** – Hydraulic simulation of floodlines,
- **2020 LULC** – for classification of the dominant land use and land cover, and
- **QGIS** – Editing spatial data and mapping.

4.2 Legislation and Guidelines

4.2.1 The National Water Act

The NWA aims to provide for the management of the national water resources to achieve sustainable water use for the benefit of all water users. This act requires that the quality of water resources be protected, as well as the integrated management of water resources, with the delegation of powers to institutions at the regional or catchment level. The purpose of the Act is to ensure that the nation's water resources are protected, used, developed, conserved and managed in ways which take into account (relevant to this study):

- Protecting aquatic and associated ecosystems and their biological diversity,
- Reducing and preventing pollution and degradation of water resources,
- Promoting dam safety, and
- Managing floods and droughts.

Section 19 of the National Water Act (Act No. 36 of 1998) (NWA) sets out the principles for "an owner of the land, a person in control of the land or a person who occupies or uses land" to:

- Cease, modify or control any act or process causing pollution,
- Comply with any prescribed waste standard or management practice,
- Contain or prevent the movement of pollutants,
- Eliminate any source of pollution,
- Remedy the effects of the pollution, and
- Remedy the effects of any disturbance to the bed and banks of a watercourse.

It also describes the actions that the catchment management agency can take to enforce the requirements of the NWA. Section 26 (1) of the NWA provides for the development of regulations that:

- Require the use of incoming and discharging water from a water resource to be monitored, measured and recorded,
- Regulate or prohibit any activity to protect a water resource or in-stream or riparian habitat, and

Prescribe the outcome or effect that must be achieved through management practices for the treatment of waste, or any class of waste, before it is discharged or deposited into or allowed to enter a water resource

4.2.2 Government Notice 704 Guidelines

According to the General Notice (GN 704) regulations of the National Water Act on the protection of surface water resources, no person in control of the mine or activity may:

- Locate or place any residue deposit, dam reservoir, together with any mine associated structure or any other facility within the 1:100 year floodline or within a horizontal distance of 100 meters from watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on waterlogged ground, or on ground likely to become water-logged, undermined, unstable or cracked,

- Place of disposal of any residue or substance which causes or is likely to cause pollution of a water resource, in the workings of any underground or opencast mine excavation, prospecting diggings, pit or any other excavation,

- Except in relation to a matter contemplated in regulation 10 (which only relates to winning sand and alluvial minerals from watercourse or estuary), carry on any underground or opencast mining, prospecting or any other operation or activity under or within 1:50 year floodline or within a horizontal distance of 100 meters from any watercourse or estuary, whichever is the greatest, and

Use any area or locate any sanitary convenience, fuel depots for any substance which causes or is likely to cause pollution of a water resource within the 1:50 year floodline of any watercourse or estuary.

5 HYDROLOGICAL ASSESSMENT

5.1 Physiographic Setting

The prospecting rights area forms part of quaternary W31B and W31C of the Mkuze River, while W22A, W22C and W22E are draining to the Black Mfolozi River basin of Pongola-Mtamvuna WMA (Figure 5-1) and are summarised in Table 5-1. For this study, the sub-drainage areas were delineated and named Drainage 1 to 5 to identify and for modelling purposes. The drainage areas are headwater reaches and originate from hilly mountains characterised by a rural setting with no developments. Across Drainage 1, several small farm dams are likely to be used for irrigation, while other portions are relatively forested plantations. With the exception of Sihlengeni and Sikhwebezi Rivers, other unnamed tributaries are non-perennial, suggesting that there is little baseflow that sustains them during the dry season.

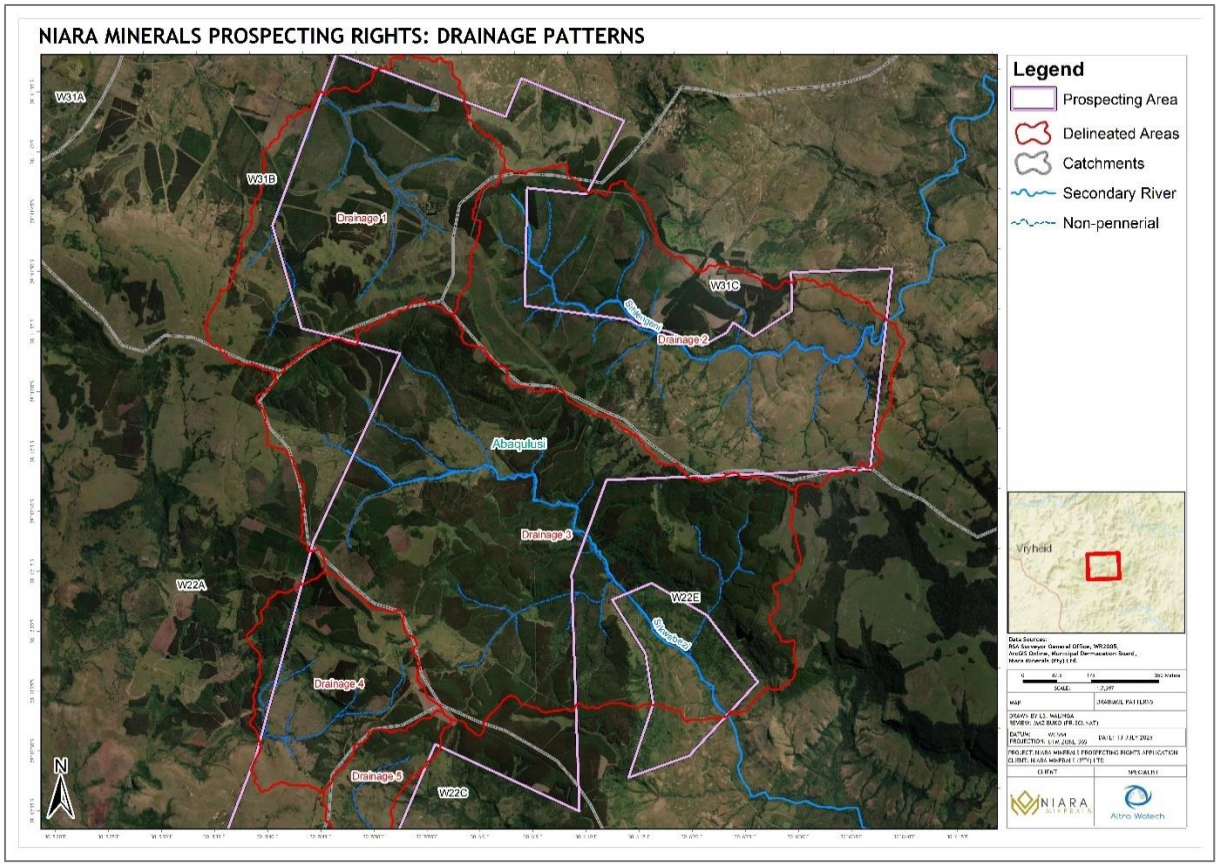

Figure 5-1: Study site drainage boundaries and river lines

Table 5-1: Quaternary catchment characteristics (Bailey & Pitman, 2015)

Catchments	Area (km^2)	MAP (mm)	MAR (Mcm)	MAE (mm)	Main River
W31B	304	796	29.2	1500	Unnamed tribuatary Mkuze
W31C	172	895	23.5	1500	Sihlengeni
W22A	239	913	31.3	1500	Unnamed tribuataries of Black Mfolozi
W22C	186	878	16.6	1500	
W22E	385	1055	63.5	1500	Sikwebezi

The headwater reaches of these quaternaries are elevated at about 1 528 meters above mean sea level (mamsl) while the lowest river outlet of the modelled rivers is at 417 mamsl. The topographic setting of the study, derived from a 30 m ALOS Digital Simulation Model (DSM), is graphically represented in Figure 5-2.

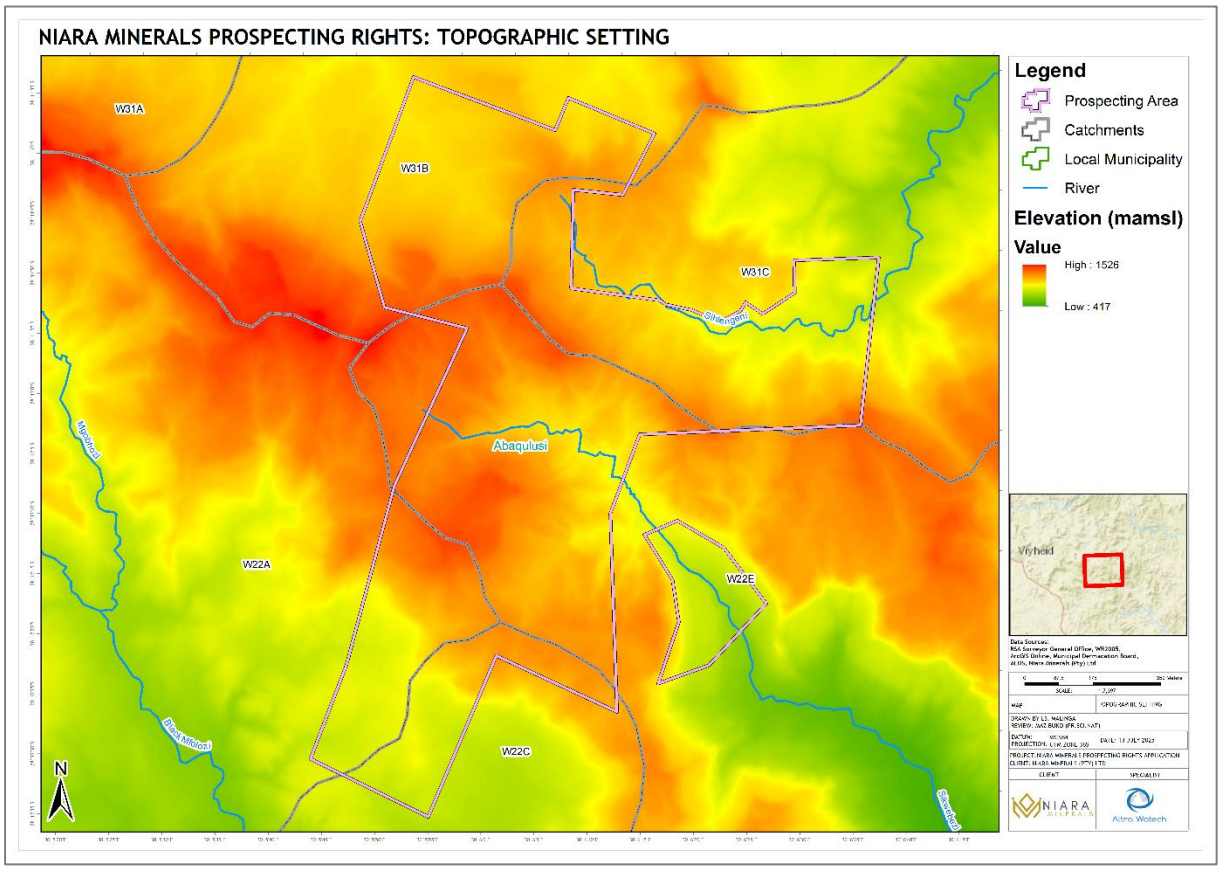

Figure 5-2: Topographic setting of the area draining to the study site

The slope of a catchment is an essential characteristic in calculating the flood peak flow volumes. Generally, steeper slopes produce higher runoff volumes and high velocities and shorten the critical duration of flood-inducing storms, thus leading to higher rainfall intensities. On steep slopes, soil layers are shallower due to less development and fewer depressions, all of which cause a more rapid runoff. The result is that infiltration is reduced and flood peaks are consequently even higher.

Slope analyses for the modelled areas used in the study area are graphically presented in Figure 5-3. The figure shows that the headwater reaches are highly elevated and rivers that drain runoff flow in deep-incised drainage channels with moderately steep slopes. This suggests that flood waters downstream of the headwater reaches have high flow velocities and erosive potential due to the effects of slopes. Detailed longitudinal profiles of the delineated longest rivers for each drainage area are provided in Appendix 9.1.

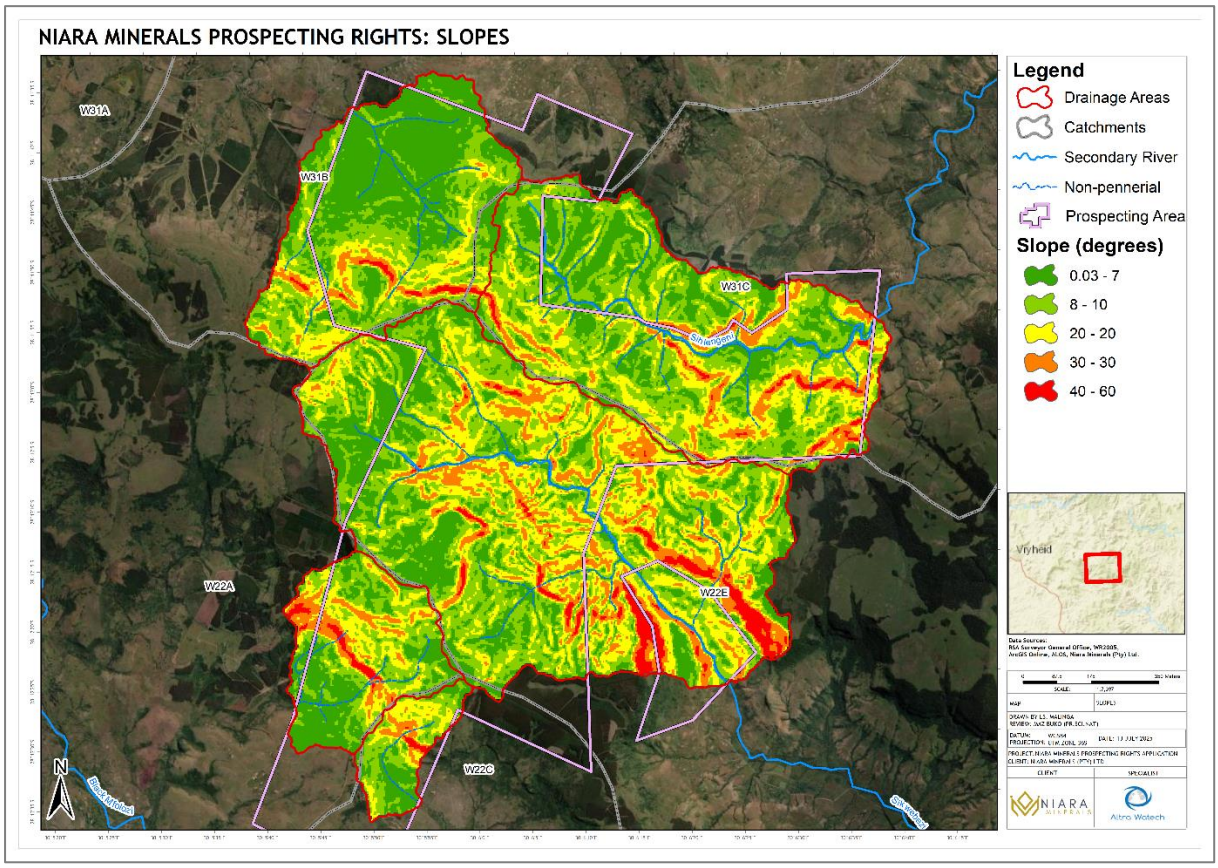

Figure 5-3: Slope characteristics of the drainage areas within the study site

The generic and dominant land cover and land use features within the drainage areas of the prospecting right area are presented in Figure 5-4. The figure shows that forest plantations dominate the land cover, followed by grassland, cultivated land and rural build-up settlements.

Along drainage areas 3, 4 and 5, indigenous forest dominates the riparian areas, while grassland is evident along the riparian zones of drainage 1 and 2, except headwater reaches of drainage area 2, which has forestry (see Figure 5-5). These observations were also made during the site visit, and they were vital in setting Manning's n values in the model to account for variations in the land cover. Given the fact that there was no measured water level or stream flow data within the study site, the initial boundary conditions used in the hydraulic model setup for all modelled river sections were based on the calculated average slope for the reaches along the outlet point of the modelled rivers.

