



CAPE WINELANDS DISTRICT
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MONTAGU **(Incorporating Ashbury)**

Storm Water Master Plan **Update 2015/16**

J35378

Final

February 2016

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(Langeberg Municipality)

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MONTAGU (incorporating Ashbury)
Storm Water Master Plan Update 2015/16

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Introduction

Terms of Reference

The Cape Winelands District Municipality via Langeberg Municipality (Mr Maynard Johnson) approached GIBB (Pty) Ltd (GIBB) in Mid-July 2015 to submit a fee proposal to undertake the updating of the Montagu Stormwater Master Plan compiled by GIBB in 1999. GIBB were appointed on 12 October 2015 to update the Montagu (incorporating Ashbury) Stormwater Master Plan (SWMP).

Scope of the SWMP

This document serves as the updated SWMP for Montagu (incorporating Ashbury) and has been compiled based on the approach and work plan proposed and listed below in chronological order:

- (i) Data collation including field visit to verify existing stormwater drainage system and flow regime.
- (ii) Stormwater Master Planning
 - Catchment delineation and determination of hydrological and hydraulic parameters.
 - Compilation of catchment hydrological and hydraulic models
 - Floodline verification
 - Capital Upgrade Cost Estimate
- (iii) Reporting
 - Compile SWMP report with drawings and tables
 - Floodline verification
 - Capital Upgrade Cost Estimate

1 *Data and Information*

The compilation of this SWMP is based upon the data and information collated pertaining to the catchment's characteristics, its flow regime and the existing stormwater drainage system.

(i) Catchment Characteristics and Flow Regime:

- Google Earth Imagery (2015)
- Field investigation by GIBB personnel.
- Existing and future land-uses as per the Langeberg Spatial Development Framework dated November 2014.
- Development plan for Erf. 245 and 535, Montagu and the "Piet se Pad" development from AJ Louw Consulting Engineers.
- 1 in 50 000 Topographical Maps and 20m contours (Department of Land Affairs, Chief Directorate of Survey and Mapping):
 - 3319 DD Robertson
 - 3320 CA Baden
 - 3320 CB Allemorgens
 - 3320 CC Montagu
 - 3320 CD Scheepersrus
 - 3320 DA Kareevlakte
 - 3320 DC Barrydale
 - 3320 DD Warmwaterberg
- Hec-Ras backwater models of the Rivers received from Element Consulting Engineers

(ii) Existing Stormwater Drainage System

- 1999 Montagu Stormwater Master Plan
- Field investigation by GIBB personnel.

2 *Catchment Description and Characteristics*

Montagu is located on District Road R62, commonly known as “Route 62”, some 10 km north east of Ashton and 61 km north west of Barrydale. The town is 180 km east of Cape Town in the Western Little Karoo. (Refer to **Figure 1, Appendix A**)

The town is located immediately upstream of the confluence of the Kingna and Keisies Rivers that form the Kogmanskloof River that runs through a narrow valley downstream. The Kingna and Keisies Rivers play a major role in the management and drainage of stormwater runoff in Montagu in that they are the spines of the town’s drainage system and that they convey flows from significant upstream catchments through the town.

2.1 **Upstream River Catchments** (Refer to **Figure 1, Appendix A**)

The upstream catchments of the Keisies and the Kingna Rivers fall within the “Southern Forder Mountains” ecoregion as per “Rivers of the Breede Water Management Area 2011” by Department of Water Affairs et al. The landscape of the catchment is moderate/high mountains and hills with a mean altitude of between 300 and 1 900 meters above mean sea level.

The land-use within these catchments is predominantly open veld being Sandstone Fynbos and Succulent Karoo vegetation with irrigated crops and pastures located in the valley bottoms along the river courses.

The general geology of the upstream river catchments is Quartzite Table Mountain Sandstone, Bokkeveld and Malmesbury Shales.