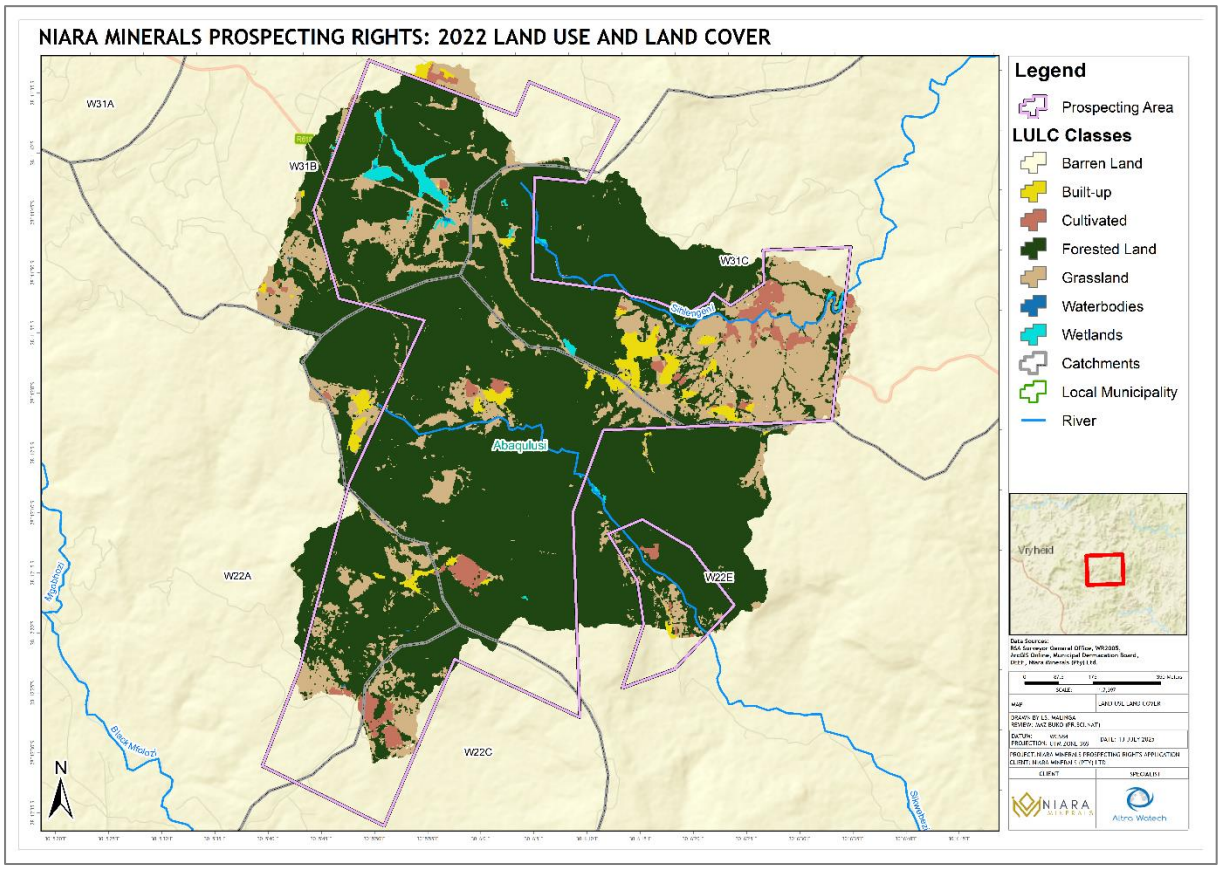

Figure 5-4: Land use and land cover features across the study area

Figure 5-5: Vegetation types in the headwater reaches of the study area

5.2 Baseline Hydrology and Hydrometeorology

The area is typically characterised by temperate climatic conditions (Cwa), Koppen-Geiger (Kottek, 2006) which has dry, cold winters and wet, periodic summers. Long-term average temperature records for the Ngome area indicate that the coldest months (June - July) experience a minimum of 6°C, while hot summers record the maximum temperatures of 26°C between December and February. These variations of temperature recordings are shown in Figure 5-6. Catchment average-based rainfall records from the 90-year record South African Water Resources Study (WR2012) (Bailey & Pitman, 2015) indicate that the area experiences a Mean Annual Precipitation (MAP) of 878 mm. The value is based on the average of all MAP values for the quaternary catchments that cover the prospecting rights areas. Potential evaporation patterns across the area have similar patterns and are classified as areas having similar evaporative volumes per year. The Mean Annual Evaporation (MAE) for the study area is 1 500 mm. The statistical distribution of monthly rainfall and evaporation is presented in **Error! Reference source not found.** and 5-8 and Table 5-2 indicates these variables' high seasonality.

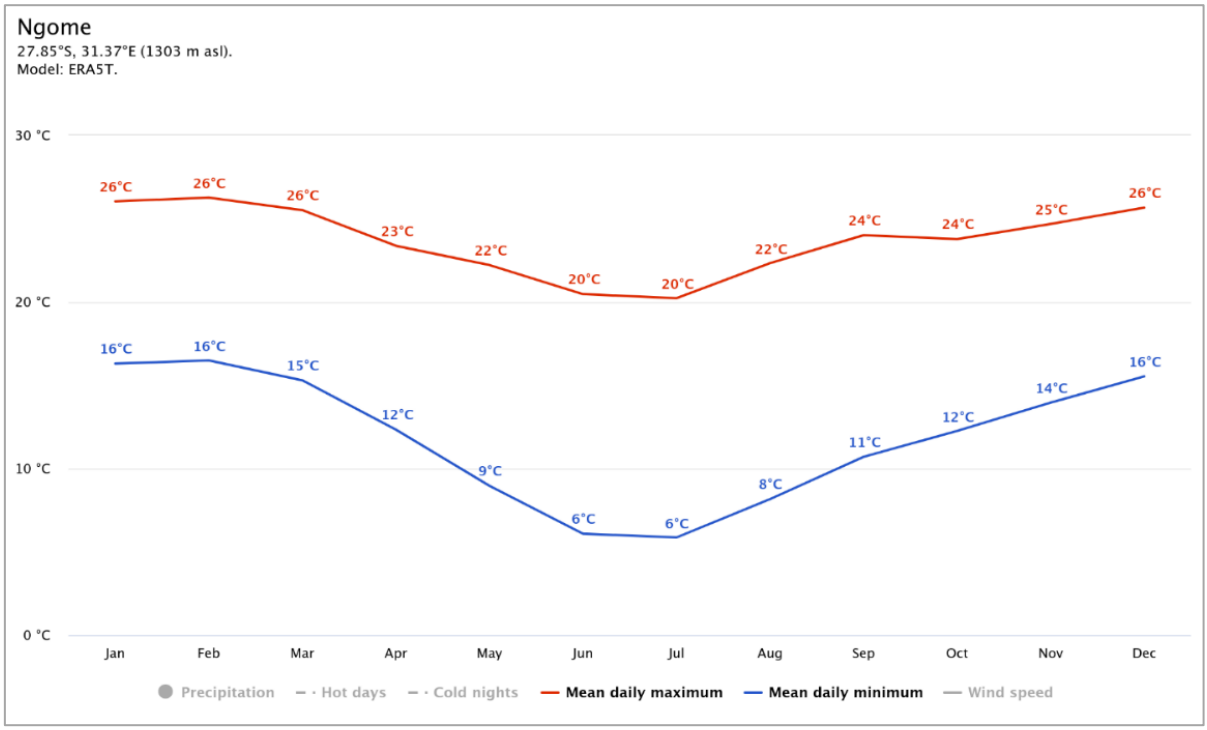

Figure 5-6: Average minimum and maximum temperature for Ngome station (Meteoblue, 2025)

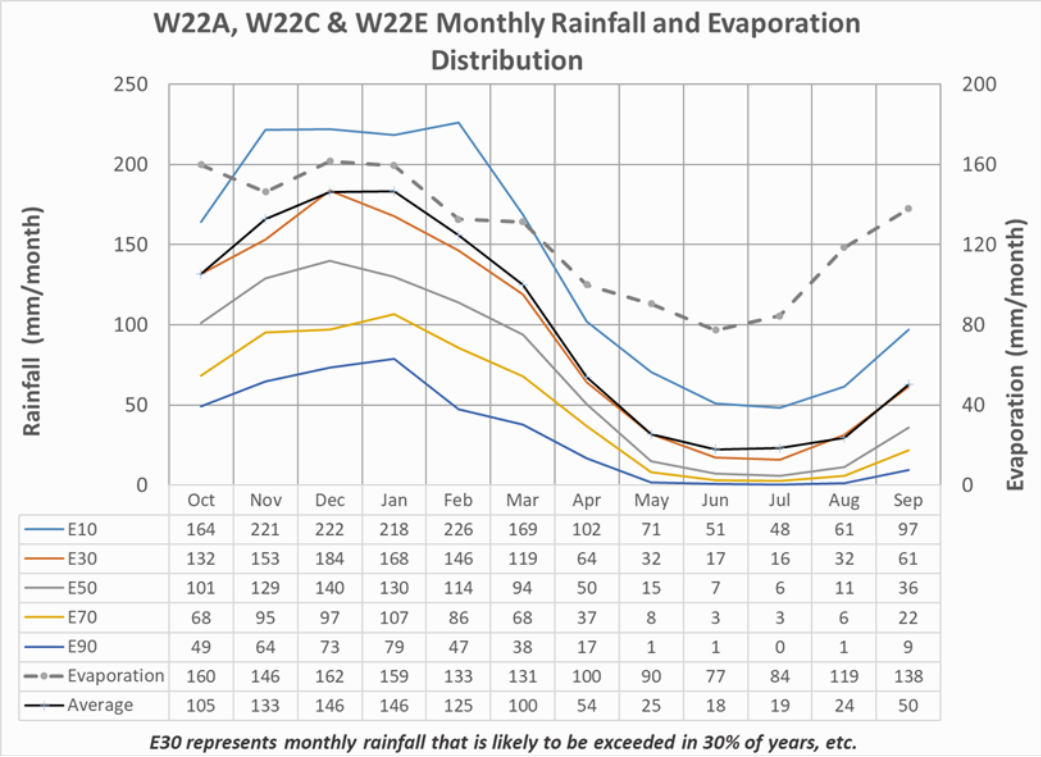

Figure 5-7: Seasonal distribution of rainfall and evaporation for W22A, W22C and W22E (Bailey and Pitman, 2015)

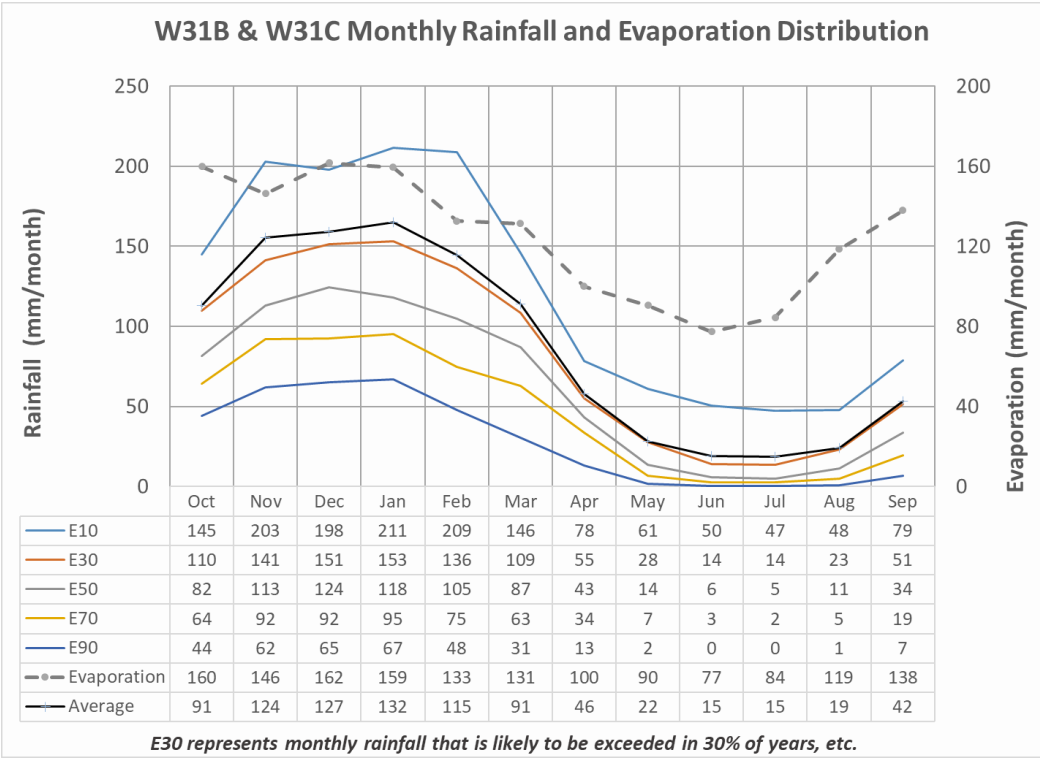

Figure 5-8: Seasonal distribution of rainfall and evaporation for W31B and W31C (Bailey and Pitman, 2015)

Table 5-2: Statistical distribution of monthly rainfall and evaporation

Month	W22A, W22C & W22E: Monthly Rainfall Distribution				Evaporation
	10th Percential	50th Percential	90th Percential	Average	
Oct	164	101	49	72	160
Nov	221	129	64	111	146
Dec	222	140	73	109	162
Jan	218	130	79	120	159
Feb	226	114	47	92	133
Mar	169	94	38	76	131
Apr	102	50	17	41	100
May	71	15	1	16	90
Jun	51	7	1	8	77
Jul	48	6	0	6	84
Aug	61	11	1	7	119
Sep	97	36	9	22	138
Month	W31B & W31C: Monthly Rainfall Distribution				Evaporation
	10th Percential	50th Percential	90th Percential	Average	
Oct	145	82	44	72	160
Nov	203	113	62	111	146
Dec	198	124	65	109	162
Jan	211	118	67	120	159
Feb	209	105	48	92	133
Mar	146	87	31	76	131
Apr	78	43	13	41	100
May	61	14	2	16	90
Jun	50	6	0	8	77
Jul	47	5	0	6	84
Aug	48	11	1	7	119
Sep	79	34	7	22	138

5.2.1 Design Rainfall

The design rainfall depths for the centre position of the area were obtained from the Design Rainfall Estimation (DRE) software (Smithers and Schulze, 2002). The program extracts the storm rainfall depths for various return periods for the six closest South African Weather Services (SAWS) rainfall stations – relative to the centroid of the study area (Table 5-3). Rainfall records from these stations are interpolated to compute the expected rainfall depths for various return periods shown in Table 5-4. These calculate the peak flows for catchment draining to the area evaluated for flood lines through the Alternative Rational Method.

Table 5-3: Summary of the six closest SAWS rain gauge stations for the study area

Station Name	SAWS Number	Distance (km)	Record Length (yrs)	MAP (mm)	Altitude (mamsl)
WELKOM	0373376_W	9.0	32	713	1,102
NGOMI (BOS)	0373680_W	10.9	70	1547	1,338
BOSHOEK-NATAL ANTHRO	0373169_W	19.9	30	1011	1,228
VLAKFONTEIN, VRYHEID	0373329_A	21.0	54	714	693
VLAKFONTEIN	0373329_W	21.0	56	714	693
WATERVAL,VRYHEID	0373114_A	25.1	36	824	1,197

Table 5-4: Summary of the design rainfall depths for various return periods

Duration	Rainfall Depth(mm)					
	1:2 year	1:5 year	1:10 year	1:20 year	1:50 year	1:100 year
5mins	16	23	28	33	42	50
10mins	21	29	36	43	54	64
15mins	24	33	41	50	63	74
30mins	30	42	51	62	78	93
45mins	34	47	58	70	89	105
1hr	37	52	64	77	97	116
1.5hrs	42	59	72	88	111	131
2hrs	46	65	79	96	121	144
4hrs	53	75	92	111	140	166
6hrs	58	81	100	121	153	181
8hrs	62	86	106	128	162	192
10hrs	65	90	111	134	170	202
12hrs	67	94	116	140	176	209
16hrs	71	100	123	148	187	222
20hrs	75	105	129	155	196	233
24hrs	**78**	**109**	**134**	**161**	**204**	**242**

5.3 Peak Flow Volumes

The calculated peak flows for the modelled rivers were based on the catchment attributes derived using various datasets to characterise factors affecting runoff generation. These included the 2022 LULC (Geoterra Image (Pty) Ltd, 2024) and soil types (Schütte *et al.*, 2023), which were quantified per drainage area to determine their spatial area relative to the catchment size. The key variables used in the calibration of the runoff coefficient for all drainage areas are summarised in Table 5-5. These were assumed to account for representative volumes, given that they are calibrated based on understanding the factors that affect runoff generation, which are set through the use of the 'c' factor in the calculations. These only include the RM; however, other methods are attached in Appendix 9.1.