2.1.1 **Keisies River**

The Keisies River upstream of Montagu commands a catchment area of 454 km², that includes the sub-catchment of the Pietersfontein River.

The catchment area lies to the north and west of Montagu where the Keisies River itself runs through a narrow valley formed by the Langeberg to the south and the Rietbokberg and Keisiesberg to the north.

The Pietersfontein River, the major tributary of the Keisies River lies to the north of the Keisies River sub-catchment, this sub-catchment is a narrow, wide fan-shaped area formed by the Waboomsberge to the north and the Keisiesberge in the south. The confluence of the Pietersfontein and the Keisies Rivers is about 447 km north-west of Montagu North (Badshoogte).

2.1.2 Kingna River

The Kingna River catchment lies mostly to the east of Montagu and commands a catchment area of 600 km². The Kingna River has 4 major tributaries being the Groot River, the Dwarriega River that forms the Kingna River from the east, the Langkloofspruit and the Joubertspoort River from the north.

2.2 Montagu Stormwater Drainage System Catchment

The town's drainage system consists of two major systems being the Keisies and Kingna Rivers.

The Keisies River system drain only a small part of the town being the western part of Badshoogte (Montagu North) and Montagu West as shown on **Figure 2** below.

The remainder of Montagu drains into the Kingna River as shown on **Figure 2**.

The existing flow regime features characterising the study area are the Keiser River to the west and the Kingna River to the east of Montagu central. These two rivers flow in a south westerly direction toward the Kogmanskloof River, and the confluence of these rivers are at the existing Longstreet Road Bridge.

Montagu (incorporating Ashbury) is currently served by 20 drainage systems. The discharge points for each of these systems and the flow regime and / or drainage system upstream of these is shown on **Drawing No.'s J35378/ SWMP-01 to SWMP-05** (refer to **Appendix D**).

Runoff from the high lying areas surrounding Montagu, i.e. external catchments, drain overland through the developed areas with limited escape routes. The drainage system within the developed areas comprises limited stormwater pipes and channels and is predominated by overland flow.

In some areas the prevalent drainage conveyances consist of two components "leiwater slote" and the surfaced or gravel (unsurfaced) roadways. In some parts these are supplemented by underground pipes. The details and capacities of the existing storm water drainage system, as shown on **Drawing No.'s J35378/ SWMP-01 to SWMP-05**, are given in **Table 4.1** (refer to **Appendix E**).

2.3 Land-use

The existing and future land-use for Montagu have been categorised as follows:

- High Density Housing
- Medium Density Housing
- Low Density Housing
- Industrial
- Institutional e.g. Schools, Colleges, Research Centres etc.
- Commercial
- Public Open Space (POS) e.g. parks, cemeteries, etc.
- Natural Veld

The above categories have been used to determine suitable runoff characteristics for both existing and future land-use scenarios.

2.3.1 Existing Land-Use

The existing land-uses of the town are shown on **Figure 3** below.

Montagu is generally surrounded by open veld with some agriculture downstream of and to the south-west of the village. The areas to the north and west are generally steep slopes that can be regarded as un-developable. The veld to the north-west of the town lies in the “Greyton Nature Reserve”.

The natural vegetation type of Montagu and surrounds is “Western Little Karoo” as per “The Vegetation of South Africa, Lesotho and Swaziland” edited by L Mucina and MC Rutherford, 2006 published by the South African National Biodiversity Institute, which features low and medium height non-succulent and succulent shrubs.