Table 5-5: Hydrological variables used in the Rational Method for peak flow calculation

DRAINAGE 1					
Soil Permeability:	**%A**	**Land-Cover:**	**%A**	**Rainfall:**	
Very Permeable (A)	2%	Forest, Dense bush & wood	5%	Mean Annual Rainfall (mm)	796
Permeable (B)	70%	Thin Bush, Cultivated land	70%	Extreme point rainfall region *	2
Semi-Permeable (C)	22%	Grassland	23%	Coastal (**C**) or Inland (**I**)	I
Impermeable (D)	6%	Bare surface	2%	Winter (**W**) or Summer (**S**)	S
DRAINAGE 2					
Soil Permeability:	**%A**	**Land-Cover:**	**%A**	**Rainfall:**	
Very Permeable (A)	1%	Forest, Dense bush & wood	12%	Mean Annual Rainfall (mm)	895
Permeable (B)	78%	Thin Bush, Cultivated land	51%	Extreme point rainfall region *	2
Semi-Permeable (C)	17%	Grassland	36%	Coastal (**C**) or Inland (**I**)	I
Impermeable (D)	4%	Bare surface	1%	Winter (**W**) or Summer (**S**)	S
DRAINAGE 3					
Soil Permeability:	**%A**	**Land-Cover:**	**%A**	**Rainfall:**	
Very Permeable (A)	16%	Forest, Dense bush & wood	20%	Mean Annual Rainfall (mm)	1055
Permeable (B)	58%	Thin Bush, Cultivated land	71%	Extreme point rainfall region *	1
Semi-Permeable (C)	20%	Grassland	9%	Coastal (**C**) or Inland (**I**)	I
Impermeable (D)	6%	Bare surface	0%	Winter (**W**) or Summer (**S**)	S
DRAINAGE 4					
Soil Permeability:	**%A**	**Land-Cover:**	**%A**	**Rainfall:**	
Very Permeable (A)	3%	Forest, Dense bush & wood	30%	Mean Annual Rainfall (mm)	913
Permeable (B)	13%	Thin Bush, Cultivated land	49%	Extreme point rainfall region *	1
Semi-Permeable (C)	60%	Grassland	20%	Coastal (**C**) or Inland (**I**)	I
Impermeable (D)	24%	Bare surface	1%	Winter (**W**) or Summer (**S**)	S
Drainage 5					
Soil Permeability:	**%A**	**Land-Cover:**	**%A**	**Rainfall:**	
Very Permeable (A)	6%	Forest, Dense bush & wood	20%	Mean Annual Rainfall (mm)	878
Permeable (B)	34%	Thin Bush, Cultivated land	42%	Extreme point rainfall region *	1
Semi-Permeable (C)	57%	Grassland	36%	Coastal (**C**) or Inland (**I**)	I
Impermeable (D)	3%	Bare surface	2%	Winter (**W**) or Summer (**S**)	S

Peak flow volumes selected for the simulation in the HEC-RAS model are summarised in Table 5-6 while the statistical distributions used to select the best-fit of the computed flow volumes for each drainage are given in Figure 5-9. Detailed peak flow computations are shown in Table 5-7.

Table 5-6: Summary of the selected peak flow volumes

Area	Peak Flow		
	1:50 (m^3/s)	1:100 (m^3/s)	Method
Drainage 1	176	214	Alt Rational Method
Drainage 2	153	186	Alt Rational Method
Drainage 3	305	369	Alt Rational Method
Drainage 4	154	198	Rational Method
Drainage 5	52	71	Rational Method

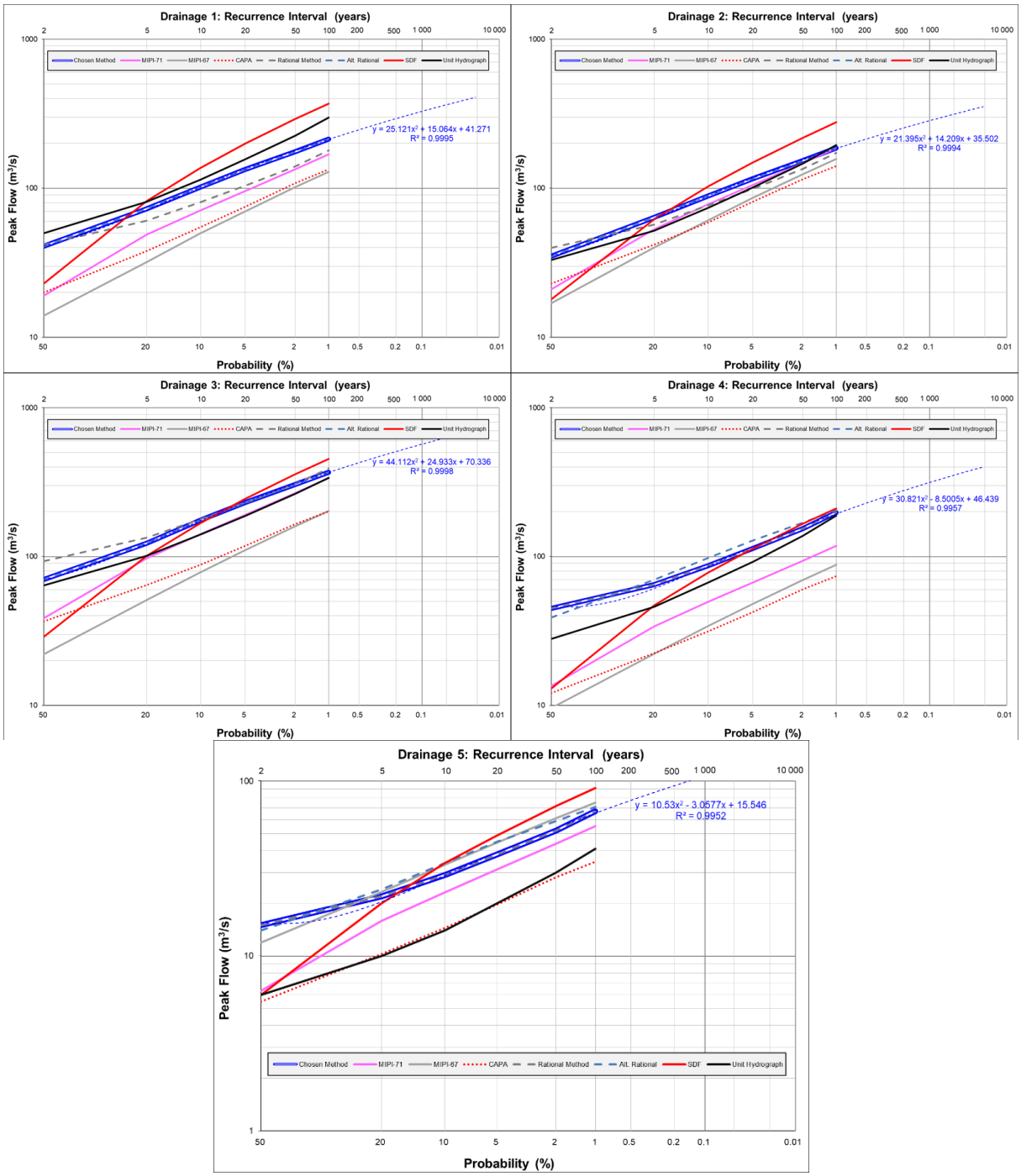

Figure 5-9: Statistical distribution of the calculated peak flow volumes

Table 5-7: Detailed description of the calculated peak flow volumes

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Unnamed Tributary of Mkuze River
Description of site: Drainage 1
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 1\Drainage 1.fld
Date: 10 July 2025

Printed: 20 July 2025 Page 1

Summary of peak flows (m³/s)

Method	1:2	1:5	1:10	1:20	1:50	1:100	1:200	Design year
Rational 1	42.06	60.52	80.61	104.25	140.63	179.05		80
Rational 2	40.82	73.45	102.08	133.54	176.47	214.04		95
Unit hydrograph	50.25	80.62	114.49	155.50	225.00	297.90		100
Standard design flood	23.46	82.38	137.08	199.01	291.42	369.06		100
Empirical			62.99	85.67	119.69	151.18		80

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Sihlengeni River
Description of site: Drainage 2
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 2\Drainage 2.fld
Date: 10 July 2025

Printed: 20 July 2025 Page 1

Summary of peak flows (m³/s)

Method	1:2	1:5	1:10	1:20	1:50	1:100	1:200	Design year
Rational 1	39.77	57.39	76.65	99.45	134.83	172.55		80
Rational 2	35.49	63.86	88.76	116.11	153.45	186.12		90
Unit hydrograph	32.55	52.07	73.99	100.71	146.39	194.80		80
Standard design flood	17.58	61.72	102.70	149.10	218.33	276.50		100
Empirical			66.41	90.32	126.18	159.39		80

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Sikhwebezi River
Description of site: Drainage 3
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 3\Drainage 3.fld
Date: 10 July 2025

Printed: 20 July 2025 Page 1

Summary of peak flows (m³/s)

Method	1:2	1:5	1:10	1:20	1:50	1:100	1:200	Design year
Rational 1	93.00	133.55	177.53	229.05	307.79	390.31		100
Rational 2	70.44	126.76	176.18	230.47	304.57	369.42		100
Unit hydrograph	64.44	101.23	141.26	188.28	264.17	338.27		100
Standard design flood	28.78	101.08	168.20	244.19	357.59	452.85		100
Empirical			114.99	156.39	218.49	275.99		100

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Unnamed Tributary Black Mfolozi River
Description of site: Drainage 4
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 4\Drainage 4.fld
Date: 10 July 2025

Printed: 20 July 2025 Page 1

Summary of peak flows (m^3/s)

Method	1:2	1:5	1:10	1:20	1:50	1:100	1:200	Design year
Rational 1	44.81	64.82	86.82	112.98	153.93	197.99		90
Rational 2	39.11	70.37	97.80	127.94	169.08	205.08		90
Unit hydrograph	28.34	46.12	66.58	92.21	137.86	188.93		80
Standard design flood	13.33	46.82	77.91	113.11	165.64	209.76		90
Empirical			44.40	60.39	84.36	106.56		70

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Unnamed Tributary Black Mfolozi River
Description of site: Drainage 5
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 5\Drainage 5.fld
Date: 10 July 2025

Printed: 20 July 2025 Page 1

Summary of peak flows (m^3/s)

Method	1:2	1:5	1:10	1:20	1:50	1:100	1:200	Design year
Rational 1	14.98	21.72	29.17	38.05	52.07	67.26		60
Rational 2	13.60	24.47	34.01	44.50	58.81	71.32		60
Unit hydrograph	5.942	9.735	14.14	19.73	29.83	41.36		50
Standard design flood	5.789	20.33	33.83	49.11	71.91	91.07		60
Empirical			21.57	29.34	40.99	51.77		55

5.4 Floodlines Determination

Floodlines simulations were undertaken using HEC-RAS version 6.5 software where all delineated catchments were modelled separately. River geometries were created throughout the river channel profiles of the identified drainage areas. The 2022 LULC data were used together with the information derived during the site visit and visual assessment of satellite imagery retrieved through Google Earth Pro to assign Manning's n-values corresponding to the dominant land cover along the segments of the modelled rivers.

The hydraulic characteristics of the catchment and geometric setting for the modelled section are summarised in Table 5-8. These include the elements related to runoff generation, routing and factors affecting the routing processes in the model.

Table 5-8: Hydraulic characteristics of the modelled catchment

Catchment	Area (km^2)	Longest River (km)	Ave. Slope (m/m)	Time of Concentration (hrs)	Manning's n		
					L. Bank	Channel	R. Bank
Drainage 1	19.0	4.62	0.013	1.13	0.08 – 0.12	0.08 – 0.035	0.08 – 0.12
Drainage 2	28.3	9.44	0.025	1.96			
Drainage 3	46.9	10.58	0.042	2.77			
Drainage 4	8.9	4.51	0.054	0.99			
Drainage 5	3.1	3.66	0.046	1.03			

6 FLOODLINES

The geometries of the modelled rivers are graphically presented in Figure 6-1 and shows the key cross-sections for the identified river reaches. Notably, most of the identified river segments included in the modelling process have contributing non-perennial tributaries. These were not included in the modelling exercise, other than the main channel, which routes the flood volumes out of the catchment. The resulting floodlines for the 1:50 and 1:100-yr return peak flow events were derived using the calculations of the Rational Method and are shown in Figure 6-2 for the whole prospecting rights area. Detailed mapping of the resulting floodlines for each drainage area used in the modelling is presented in Figure 6-23 to 6-7. Modelling results show that the nature of the area's topographic setting and the dominant soil characteristics allow for the generation of flash floods, resulting in large volumes of peak discharges into the river systems. Due to the slope characteristics of most rivers, with the exception of Drainage 1, flood waters will be contained within the river valleys and are not likely to inundate larger spatial areas. Areas along Drainage 1 are relatively flat, with grasslands dominant along the riparian zones, which are likely to have large areas inundated with flood waters. Based on the risk hazard of the floods across the prospecting area, rivers with steep and incised channels will have floods characterised by turbulent flows and high erosive potential, which makes them more risky than those on a relatively flat terrain.

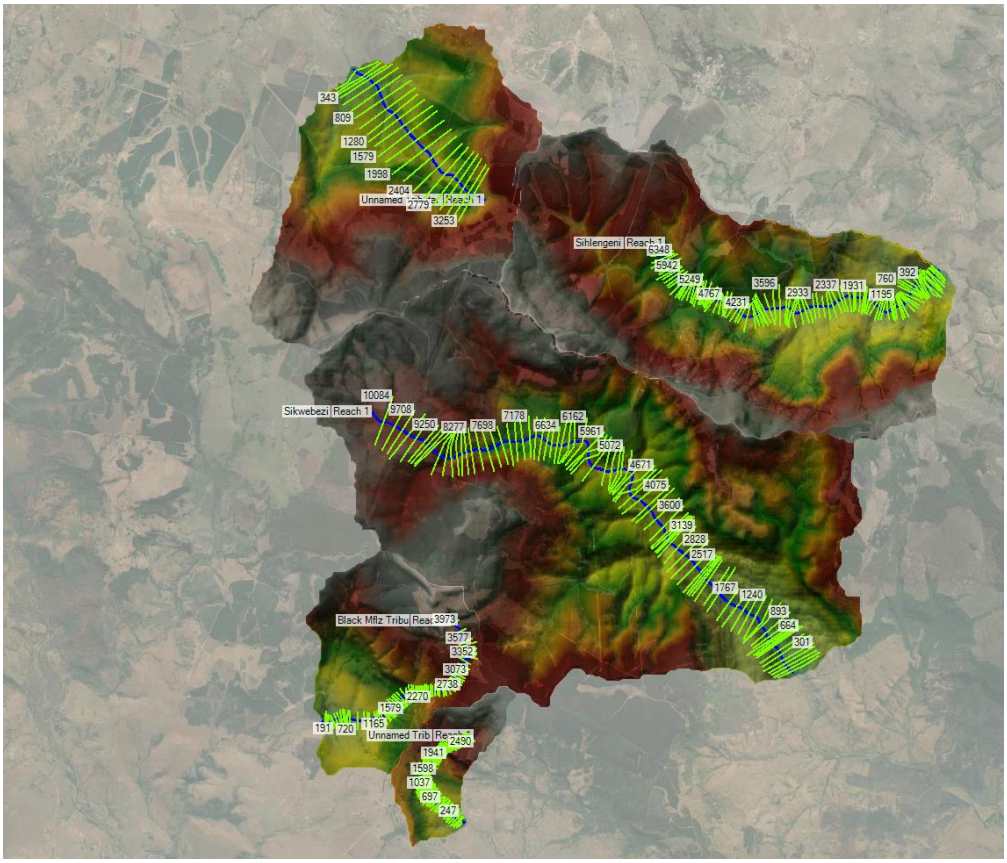

Figure 6-1: Modelled river section geometry used in the simulation of the floodlines