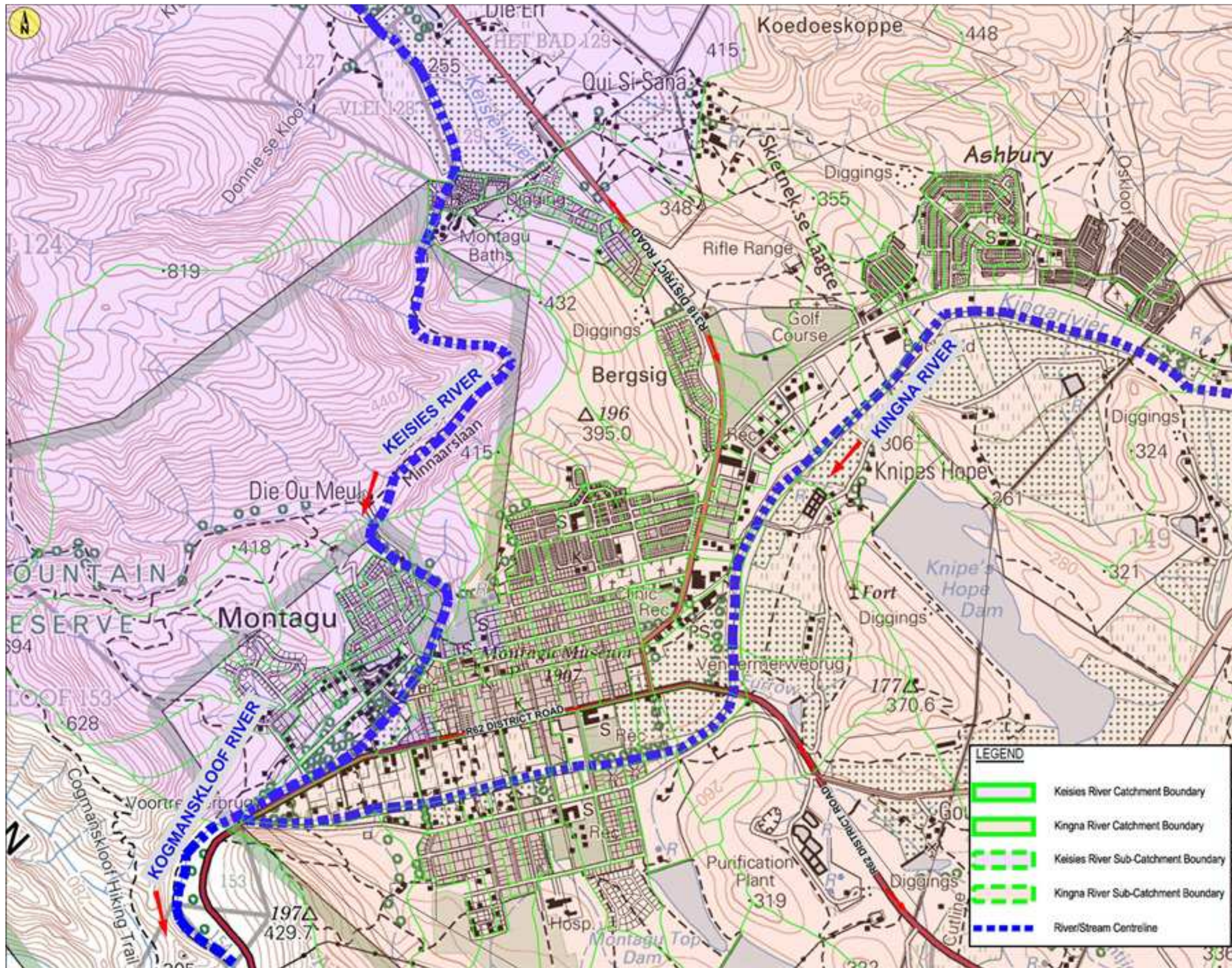


Figure 2: Montagu Stormwater Drainage System

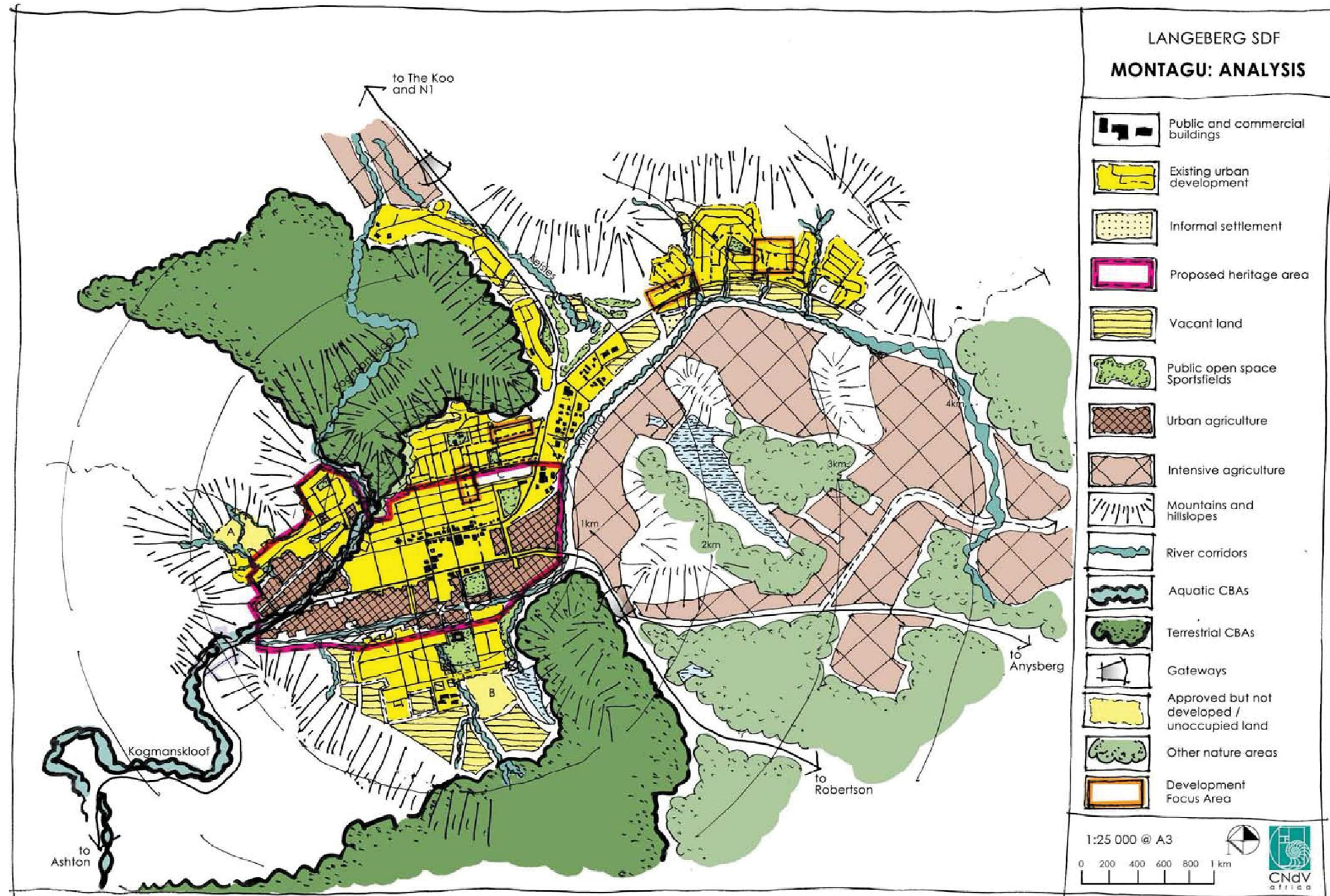


Figure 5.9.1.2 Montagu: Analysis



CNdV africa (Pty) Ltd

Figure 3: Existing Land-use

2.3.2 Future Land-Use

The future land-uses of the town are shown on **Figure 3** (Refer to **Appendix C**). The future town planning for Montagu is as per the the “Langeberg Spatial Development Framework” dated November 2014, Compiled by CNdV africa.

2.3.3 Hydrological Soil Characteristics

The soils have been mapped as shallow sandy loams in the steep mountainous areas and moderate to deep sandy loams on the lower undulating relief of the catchment areas.