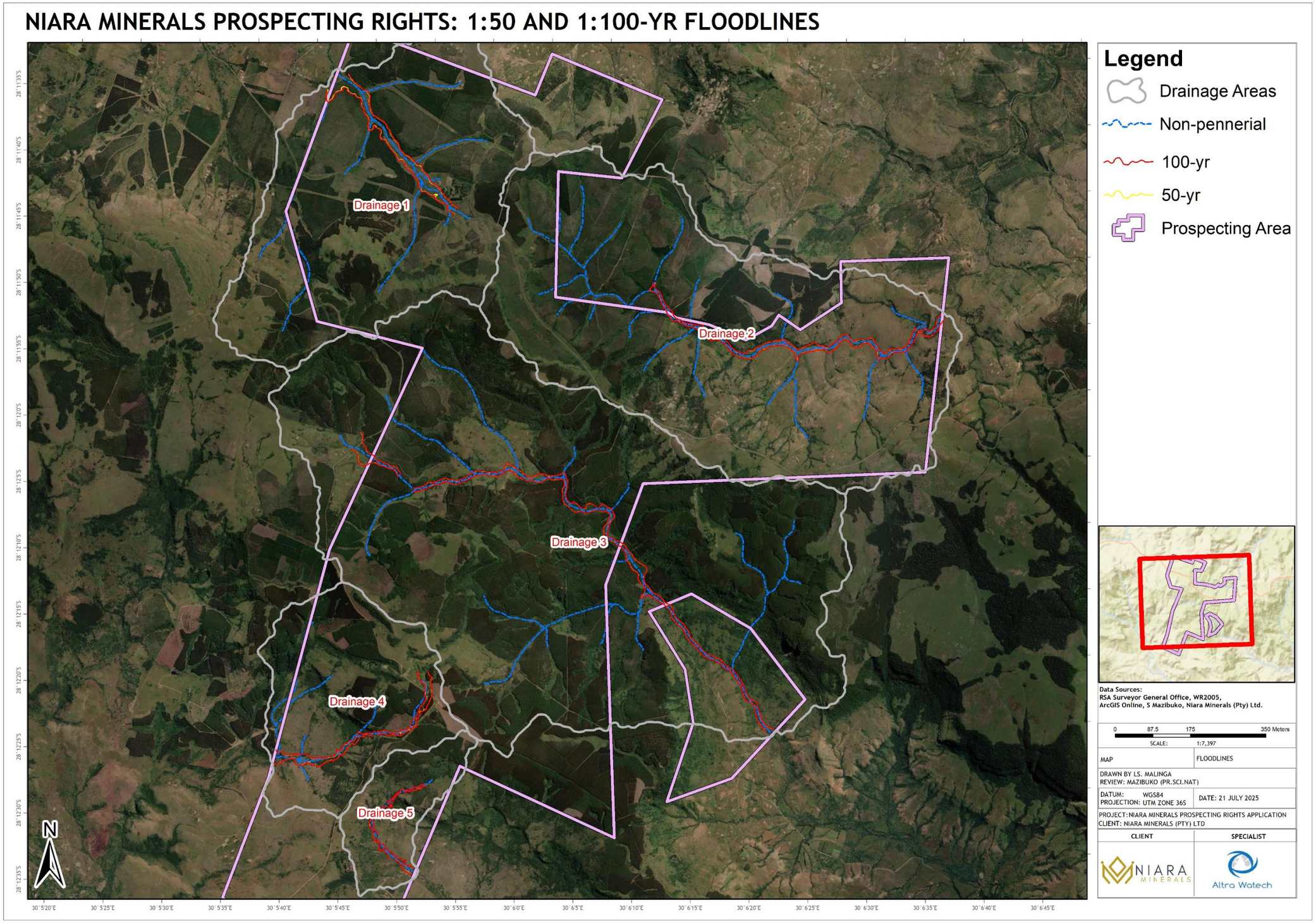

Figure 6-2: All simulated 1:50 and 1:100-yr floodlines

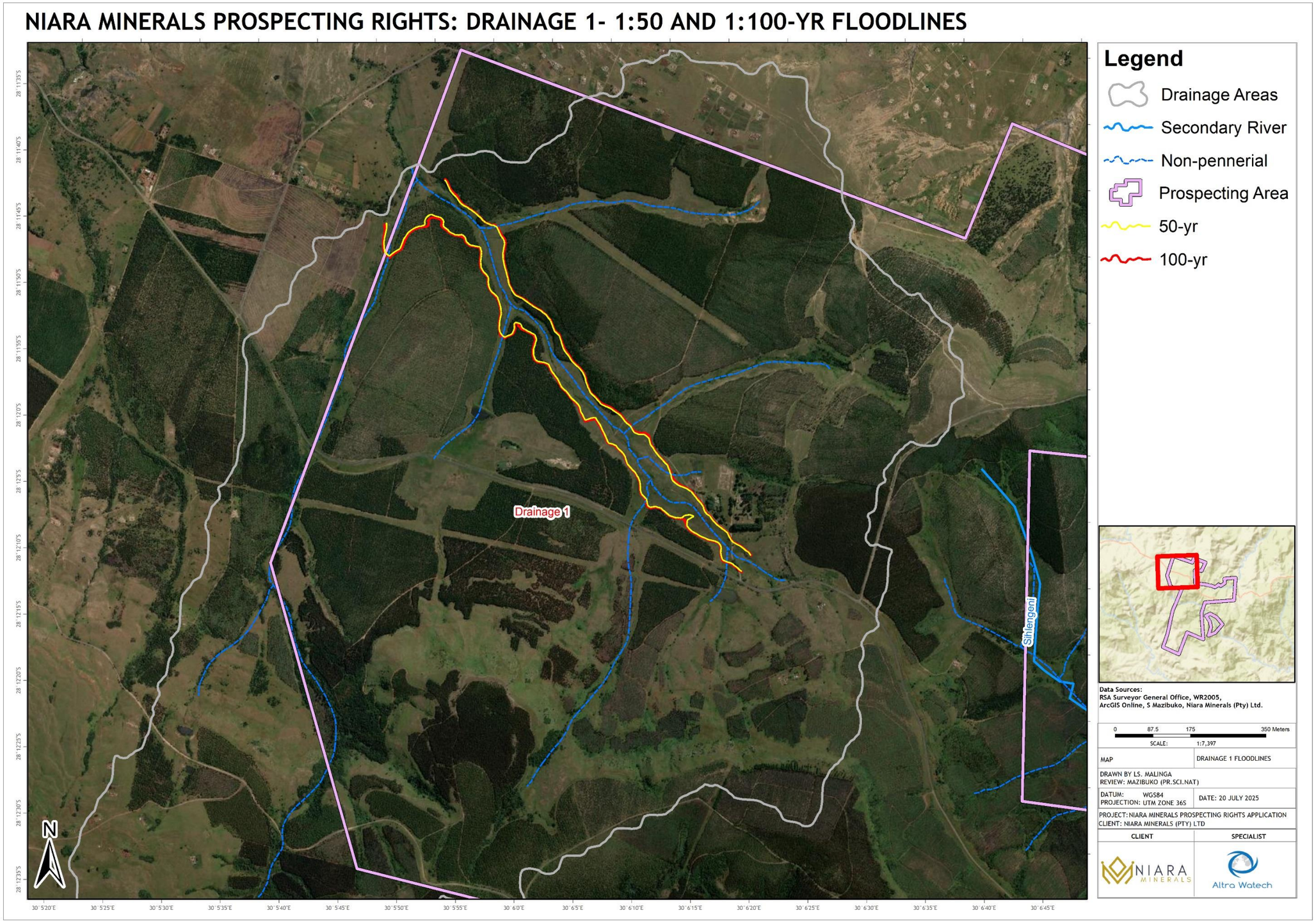

Figure 6-3: Drainage 1 simulated 1:50 and 1:100-yr floodlines

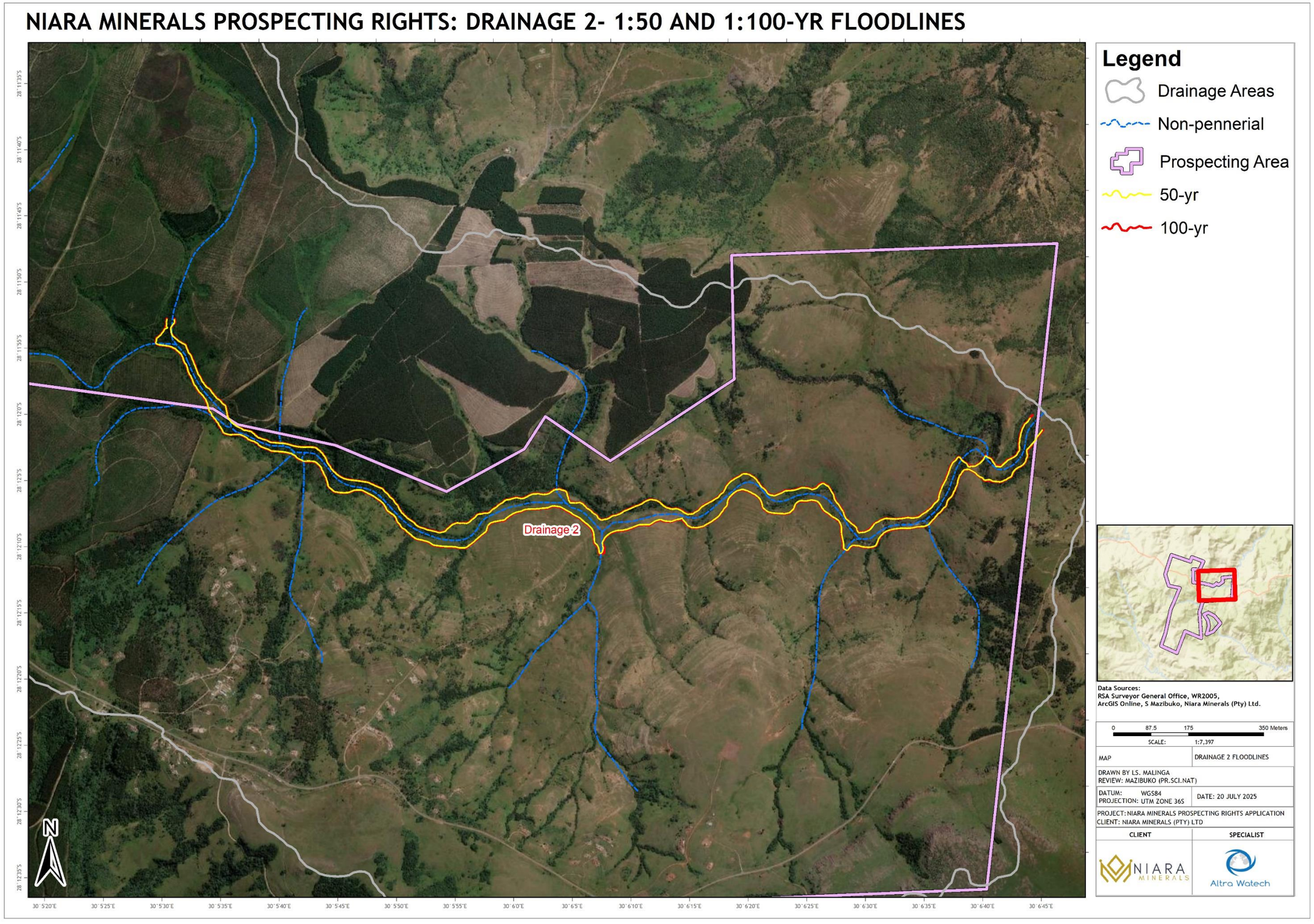

Figure 6-4: Drainage 2 simulated 1:50 and 1:100-yr floodlines

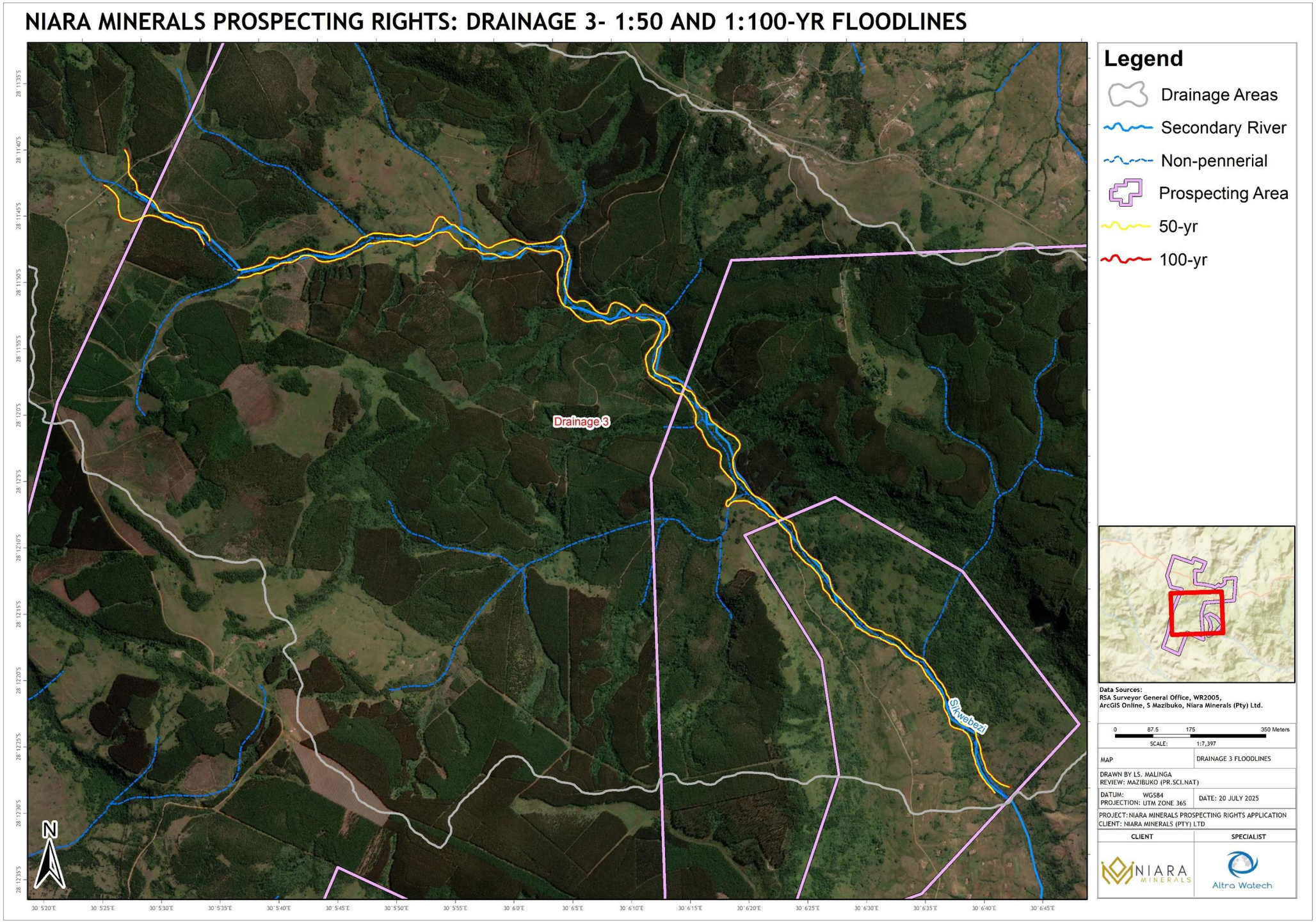

Figure 6-5: Drainage 3 simulated 1:50 and 1:100-yr floodlines

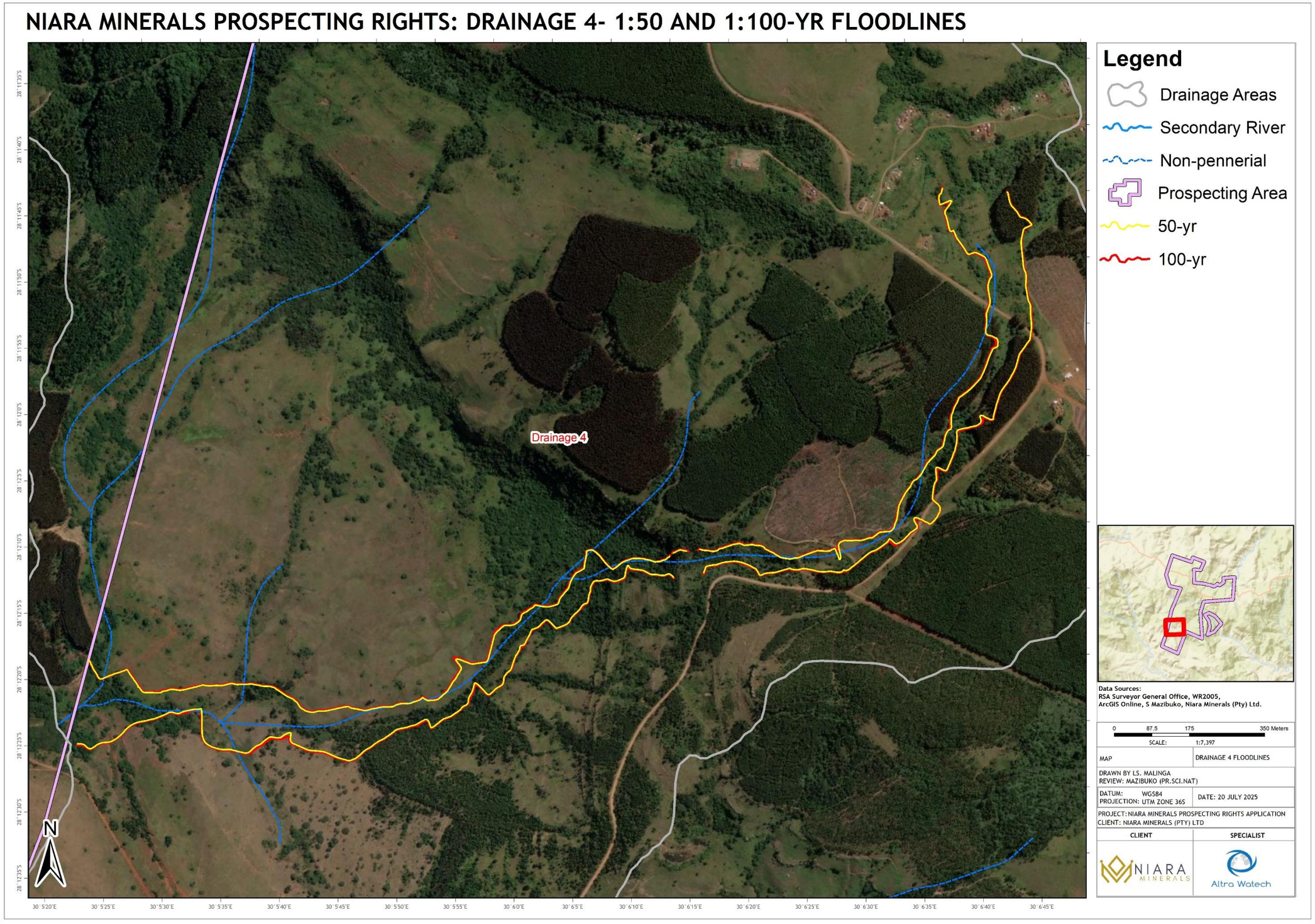

Figure 6-6: Drainage 4 simulated 1:50 and 1:100-yr floodlines

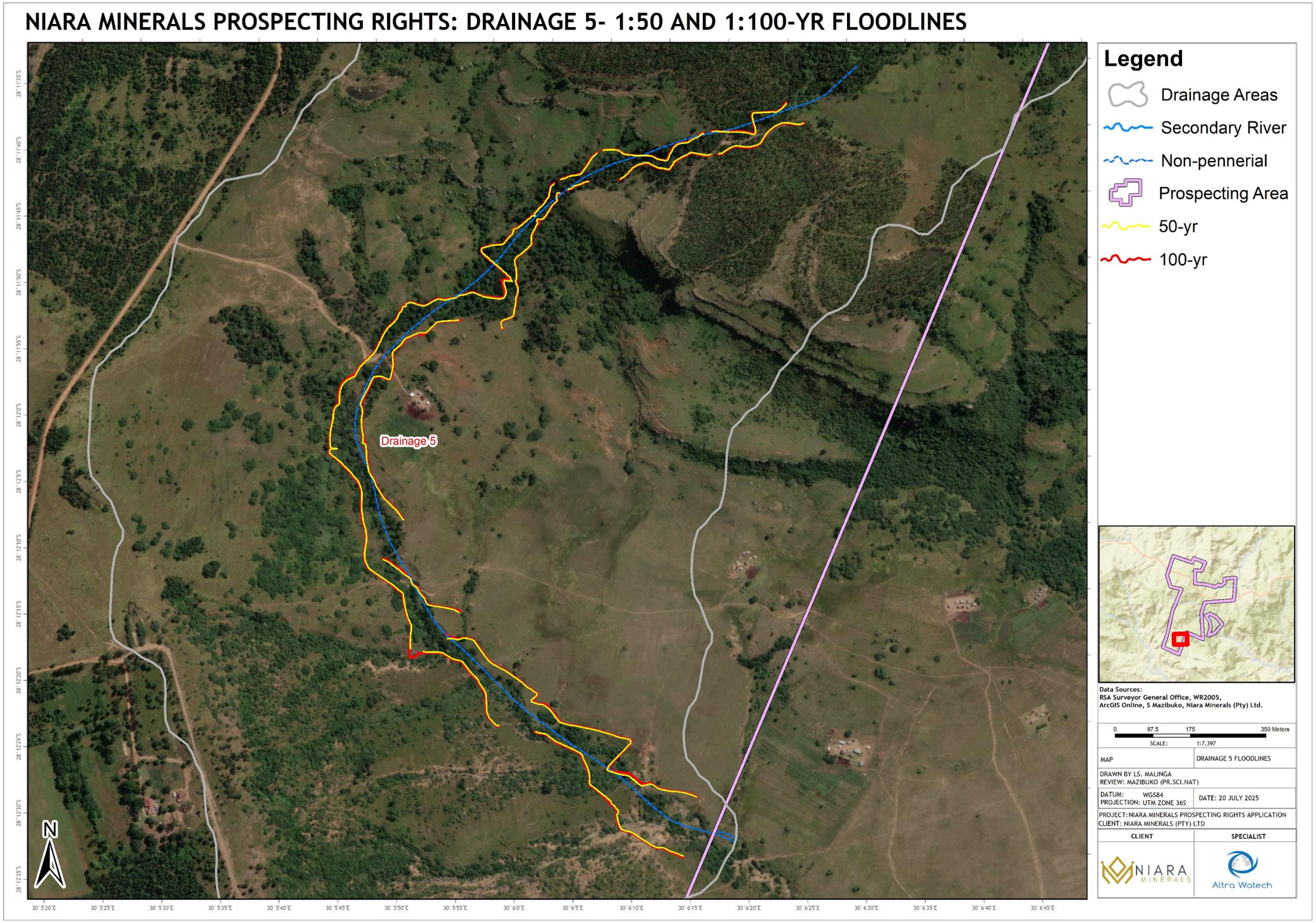

Figure 6-7: Drainage 5 simulated 1:50 and 1:100-yr floodlines

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Recommendations

- To ensure the safety and compliance with the relevant regulations and legislation, it is recommended that any potential developments be conducted outside the bounds of the simulated 1:50 and 1:100-yr floodlines presented in this study. In the event of potential development along the river reaches with inline structures such as low-crossing bridges and culverts, the simulated flood lines need to be refined as a means of ensuring that these structures are represented in the model well.

7.2 Conclusions

This floodline assessment aimed to delineate the 1:50 and 1:100-yr floodlines for the prospecting rights areas associated with the main rivers and tributary networks. The following conclusions were made:

- The study site is characterised by a rural setting dominated by forestry and grassland and an undeveloped area on a hilly mountain with deep valley ridges. gentle slope, which routes its natural runoff to the swampy flat riparian area modelled in this study.
- A total of five sub-drainage areas were delineated, for which their longest river sections were modelled in this study. These form part of the Upper Mkuze and Black Mfolozi River Basins of the Pongola-Mtamvuna Water Management Area. The geometries of the modelled rivers of the delineated drainage areas were derived using the 5m contour data. Several cross-sections were drawn to account for changes in the river flow and riparian land cover.
- The 1:50 and 1:100-yr peak flow volumes for Drainages 1, 2 and 3 were derived from the Rational Method, while Drainages 4 and 5 were based on the MIPI method. These were based on the runoff coefficient's calibration principles and the modelled catchment sizes.
- Flood simulation results using these selected peak flow volumes were mapped for all corresponding basins. Results show that the hydraulic model could simulate the flood waters; however, there is an overestimation of the flows on the river banks. This is attributed to the limitation of the spatial resolution of the dataset used to configure the hydraulic model.

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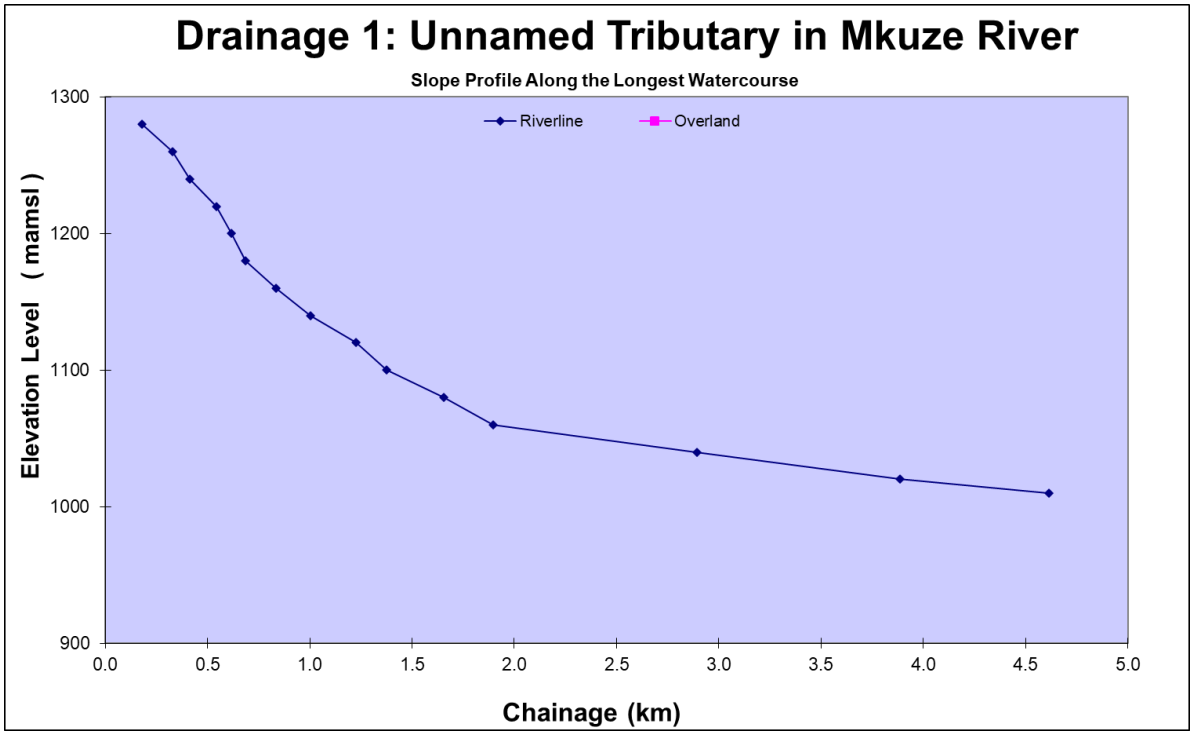
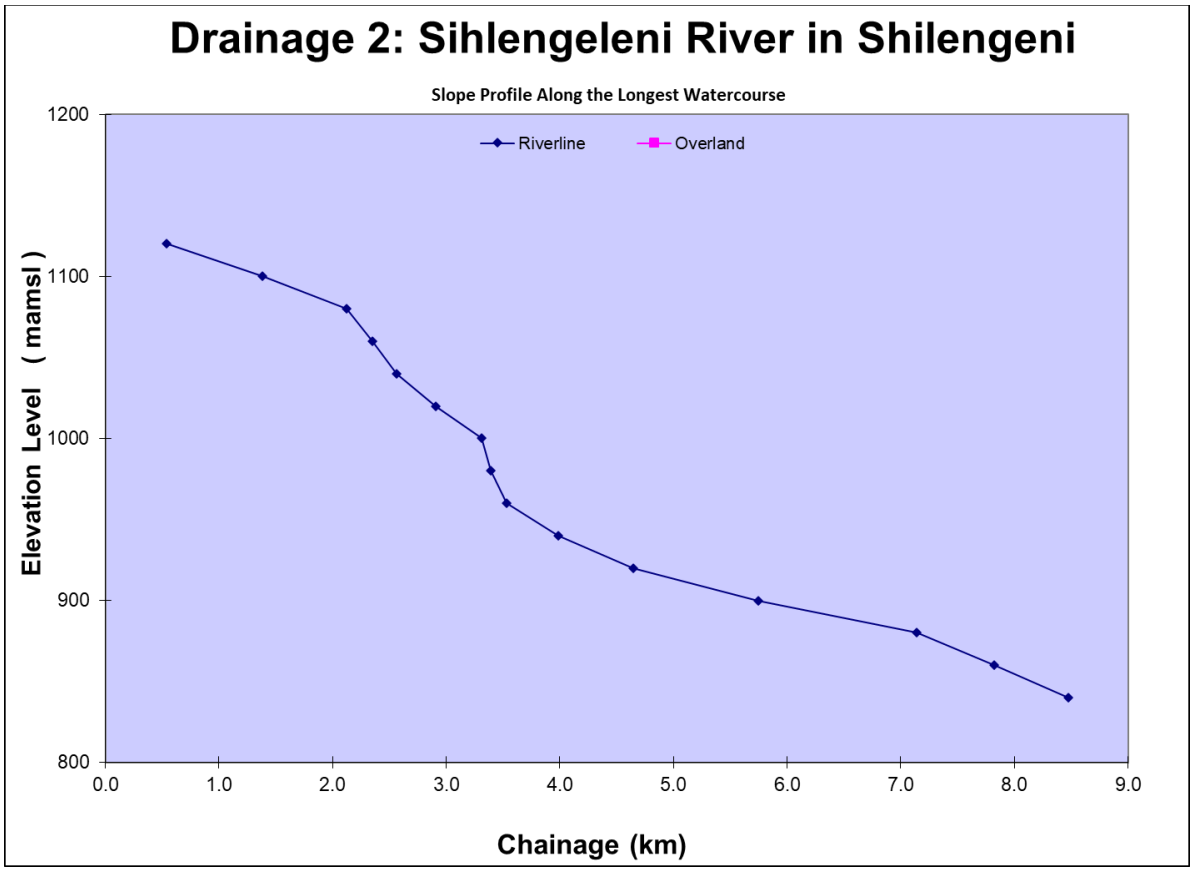
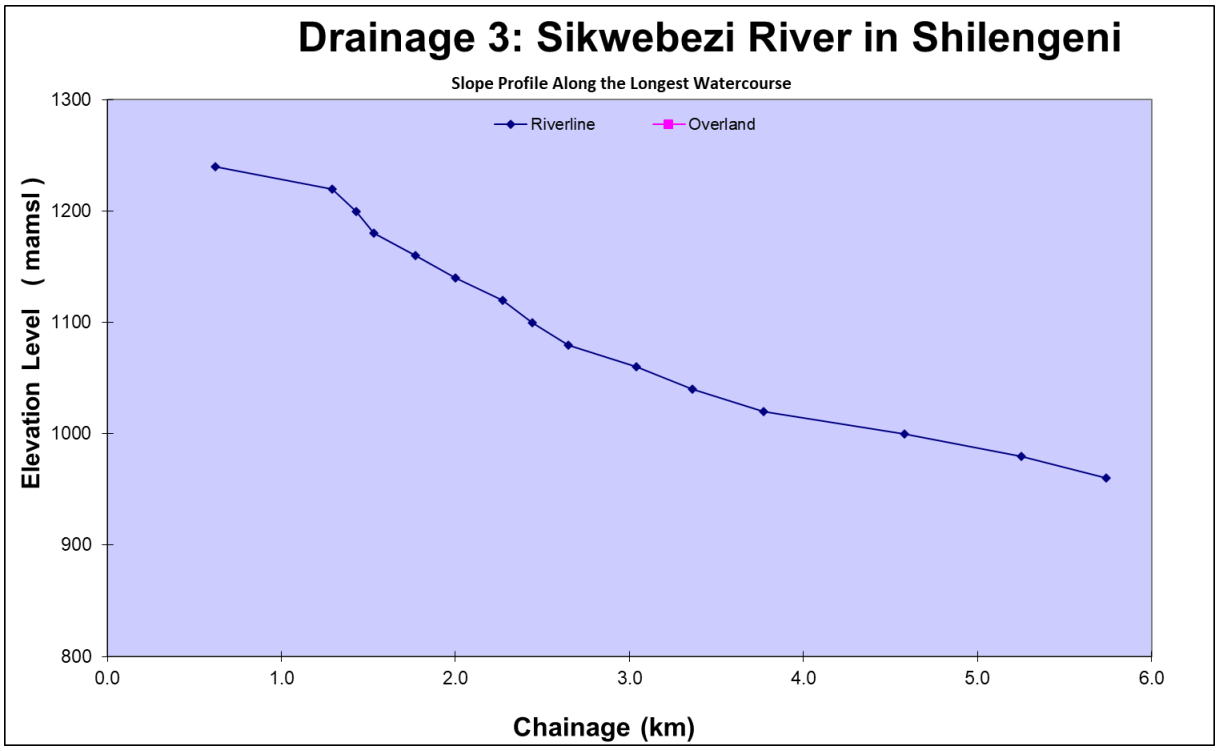
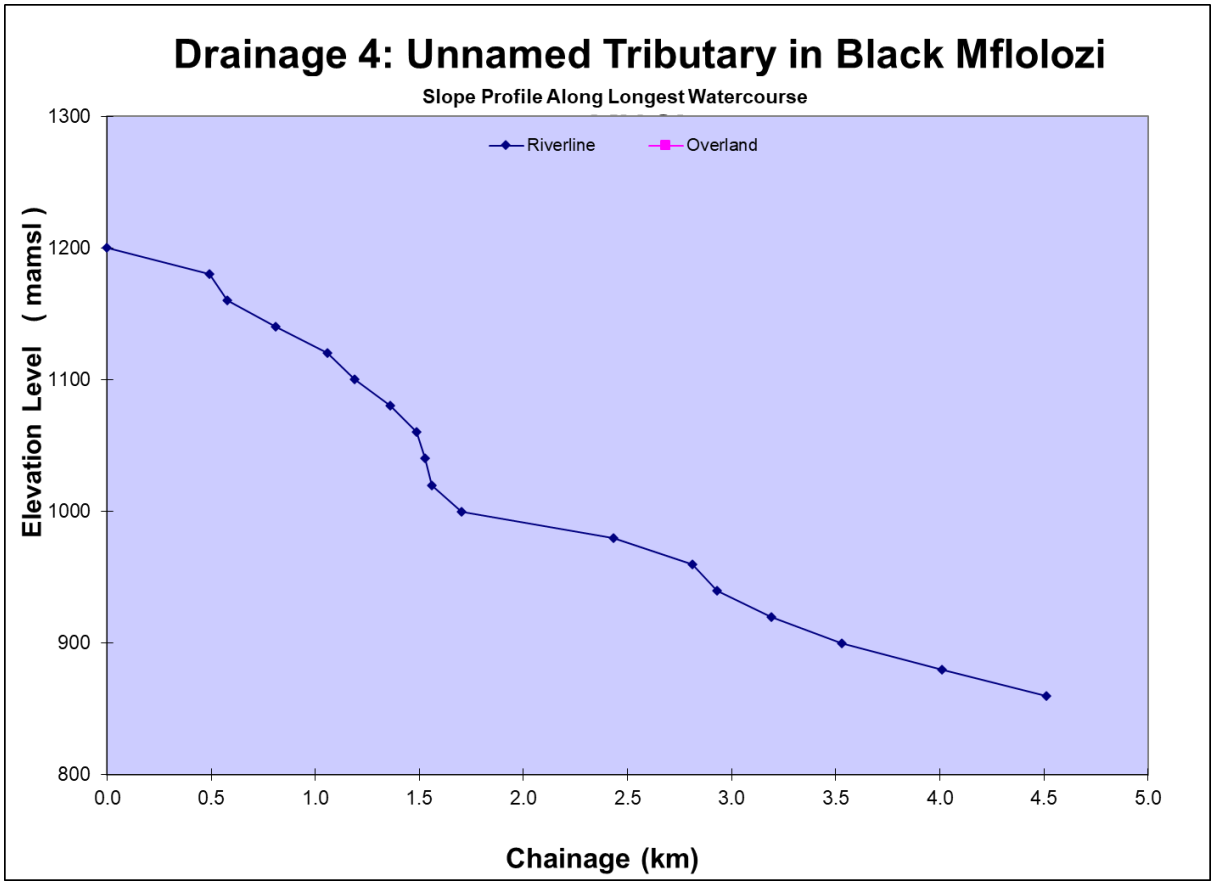
9 APPENDICES