The soils have been classified as hydrological soil group **Type C**, which have a moderately high storm flow potential with slow to rapidly deteriorating infiltration rates (6 mm/h) and restricted permeability (rates of 1.3 to 3.8 mm/h). In developed areas and future planned development areas, the hydrological soil group classification has been assumed to be a **Type C/D** to account for the compaction and the modification of the soils hydrological characteristics during the construction and development of these areas.

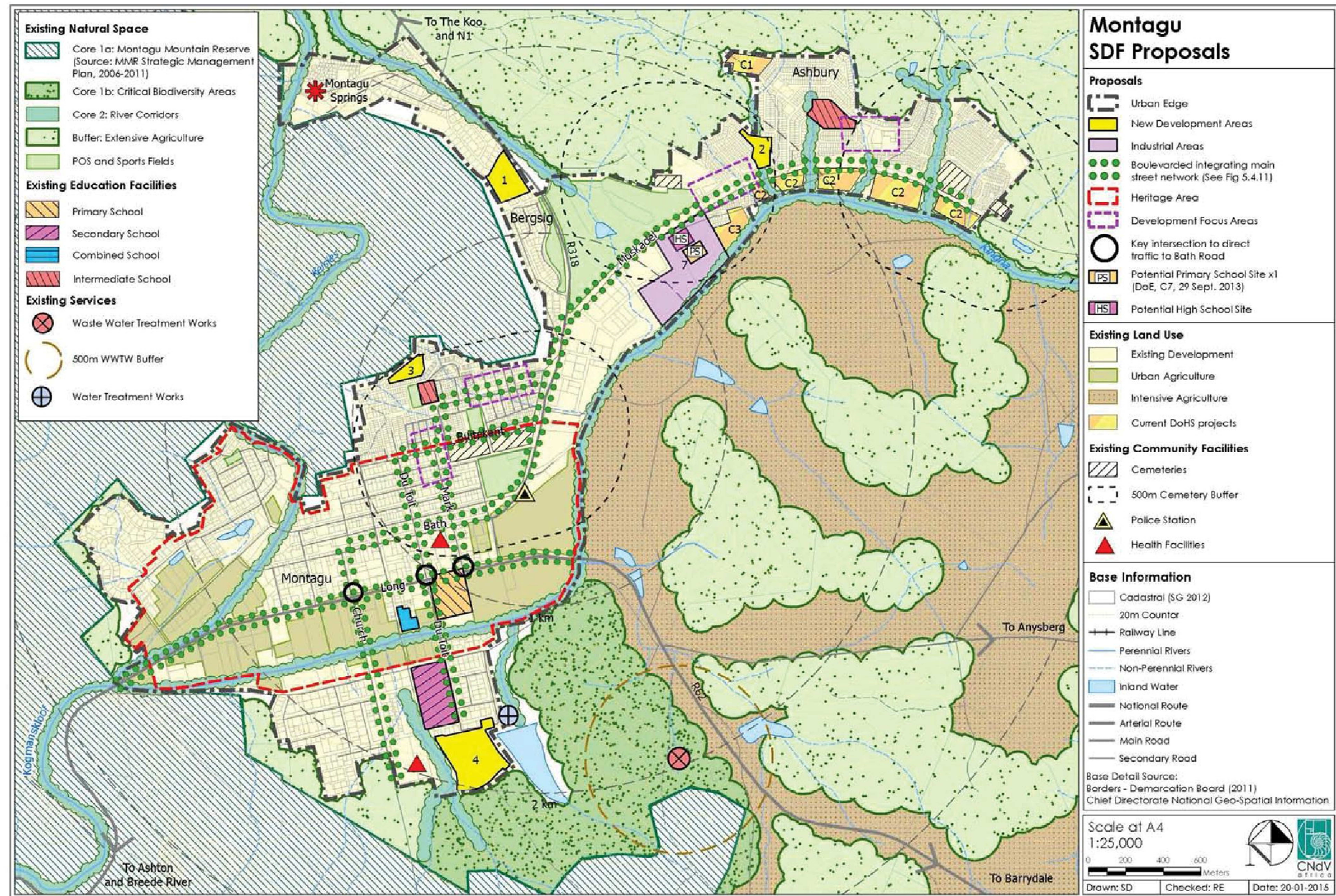


Figure 5.9.2.1 Montagu: Draft Spatial Development Framework

2.4 Storm Rainfall

The town of Montagu falls within quaternary sub-catchments of H30A, H30B, H30C and H30D, as per Water Research Commission (WRC) Report No's 299/4.1/94 and 298/4.2/94 (SWR 90). The average annual precipitation (MAP) for these four catchments are 784 mm and 1 850 mm respectively.

The computer programme "Design Rainfall Estimation in South Africa" which accompanies the WRC Report K5/1060 was used to conduct a rainfall station search and to obtain storm rainfall data.

Table 2.1: Rainfall Station Information and Storm Rainfall Data for Montagu

Rainfall Station Information					
Station Name		Montagu (POL)	Ashton (POL)	Bonnievale (SKL)	Montagu [#]
*SAWS Station No		0024197_W	0007062_W	0024146_W	N/A
Location Latitude		33°47′	33°50′	33°56′	33° 47′
Longitude		20°7′	20°4′	20°3′	20°7′
MAP (mm)		269	316	266	269
Altitude (mamsl)		221	166	130	Average = 227
Distance from Montagu (km)		0	7.6	16.3	N/A
Length of Record (Years)		99	36	59	N/A
One Day Storm Rainfall Depths (mm)					
Return Period	1 in 2 year	38	34	32	35
	1 in 5 year	55	50	46	51
	1 in 10 year	69	62	58	64
	1 in 20 year	84	76	70	78
	1 in 50 year	106	96	88	99
	1 in 100 year	125	113	104	116

Notes: * - SAWS denotes South Africa Weather Services

- Montagu is not a rainfall station but the data given is generated by the "Design Rainfall Estimation in South Africa" Programme for the centroid of the catchment.