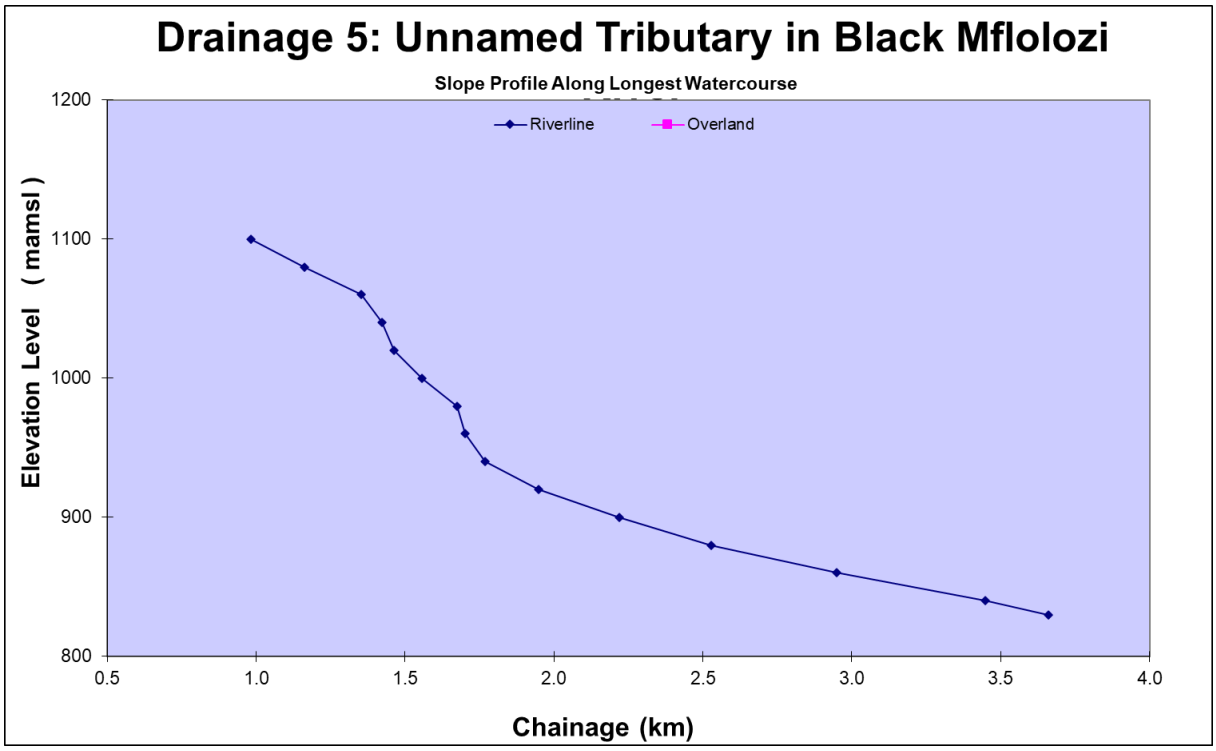
9.1 Slope Profiles






Drainage 3: Sikwebezi River in Shilengeni
Slope Profile Along the Longest Watercourse
Riverline
Overland
Elevation Level (mamsl)
1300
1200
1100
1000
900
800
0.0
1.0
2.0
3.0
4.0
5.0
6.0
Chainage (km)


Drainage 4: Unnamed Tributary in Black Mflolozi
Slope Profile Along Longest Watercourse
Riverline
Overland
Elevation Level (mamsl)
1300
1200
1100
1000
900
800
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Chainage (km)



9.2 Catchment Characteristics

DRAINAGE 1: CHARACTERISTICS

Catchment Area and Slope:

Total:	A	=	19.0	km^2	Dolomitic areas in effective catchment:				
Ineffective:	A_i	=	0	km^2	Part of A_e considered as dolomitic:	A_d	=	0	km^2
Effective:	A_e	=	19	km^2	Reduction factor	k	=	0.46	
Mean steepness of A_e	S_A	=	17.90	%	Flood peak reduction coefficient	f_d	=	1.00	

Watercourse Properties:

Longest Watercourse:					Mean Slope:			
Natural channel	L_1	=	4.62	km	Mean slope of L_1	S_1	=	0.031164
Total length	L	=	4.62	km	Mean slope of L_{total}	S_L	=	0.031164
Distance to centre of A	L_c	=	2.20	km	(distance, along channel, to a point closest to the centre of catchment)			

Time of Concentration (T_c):

TYPE OF FLOW	TIME OF CONCENTRATION (hours)		
Natural channel	$t_{c1} = T\,[0.87*L_1^2 / (1000*S_1)]^{0.385}$	1.11	
Overland	$t_{c2} = 0{,}6 * [\, r * L_2 / (S_2)^{0.5}\,]^{0.467}$	0.00	**1.0**

where

A_e	=	19.0	to calculate T
T	=	1.4	corr according to size of A
r	=	0.40	roughness factor

Typical r values	Pavement	0,02	Bare soil	0,1	Poor grass	0,3	Average grass & Cultivated land	0,4	Dense grass	0,8

Rainfall-Runoff Properties:

Veld Type Zones	9	
Relative Weight (%)	100%	

Catchment Coverage as Required for Rational Method:

Rural	Urban	Lakes
96%	0%	4%

DRAINAGE 2: CHARACTERISTICS

Catchment Area and Slope:

Total:	A	=	28.3	km^2	Dolomitic areas in effective catchment:				
Ineffective:	A_i	=	0	km^2	Part of A_e considered as dolomitic:	A_d	=	0	km^2
Effective:	A_e	=	28	km^2	Reduction factor	k	=	0.46	
Mean steepness of A_e	S_A	=	17.90	%	Flood peak reduction coefficient	f_d	=	1.00	

Watercourse Properties:

Longest Watercourse:					Mean Slope:			
Natural channel	L_1	=	9.44	km	Mean slope of L_1	S_1	=	0.025382
Total length	L	=	9.44	km	Mean slope of L_{total}	S_L	=	0.025382
Distance to centre of A	L_c	=	4.50	km	(distance, along channel, to a point closest to the centre of catchment)			

Time of Concentration (T_c):

TYPE OF FLOW	TIME OF CONCENTRATION (hours)			where			
Natural channel	$t_{c1} = T\,[0.87*L_1^2 / (1000*S_1)]^{0.385}$	1.96		A_e =	28.3	to calculate	T
Overland	$t_{c2} = 0{,}6 * [\, r * L_2 / (S_2)^{0.5}\,]^{0.467}$	0.00	**2.0**	T =	1.3	corr according to size of A	
				r =	0.80	roughness factor	

Typical r values	Pavement	0,02	Bare soil	0,1	Poor grass	0,3	Average grass & Cultivated land	0,4	Dense grass	0,8

Rainfall-Runoff Properties:

Veld Type Zones	9	8
Relative Weight (%)	80%	20%

Catchment Coverage as Required for Rational Method:

Rural	Urban	Lakes
99%	0%	1%

DRAINAGE 3: CHARACTERISTICS

Catchment Area and Slope:

Total:	A	=	46.9	km^2	Dolomitic areas in effective catchment:				
Ineffective:	A_i	=	0	km^2	Part of A_e considered as dolomitic:	A_d	=	0	km^2
Effective:	A_e	=	47	km^2	Reduction factor	k	=	0.46	
Mean steepness of A_e	S_A	=	17.90	%	Flood peak reduction coefficient	f_d	=	1.00	

Watercourse Properties:

Longest Watercourse:					Mean Slope:			
Natural channel	L_1	=	10.58	km	Mean slope of L_1	S_1	=	0.042098
Total length	L	=	10.58	km	Mean slope of L_{total}	S_L	=	0.042098
Distance to centre of A	L_c	=	5.10	km	(distance, along channel, to a point closest to the centre of catchment)			

Time of Concentration (T_c):

TYPE OF FLOW	TIME OF CONCENTRATION (hours)			where			
Natural channel	$t_{c1} = T\,[0.87*L_1^2 / (1000*S_1)]^{0.385}$	1.61		A_e =	46.9	to calculate	T
Overland	$t_{c2} = 0{,}6 * [\, r * L_2 / (S_2)^{0.5}\,]^{0.467}$	0.00	**1.5**	T =	1.2	corr according to size of A	
				r =	0.80	roughness factor	

Typical r values	Pavement	0,02	Bare soil	0,1	Poor grass	0,3	Average grass & Cultivated land	0,4	Dense grass	0,8

Rainfall-Runoff Properties:

Veld Type Zones (HRU 1/72 fig.F1)	9	8	
Relative Weight (%)	95%	5%	

Catchment Coverage as Required for Rational Method:

Rural	Urban	Lakes
100%	0%	0%

DRAINAGE 4: CHARACTERISTICS

Catchment Area and Slope:

Total:	A	=	8.9	km^2	Dolomitic areas in effective catchment:				
Ineffective:	A_i	=	0	km^2	Part of A_e considered as dolomitic:	A_d	=	0	km^2
Effective:	A_e	=	9	km^2	Reduction factor	k	=	0.46	
Mean steepness of A_e	S_A	=	17.90	%	Flood peak reduction coefficient	f_d	=	1.00	

Watercourse Properties:

Longest Watercourse:					Mean Slope:			
Natural channel	L_1	=	4.51	km	Mean slope of L_1	S_1	=	0.053774
Total length	L	=	4.51	km	Mean slope of L_{total}	S_L	=	0.053774
Distance to centre of A	L_c	=	1.70	km	(distance, along channel, to a point closest to the centre of catchment)			

Time of Concentration (T_c):

TYPE OF FLOW	TIME OF CONCENTRATION (hours)			where			
Natural channel	$t_{c1} = T\,[0.87*L_1^2 / (1000*S_1)]^{0.385}$	0.99		A_e =	8.9	to calculate	T
Overland	$t_{c2} = 0{,}6 * [\,r * L_2 / (S_2)^{0.5}\,]^{0.467}$	0.00	**1.0**	T =	1.5	corr according to size of A	
				r =	0.40	roughness factor	

Typical r values	Pavement	0,02	Bare soil	0,1	Poor grass	0,3	Average grass & Cultivated land	0,4	Dense grass	0,8

Rainfall-Runoff Properties:

Veld Type Zones	9	
Relative Weight (%)	100%	

Catchment Coverage as Required for Rational Method:

Rural	Urban	Lakes
100%	0%	0%

DRAINAGE 5: CHARACTERISTICS

Catchment Area and Slope:

Total:	A	=	3.1	km^2	Dolomitic areas in effective catchment:				
Ineffective:	A_i	=	0	km^2	Part of A_e considered as dolomitic:	A_d	=	0	km^2
Effective:	A_e	=	3	km^2	Reduction factor	k	=	0.46	
Mean steepness of A_e	S_A	=	17.90	%	Flood peak reduction coefficient	f_d	=	1.00	

Watercourse Properties:

Longest Watercourse:					Mean Slope:			
Natural channel	L_1	=	3.66	km	Mean slope of L_1	S_1	=	0.046364
Total length	L	=	3.66	km	Mean slope of L_{total}	S_L	=	0.046364
Distance to centre of A	L_c	=	1.04	km	(distance, along channel, to a point closest to the centre of catchment)			

Time of Concentration (T_c):

TYPE OF FLOW	TIME OF CONCENTRATION (hours)			where			
Natural channel	$t_{c1} = T\,[0.87*L_1^2 / (1000*S_1)]^{0.385}$	1.03		A_e =	3.1	to calculate	T
Overland	$t_{c2} = 0{,}6 * [\,r * L_2 / (S_2)^{0.5}\,]^{0.467}$	0.00	**1.0**	T =	1.8	corr according to size of A	
				r =	0.04	roughness factor	

Typical r values	Pavement	0,02	Bare soil	0,1	Poor grass	0,3	Average grass & Cultivated land	0,4	Dense grass	0,8

Rainfall-Runoff Properties:

Veld Type Zones (HRU 1/72 fig.F1)	9	
Relative Weight (%)	100%	

Catchment Coverage as Required for Rational Method:

Rural	Urban	Lakes
100%	0%	0%

9.3 Peak Flow Calculations – Rational Method

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Unnamed Tributary of Mkuze River
Description of site: Drainage 1
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 1\Drainage 1.fld
Date: 10 July 2025

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```
Flood Frequency Analysis: Rational Method 1

Project                                = Niara Minerals Prospecting Rights - Floodlines
Analysed by                            = SC Mazibuko (Pr.Sci.Nat.)
Name of river                          = Unnamed Tributary of Mkuze River
Description of site                    = Drainage 1
Date                                   = 7/10/2025
Area of catchment                      = 19.04 km²
Dolomitic area                         = 0.0 %
Mean annual rainfall (MAR)             = 796.00 mm
Length of longest watercourse          = 4.62 km
Flow of water                          = Defined water course
Height difference along 10-85 slope    = 47.0 m
Rainfall region                        = Inland
Area distribution                      = Rural: 96 %,  Urban: 0 %,  Lakes: 4 %

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          5    Very permeable     2     Thick bush & forests          5
Flat area               75   Permeable          70    Light bush & cultivated land  70
Hilly                   20   Semi-permeable     22    Grasslands                    23
Steep areas             0    Impermeable        6     Bare                          2
-----------------------------------------------------------------------------------------
Average slope                          = 0.01356 m/m
Time of concentration                  = 1.13 h
Run-off factor
Rural - C1                             = 0.334
Urban - C2                             = 0.000
Lakes - C3                             = 0.000
Combined - C                           = 0.321
The HRU, Report 2/78, Depth-Duration-Frequency diagram was used to determine the point rainfall.

-----------------------------------------------------------------------------------------
Return      Time of        Point       ARF      Average     Factor      Runoff       Peak
Period      concentration  rainfall             intensity   Ft          coefficient  flow
(years)     (hours)        (mm)        (%)      (mm/h)                  (%)          (m³/s)
-----------------------------------------------------------------------------------------
1:2         1.13           38.3        97.5     33.1        0.75        24.0         42.06
1:5         1.13           52.1        96.6     44.6        0.80        25.7         60.52
1:10        1.13           66.0        95.7     55.9        0.85        27.3         80.61
1:20        1.13           81.4        94.6     68.3        0.90        28.9         104.25
1:50        1.13           105.9       93.0     87.3        0.95        30.5         140.63
1:100       1.13           130.3       91.4     105.6       1.00        32.1         179.05
Run-off coefficient percentage includes adjustment saturation factors (Ft) for steep and impermeable
catchments


Calculated using Utility Programs for Drainage 2.0.0
```

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Sihlengeni River
Description of site: Drainage 2
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 2\Drainage 2.fld
Date: 10 July 2025

Printed: 20 July 2025 Page 1

Flood Frequency Analysis: Rational Method 1

Project	= Niara Minerals Prospecting Rights - Floodlines
Analysed by	= SC Mazibuko (Pr.Sci.Nat.)
Name of river	= Sihlengeni River
Description of site	= Drainage 2
Date	= 7/10/2025
Area of catchment	= 28.3 km²
Dolomitic area	= 0.0 %
Mean annual rainfall (MAR)	= 895.00 mm
Length of longest watercourse	= 9.44 km
Flow of water	= Defined water course
Height difference along 10-85 slope	= 37.0 m
Rainfall region	= Inland
Area distribution	= Rural: 99 %, Urban: 0 %, Lakes: 1 %

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	2	Very permeable	1	Thick bush & forests	12
Flat area	39	Permeable	78	Light bush & cultivated land	51
Hilly	49	Semi-permeable	17	Grasslands	36
Steep areas	10	Impermeable	4	Bare	1

Average slope	= 0.00523 m/m
Time of concentration	= 2.82 h
Run-off factor	
Rural - C1	= 0.376
Urban - C2	= 0.000
Lakes - C3	= 0.000
Combined - C	= 0.372

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 (m³/s)
1:2	2.82	52.1	98.2	18.1	0.75	27.9	39.77
1:5	2.82	71.0	97.5	24.5	0.80	29.8	57.39
1:10	2.82	89.9	96.9	30.8	0.85	31.6	76.65
1:20	2.82	110.9	96.2	37.8	0.90	33.5	99.45
1:50	2.82	144.2	95.0	48.5	0.95	35.4	134.83
1:100	2.82	177.5	93.9	59.0	1.00	37.2	172.55

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

Calculated using Utility Programs for Drainage 2.0.0

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Sikhwebezi River
Description of site: Drainage 3
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 3\Drainage 3.fld
Date: 10 July 2025

Printed: 20 July 2025 Page 1

Flood Frequency Analysis: Rational Method 1

Project	= Niara Minerals Prospecting Rights - Floodlines
Analysed by	= SC Mazibuko (Pr.Sci.Nat.)
Name of river	= Sikhwebezi River
Description of site	= Drainage 3
Date	= 7/10/2025
Area of catchment	= 46.9 km²
Dolomitic area	= 0.0 %
Mean annual rainfall (MAR)	= 1055.00 mm
Length of longest watercourse	= 10.58 km
Flow of water	= Defined water course
Height difference along 10-85 slope	= 55.0 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	16	Thick bush & forests	20
Flat area	30	Permeable	58	Light bush & cultivated land	71
Hilly	55	Semi-permeable	20	Grasslands	9
Steep areas	15	Impermeable	6	Bare	0

Average slope	= 0.00693 m/m
Time of concentration	= 2.77 h
Run-off factor	
Rural - C1	= 0.451
Urban - C2	= 0.000
Lakes - C3	= 0.000
Combined - C	= 0.451

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 (m³/s)
1:2	2.77	60.2	97.0	21.1	0.75	33.8	93.00
1:5	2.77	82.0	95.9	28.4	0.80	36.1	133.55
1:10	2.77	103.8	94.8	35.5	0.85	38.3	177.53
1:20	2.77	128.1	93.5	43.3	0.90	40.6	229.05
1:50	2.77	166.5	91.6	55.1	0.95	42.8	307.79
1:100	2.77	205.0	89.6	66.4	1.00	45.1	390.31

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

Calculated using Utility Programs for Drainage 2.0.0

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Unnamed Tributary Black Mfolozi River
Description of site: Drainage 4
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 4\Drainage 4.fld
Date: 10 July 2025

Printed: 20 July 2025 Page 1

Flood Frequency Analysis: Rational Method 1

Project	= Niara Minerals Prospecting Rights - Floodlines
Analysed by	= SC Mazibuko (Pr.Sci.Nat.)
Name of river	= Unnamed Tributary Black Mfolozi River
Description of site	= Drainage 4
Date	= 7/10/2025
Area of catchment	= 8.9 km²
Dolomitic area	= 0.0 %
Mean annual rainfall (MAR)	= 913.00 mm
Length of longest watercourse	= 4.51 km
Flow of water	= Defined water course
Height difference along 10-85 slope	= 80.0 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	3	Thick bush & forests	30
Flat area	25	Permeable	13	Light bush & cultivated land	49
Hilly	60	Semi-permeable	60	Grasslands	20
Steep areas	15	Impermeable	24	Bare	1

Average slope	= 0.02365 m/m
Time of concentration	= 53.7 min
Run-off factor	
Rural - C1	= 0.541
Urban - C2	= 0.000
Lakes - C3	= 0.000
Combined - C	= 0.541

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 (m³/s)
1:2	0.89	40.4	98.9	44.7	0.75	40.5	44.81
1:5	0.89	55.0	98.5	60.6	0.80	43.2	64.82
1:10	0.89	69.7	98.1	76.4	0.85	45.9	86.82
1:20	0.89	86.0	97.7	93.9	0.90	48.6	112.98
1:50	0.89	111.8	97.0	121.3	0.95	51.3	153.93
1:100	0.89	137.6	96.3	148.2	1.00	54.1	197.99

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

Calculated using Utility Programs for Drainage 2.0.0

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Unnamed Tributary Black Mfolozi River
Description of site: Drainage 5
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 5\Drainage 5.fld
Date: 10 July 2025

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Flood Frequency Analysis: Rational Method 1

Project	= Niara Minerals Prospecting Rights - Floodlines
Analysed by	= SC Mazibuko (Pr.Sci.Nat.)
Name of river	= Unnamed Tributary Black Mfolozi River
Description of site	= Drainage 5
Date	= 7/10/2025
Area of catchment	= 3.1 km²
Dolomitic area	= 0.0 %
Mean annual rainfall (MAR)	= 878.00 mm
Length of longest watercourse	= 3.66 km
Flow of water	= Defined water course
Height difference along 10-85 slope	= 96.0 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	6	Thick bush & forests	20
Flat area	20	Permeable	34	Light bush & cultivated land	42
Hilly	55	Semi-permeable	57	Grasslands	36
Steep areas	25	Impermeable	3	Bare	2

Average slope	= 0.03497 m/m
Time of concentration	= 39.3 min
Run-off factor	
Rural - C1	= 0.433
Urban - C2	= 0.000
Lakes - C3	= 0.000
Combined - C	= 0.433

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 (m³/s)
1:2	0.66	35.3	99.5	53.6	0.75	32.5	14.98
1:5	0.66	48.0	99.4	72.8	0.80	34.6	21.72
1:10	0.66	60.8	99.2	92.0	0.85	36.8	29.17
1:20	0.66	75.0	99.0	113.4	0.90	39.0	38.05
1:50	0.66	97.5	98.8	147.0	0.95	41.1	52.07
1:100	0.66	120.0	98.5	180.4	1.00	43.3	67.26

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

Calculated using Utility Programs for Drainage 2.0.0

9.4 Peak Flow Calculations – Alternative Rational Method

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Unnamed Tributary of Mkuze River
Description of site: Drainage 1
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 1\Drainage 1.fld
Date: 10 July 2025

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```
Flood Frequency Analysis: Rational Method 2

Project                                  = Niara Minerals Prospecting Rights - Floodlines
Analysed by                              = SC Mazibuko (Pr.Sci.Nat.)
Name of river                            = Unnamed Tributary of Mkuze River
Description of site                      = Drainage 1
Date                                     = 7/10/2025
Area of catchment                        = 19.04 km²
Dolomitic area                           = 0.0 %
Length of longest watercourse            = 4.62 km
Flow of water                            = Defined water course
Height difference along 10-85 slope      = 47.0 m
Area distribution                        = Rural: 96 %,  Urban: 0 %,  Lakes: 4 %

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           5     Very permeable      2    Thick bush & forests          5
Flat area               75     Permeable          70    Light bush & cultivated land  70
Hilly                   20     Semi-permeable     22    Grasslands                    23
Steep areas              0     Impermeable         6    Bare                          2
Days on which thunder was heard          = 60 days/year
Weather Services station number          =
Weather Services station location        =
Mean annual precipitation (MAP)          =  796  mm
Duration 2     5     10    20    50    100   200
1 day    82    114   139   165   203   236   272
2 days   104   145   176   209   258   299   344
3 days   120   166   202   240   296   343   395
7 days   158   216   266   316   390   452   521
The modified recalibrated Hershfield relationship was used to determine point rainfall.
-------------------------------------------------------------------------------------------
Average slope                            = 0.01356 m/m
Time of concentration                    = 1.13 h
Run-off factor
Rural - C1                               = 0.334
Urban - C2                               = 0.000
Lakes - C3                               = 0.000
Combined - C                             = 0.321
-------------------------------------------------------------------------------------------
Return      Time of        Point       ARF      Average      Factor      Runoff       Peak
period      concentration  rainfall              intensity    Ft          coefficient  flow
(years)     (hours)        (mm)        (%)      (mm/h)                   (%)          (m³/s)
-------------------------------------------------------------------------------------------
1:2         1.13           37.17       97.4     32.09        0.75        24.0         40.82
1:5         1.13           62.70       97.4     54.14        0.80        25.7         73.45
1:10        1.13           82.02       97.4     70.82        0.85        27.3         102.08
1:20        1.13           101.33      97.4     87.49        0.90        28.9         133.54
1:50        1.13           126.87      97.4     109.54       0.95        30.5         176.47
1:100       1.13           146.19      97.4     126.22       1.00        32.1         214.04
Run-off coefficient percentage includes adjustment saturation factors (Ft) for steep and impermeable
catchments

Calculated using Utility Programs for Drainage 2.0.0
```

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Sihlengeni River
Description of site: Drainage 2
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 2\Drainage 2.fld
Date: 10 July 2025

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Flood Frequency Analysis: Rational Method 2

Project	= Niara Minerals Prospecting Rights - Floodlines
Analysed by	= SC Mazibuko (Pr.Sci.Nat.)
Name of river	= Sihlengeni River
Description of site	= Drainage 2
Date	= 7/10/2025
Area of catchment	= 28.3 km²
Dolomitic area	= 0.0 %
Length of longest watercourse	= 9.44 km
Flow of water	= Defined water course
Height difference along 10-85 slope	= 37.0 m
Area distribution	= Rural: 99 %, Urban: 0 %, Lakes: 1 %

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	2	Very permeable	1	Thick bush & forests	12
Flat area	39	Permeable	78	Light bush & cultivated land	51
Hilly	49	Semi-permeable	17	Grasslands	36
Steep areas	10	Impermeable	4	Bare	1

Days on which thunder was heard	= 60 days/year
Weather Services station number	=
Weather Services station location	=
Mean annual precipitation (MAP)	= 895 mm

Duration	2	5	10	20	50	100	200
1 day	82	114	139	165	203	236	272
2 days	104	145	176	209	258	299	344
3 days	120	166	202	240	296	343	395
7 days	158	216	266	316	390	452	521

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

Average slope	= 0.00523 m/m
Time of concentration	= 2.82 h
Run-off factor	
Rural - C1	= 0.376
Urban - C2	= 0.000
Lakes - C3	= 0.000
Combined - C	= 0.372

Return period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m³/s)
1:2	2.82	46.12	99.1	16.18	0.75	27.9	35.49
1:5	2.82	77.81	99.1	27.29	0.80	29.8	63.86
1:10	2.82	101.78	99.1	35.70	0.85	31.6	88.76
1:20	2.82	125.75	99.1	44.10	0.90	33.5	116.11
1:50	2.82	157.44	99.1	55.21	0.95	35.4	153.45
1:100	2.82	181.41	99.1	63.62	1.00	37.2	186.12

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

Calculated using Utility Programs for Drainage 2.0.0

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Sikhwebezi River
Description of site: Drainage 3
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 3\Drainage 3.fld
Date: 10 July 2025

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Flood Frequency Analysis: Rational Method 2

Project	= Niara Minerals Prospecting Rights - Floodlines
Analysed by	= SC Mazibuko (Pr.Sci.Nat.)
Name of river	= Sikhwebezi River
Description of site	= Drainage 3
Date	= 7/10/2025
Area of catchment	= 46.9 km²
Dolomitic area	= 0.0 %
Length of longest watercourse	= 10.58 km
Flow of water	= Defined water course
Height difference along 10-85 slope	= 55.0 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	16	Thick bush & forests	20
Flat area	30	Permeable	58	Light bush & cultivated land	71
Hilly	55	Semi-permeable	20	Grasslands	9
Steep areas	15	Impermeable	6	Bare	0

Days on which thunder was heard = 60 days/year
Weather Services station number =
Weather Services station location =
Mean annual precipitation (MAP) = 1055 mm

Duration	2	5	10	20	50	100	200
1 day	82	114	139	165	203	236	272
2 days	104	145	176	209	258	299	344
3 days	120	166	202	240	296	343	395
7 days	158	216	266	316	390	452	521

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

Average slope	= 0.00693 m/m
Time of concentration	= 2.77 h
Run-off factor	
Rural - C1	= 0.451
Urban - C2	= 0.000
Lakes - C3	= 0.000
Combined - C	= 0.451

Return period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m³/s)
1:2	2.77	45.92	96.3	15.99	0.75	33.8	70.44
1:5	2.77	77.46	96.3	26.97	0.80	36.1	126.76
1:10	2.77	101.33	96.3	35.28	0.85	38.3	176.18
1:20	2.77	125.19	96.3	43.58	0.90	40.6	230.47
1:50	2.77	156.74	96.3	54.57	0.95	42.8	304.57
1:100	2.77	180.60	96.3	62.87	1.00	45.1	369.42

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

Calculated using Utility Programs for Drainage 2.0.0

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Unnamed Tributary Black Mfolozi River
Description of site: Drainage 4
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 4\Drainage 4.fld
Date: 10 July 2025

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Flood Frequency Analysis: Rational Method 2

Project	= Niara Minerals Prospecting Rights - Floodlines
Analysed by	= SC Mazibuko (Pr.Sci.Nat.)
Name of river	= Unnamed Tributary Black Mfolozi River
Description of site	= Drainage 4
Date	= 7/10/2025
Area of catchment	= 8.9 km²
Dolomitic area	= 0.0 %
Length of longest watercourse	= 4.51 km
Flow of water	= Defined water course
Height difference along 10-85 slope	= 80.0 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	3	Thick bush & forests	30
Flat area	25	Permeable	13	Light bush & cultivated land	49
Hilly	60	Semi-permeable	60	Grasslands	20
Steep areas	15	Impermeable	24	Bare	1

Days on which thunder was heard	= 60 days/year
Weather Services station number	=
Weather Services station location	=
Mean annual precipitation (MAP)	= 913 mm

Duration	2	5	10	20	50	100	200
1 day	82	114	139	165	203	236	272
2 days	104	145	176	209	258	299	344
3 days	120	166	202	240	296	343	395
7 days	158	216	266	316	390	452	521

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

Average slope	= 0.02365 m/m
Time of concentration	= 53.7 min
Run-off factor	
Rural - C1	= 0.541
Urban - C2	= 0.000
Lakes - C3	= 0.000
Combined - C	= 0.541

Return period (years)	Time of concentration (hours)	Point rainfall (mm)	ARF (%)	Average intensity (mm/h)	Factor Ft	Runoff coefficient (%)	Peak flow (m³/s)
1:2	0.89	34.90	100.0	39.02	0.75	40.5	39.11
1:5	0.89	58.87	100.0	65.83	0.80	43.2	70.37
1:10	0.89	77.01	100.0	86.11	0.85	45.9	97.80
1:20	0.89	95.14	100.0	106.39	0.90	48.6	127.94
1:50	0.89	119.12	100.0	133.19	0.95	51.3	169.08
1:100	0.89	137.26	100.0	153.47	1.00	54.1	205.08

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

Calculated using Utility Programs for Drainage 2.0.0

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Unnamed Tributary Black Mfolozi River
Description of site: Drainage 5
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 5\Drainage 5.fld
Date: 10 July 2025

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```
Flood Frequency Analysis: Rational Method 2

Project                                = Niara Minerals Prospecting Rights - Floodlines
Analysed by                            = SC Mazibuko (Pr.Sci.Nat.)
Name of river                          = Unnamed Tributary Black Mfolozi River
Description of site                    = Drainage 5
Date                                   = 7/10/2025
Area of catchment                      = 3.1 km²
Dolomitic area                         = 0.0 %
Length of longest watercourse          = 3.66 km
Flow of water                          = Defined water course
Height difference along 10-85 slope    = 96.0 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      6    Thick bush & forests          20
Flat area               20     Permeable           34   Light bush & cultivated land  42
Hilly                   55     Semi-permeable      57   Grasslands                    36
Steep areas             25     Impermeable         3    Bare                          2
Days on which thunder was heard        = 60 days/year
Weather Services station number        =
Weather Services station location      =
Mean annual precipitation (MAP)        =  878  mm
Duration 2     5     10    20    50    100   200
1 day    82    114   139   165   203   236   272
2 days   104   145   176   209   258   299   344
3 days   120   166   202   240   296   343   395
7 days   158   216   266   316   390   452   521
The modified recalibrated Hershfield relationship was used to determine point rainfall.
-----------------------------------------------------------------------------------------
Average slope                          = 0.03497 m/m
Time of concentration                  = 39.3 min
Run-off factor
Rural - C1                             = 0.433
Urban - C2                             = 0.000
Lakes - C3                             = 0.000
Combined - C                           = 0.433
-----------------------------------------------------------------------------------------
Return      Time of       Point       ARF      Average     Factor      Runoff      Peak
period      concentration rainfall            intensity   Ft          coefficient flow
(years)     (hours)       (mm)        (%)      (mm/h)                  (%)         (m³/s)
-----------------------------------------------------------------------------------------
1:2         0.66          31.86       100.0    48.64       0.75        32.5        13.60
1:5         0.66          53.74       100.0    82.05       0.80        34.6        24.47
1:10        0.66          70.30       100.0    107.33      0.85        36.8        34.01
1:20        0.66          86.86       100.0    132.60      0.90        39.0        44.50
1:50        0.66          108.74      100.0    166.01      0.95        41.1        58.81
1:100       0.66          125.30      100.0    191.29      1.00        43.3        71.32
Run-off coefficient percentage includes adjustment saturation factors (Ft) for steep and impermeable
catchments

Calculated using Utility Programs for Drainage 2.0.0
```

9.5 Peak Flow Calculations – Standard Design Flood Method

9.6 Peak Flow Calculations – Empirical Method

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Unnamed Tributary of Mkuze River
Description of site: Drainage 1
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 1\Drainage 1.fld
Date: 10 July 2025

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```
Flood Frequency Analysis: Empirical methods

Project                                  = Niara Minerals Prospecting Rights - Floodlines
Analysed by                              = SC Mazibuko (Pr.Sci.Nat.)
Name of river                            = Unnamed Tributary of Mkuze River
Description of site                      = Drainage 1
Date                                     = 7/10/2025
-------------------------------------------------------------------------------------------
Area of catchment                        = 19.04 km²
Length of longest watercourse            = 4.62 km
Height difference along equal-area slope = 47.0 m
Distance to catchment centroid           = 2.2 km
Dolomitic area                           = 0.0 %
Mean annual rainfall                     = 796.0 mm
Veld type                                = 9
Kovács region                            = K8(K = 5.6)
Catchment parameter with regard to
reaction time                            = 0.189
-------------------------------------------------------------------------------------------
Peak discharges by means of an empirical method developed by Midgley and Pitman
-------------------------------------
Return          KT          Peak
period       constant       flow
(years)                     (m³/s)
-------------------------------------
 1:10           0.50        62.99
 1:20           0.68        85.67
 1:50           0.95        119.69
 1:100          1.20        151.18


Calculated using Utility Programs for Drainage 2.0.0
```

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Sihlengeni River
Description of site: Drainage 2
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 2\Drainage 2.fld
Date: 10 July 2025

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Flood Frequency Analysis: Empirical methods

Project	= Niara Minerals Prospecting Rights - Floodlines
Analysed by	= SC Mazibuko (Pr.Sci.Nat.)
Name of river	= Sihlengeni River
Description of site	= Drainage 2
Date	= 7/10/2025
Area of catchment	= 28.3 km²
Length of longest watercourse	= 9.44 km
Height difference along equal-area slope	= 37.0 m
Distance to catchment centroid	= 4.5 km
Dolomitic area	= 0.0 %
Mean annual rainfall	= 895.0 mm
Veld type	= 9
Kovács region	= K8(K = 5.6)
Catchment parameter with regard to reaction time	= 0.042

Peak discharges by means of an empirical method developed by Midgley and Pitman

Return period (years)	KT constant	Peak flow (m³/s)
1:10	0.50	66.41
1:20	0.68	90.32
1:50	0.95	126.18
1:100	1.20	159.39

Calculated using Utility Programs for Drainage 2.0.0

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Sikhwebezi River
Description of site: Drainage 3
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 3\Drainage 3.fld
Date: 10 July 2025

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Flood Frequency Analysis: Empirical methods

Project	= Niara Minerals Prospecting Rights - Floodlines
Analysed by	= SC Mazibuko (Pr.Sci.Nat.)
Name of river	= Sikhwebezi River
Description of site	= Drainage 3
Date	= 7/10/2025
Area of catchment	= 46.9 km²
Length of longest watercourse	= 10.58 km
Height difference along equal-area slope	= 55.0 m
Distance to catchment centroid	= 5.1 km
Dolomitic area	= 0.0 %
Mean annual rainfall	= 1055.0 mm
Veld type	= 9
Kovács region	= K8(K = 5.6)
Catchment parameter with regard to reaction time	= 0.063

Peak discharges by means of an empirical method developed by Midgley and Pitman

Return period (years)	KT constant	Peak flow (m³/s)
1:10	0.50	114.99
1:20	0.68	156.39
1:50	0.95	218.49
1:100	1.20	275.99

Calculated using Utility Programs for Drainage 2.0.0

Utility Programs for Drainage
Flood calculations

Sinotech

Project name: Niara Minerals Prospecting Rights - Floodlines
Analysed by: SC Mazibuko (Pr.Sci.Nat.)
Name of river: Unnamed Tributary Black Mfolozi River
Description of site: Drainage 5
Filename: C:\Users\user\Desktop\Niara Minerals - Floodlines\Drainage 5\Drainage 5.fld
Date: 10 July 2025

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```
Flood Frequency Analysis: Empirical methods

Project                                  = Niara Minerals Prospecting Rights - Floodlines
Analysed by                              = SC Mazibuko (Pr.Sci.Nat.)
Name of river                            = Unnamed Tributary Black Mfolozi River
Description of site                      = Drainage 5
Date                                     = 7/10/2025
-------------------------------------------------------------------------------------------
Area of catchment                        = 3.1 km²
Length of longest watercourse            = 3.66 km
Height difference along equal-area slope = 88.0 m
Distance to catchment centroid           = 1.04 km
Dolomitic area                           = 0.0 %
Mean annual rainfall                     = 878.0 mm
Veld type                                = 9
Kovács region                            = K8(K = 5.6)
Catchment parameter with regard to
reaction time                            = 0.126
-------------------------------------------------------------------------------------------
Peak discharges by means of an empirical method developed by Midgley and Pitman
-------------------------------------
Return          KT          Peak
period       constant       flow
(years)                     (m³/s)
-------------------------------------
 1:10           0.50        21.57
 1:20           0.68        29.34
 1:50           0.95        40.99
 1:100          1.20        51.77


Calculated using Utility Programs for Drainage 2.0.0
```

9.7 Longitudinal profiles of the simulated flood waters

9.8 Design Rainfall Estimation

Gridded values of all points within the specified block

Latitude (°)	Latitude (')	Longitude (°)	Longitude (')	MAP (mm)	Altitude (m)	Duration (m/h/d)	Return Period (years) 2	2L	2U	5	5L	5U	10	10L	10U	20	20L	20U	50	50L	50U	100	100L	100U
27	49	31	17	967	1338	5 m	11.9	7.8	16.1	16.7	10.9	22.5	20.4	13.3	27.6	24.5	15.8	33.4	30.5	19.4	42.2	35.7	22.6	50.1
						10 m	15.9	11.1	20.6	22.2	15.6	28.8	27.2	19.0	35.5	32.6	22.6	42.9	40.7	27.8	54.2	47.7	32.3	64.3
						15 m	18.8	13.8	23.8	26.3	19.2	33.4	32.2	23.4	41.0	38.6	27.9	49.6	48.1	34.4	62.7	56.4	39.9	74.4
						30 m	23.8	17.9	29.7	33.3	25.0	41.6	40.7	30.4	51.1	48.8	36.2	61.8	60.9	44.6	78.1	71.4	51.8	92.7
						45 m	27.3	20.8	33.8	38.2	29.1	47.3	46.7	35.4	58.1	56.1	42.2	70.3	69.9	52.0	88.8	81.9	60.3	105.4
						1 h	30.1	23.2	37.0	42.1	32.5	51.8	51.6	39.5	63.7	61.8	47.0	77.0	77.1	58.0	97.2	90.4	67.2	115.5
						1.5 h	34.5	27.0	42.1	48.4	37.8	58.9	59.2	46.0	72.4	70.9	54.8	87.5	88.5	67.5	110.6	103.7	78.4	131.3
						2 h	38.1	30.1	46.1	53.3	42.2	64.5	65.3	51.3	79.3	78.2	61.1	95.9	97.6	75.3	121.1	114.4	87.3	143.9
						4 h	44.4	35.5	53.3	62.2	49.7	74.6	76.1	60.5	91.7	91.2	72.1	110.9	113.8	88.8	140.1	133.3	103.0	166.3
						6 h	48.6	39.1	58.0	68.0	54.8	81.2	83.2	66.7	99.9	99.8	79.4	120.7	124.5	97.8	152.5	145.8	113.5	181.1
						8 h	51.8	41.9	61.6	72.5	58.7	86.3	88.7	71.4	106.1	106.3	85.0	128.2	132.7	104.8	162.0	155.4	121.6	192.3
						10 h	54.4	44.2	64.5	76.2	61.9	90.4	93.2	75.3	111.1	111.7	89.7	134.3	139.4	110.5	169.7	163.3	128.2	201.5
						12 h	56.6	46.2	67.1	79.3	64.6	93.9	97.0	78.7	115.5	116.3	93.7	139.6	145.1	115.4	176.3	170.0	133.9	209.4
						16 h	60.4	49.5	71.2	84.5	69.2	99.7	103.4	84.3	122.6	124.0	100.3	148.2	154.7	123.6	187.3	181.2	143.4	222.4
						20 h	63.4	52.2	74.6	88.8	73.0	104.5	108.6	88.9	128.5	130.2	105.8	155.3	162.5	130.4	196.2	190.4	151.3	233.0
						24 h	66.0	54.5	77.5	92.4	76.3	108.6	113.1	92.8	133.5	135.6	110.5	161.4	169.2	136.2	203.9	198.2	158.0	242.1
						1 d	56.0	46.2	65.8	78.4	64.7	92.1	95.9	78.7	113.2	115.0	93.8	136.9	143.5	115.5	172.9	168.1	134.0	205.4

SBONGISENI MAZIBUKO

Hydrologist

(Pr.Sci.Nat – Registration No: 011204)

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PROFILE

Technically proficient hydrologist specializing in surface water resources with emphasis on flood hydrology, water resources assessments, stormwater planning, water balances, geospatial analytics and modelling.

QUALIFICATIONS

- MSc (Hydrology)
  Rhodes University, 2017
- BSc Honours (Hydrology)
  University of Zululand, 2011
- BSc Hydrosciences
  University of Zululand, 2009

ACADEMICS

- Supervised 1 MSc & 9 BSc Hons
  University of Zululand2017
- 9 BSc Honours (Hydrology)
  University of Zululand, 2011
- Hughes, D.A and Mazibuko, S.C. (2018). Simulating saturation-excess surface runoff in a semi-distributed hydrological model. Hydrological Processes, doi.org/10.1002/hyp.13182

TRAINING

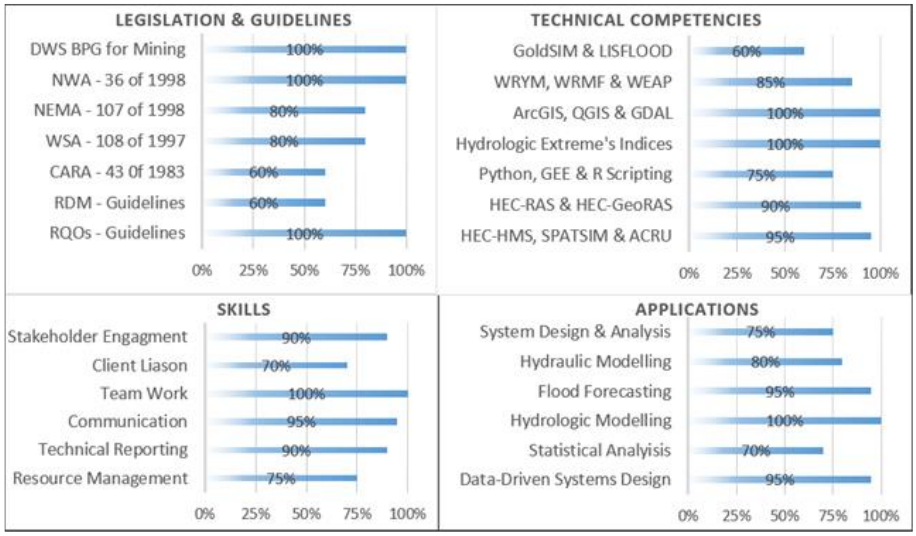
- PCRaster Python Framework for Hydrological Applications
- QGIS for Hydrological Applications
- Structures with HEC-RAS
- Dam Breach Analysis with HEC-RAS
- Flood Hydrology
- Sediment Transport with HEC-RAS
- HEC-RAS 1D&2D Essentials
- Revised Desktop Reserve Model

KEY EXPERIENCE

Hydrologist Associate at Altra Watech (Pty) Ltd

- Peak Flow Determination & Flood Frequency Analysis.
- Surface Water Impact Assessments.
- Floodline Modelling using HEC-RAS and GeoHEC-RAS.
- Rainfall-Runoff Modelling using ACRU and Pitman Models.
- Water Resources Planning and Development using WRMF.
- Storm Water Management Plans using PCSWMM.
- Geospatial Analysis using GlobalMapper, QGIS and ArcGIS.
- Water Conservation Water Demand Management Plans.
- Surface and Groundwater Monitoring Database Development.
- Static and Dynamic Water and Salt Balance sing Excel & GoldSIM.
- Writing Project Proposals and Technical Reports.
- Field Data Collection (water quality, quantity and soil sampling).
- Geospatial Data Analytics with Google Earth Engine.

COMPETENCIES MATRIX



AUTHORED RELEVANT PROJECTS

PROJECT
Water Balance Study for Burnside Coal, Glencoe
N'komati Anthracite Mine – Water Conservation and Demand Management Plan
Hydrological Assessments for Lichtenburg, Coligny, Itekeng, Itsoseng and Ipelegeng WWTWs
Construction of Gauging Weir in the Valsriver at Bothaville – Hydrological Assessment
Lindley WWTW – Hydrological Assessment
Hydrological Assessment for Olifantsdrift 10-KP Farm
Kroonvaal Engen 1-Stop Filling Station - Water Balance Study
Tugela and North Coast Engen 1-Stop Filling Stations - Water Balance Study
Kariboo Colliery - Water Balance & Salt Update
Vlakvarkfontein Colliery – Salt & Water Balance Update
Douglas and Willem Brummer Dam – Hydrological Assessment
Idwala Coal - Water Balance Study
Water Conservation and Demand Management Plan for Dingwell Quarry Mine
Kelvin Power Station – Salt & Water Balance Update Study
N'komati Anthracite Mine – Salt & Water Balance Update Study
Selkatkop Mine – Hydrological Assessment & Water Balance
Seriti Klipspruit Colliery – Hydrological Assessment, Salt & Water Balance Update Synthesis
Mbali Colliery – Salt & Water Balance Update Study

SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Sbongiseni Christian Mazibuko

Registration Number: 011204

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following field(s) of practice (Schedule 1 of the Act)

Water Resources Science: Hydrological Science (Professional Natural Scientist)

Effective **19 November 2014** Expires **31 March 2026**

Chairperson

Chief Executive Officer

To verify this certificate scan this code

RHODES UNIVERSITY

THIS IS TO CERTIFY THAT

SBONGISENI CHRISTIAN MAZIBUKO

WAS THIS DAY AT A CONGREGATION OF THE UNIVERSITY
ADMITTED TO THE DEGREE OF

MASTER OF SCIENCE

IN

HYDROLOGY

VICE CHANCELLOR

DEAN OF THE FACULTY OF SCIENCE

REGISTRAR

GRAHAMSTOWN
21 APRIL 2017

University of Zululand

This is to certify that the degree of

Honours Bachelor of Science
(Hydrology)

has been awarded to

Mazibuko, Sbongiseni Christian
20054556

who satisfied all the requirements in the year

2010

UZ 00969

Vice-Chancellor

Registrar

Dean

27 May 2011

University of Zululand

This is to certify that the degree of

Bachelor of Science (Hydrosciences)

First Class

has been awarded to

Mazibuko, Sbongiseni Christian
20054556

who satisfied all the requirements in the year

2008

Vice-Chancellor

Registrar

Dean

22-May-2009