The selection of a suitable rainfall station, upon whose data, the storm rainfall depths can be based is dependent upon the location and altitude of the rainfall station in relation to the site for which the rainfall depths are required, as well as the length of the data record. The "Design Rainfall Programme" is known to produce some anomalies in mountainous areas and

hence the need to verify the rainfall data to be used for the compilation of this Storm Water Master Plan for Montagu.

The 24hr storm rainfall depths were verified by means of comparing the values generated for Montagu with those determined using the Op Ten Noort Equation and data from TR 102. The verification was completed using the data for the Montagu (POL) Rainfall Station because of the availability of data.

Table 2.2: 24h Rainfall Depth Comparison

Data Source		Return Period					
		1 in 2 year	1 in 5 year	1 in 10 year	1 in 20 year	1 in 50 year	1 in 100 year
Montagu (POL)	Op Ten Noort	29	38	47	57	76	93
	TR102	47	70	90	111	144	173
	Smithers / Schulze	47	70	90	111	144	173
	Design Rainfall	41	60	75	91	115	135
Average		41	60	76	93	120	144
Design Rainfall for Montagu		41	60	75	91	115	135

Based on the above table it can be seen that the 24 hour rainfall depths generated for Montagu compare favourably with the data for the Montagu (POL) station and therefore these were adopted for further hydrological modelling.

For the purpose of this SWMP update the SCS-SA Type II 24 hour storm rainfall pattern has been used as per “SCS Based Design Runoff” by EJ Schmidt and RE Schulze.

3 Storm Water Master Planning Fundamentals

3.1 Drainage System Definition

A stormwater drainage system is defined as those components used for the conveyance, storage, treatment, use and disposal of storm runoff from a drainage area or catchment to or at a specific point.

The drainage systems, both existing and future, have been classified for this stormwater management plan as per the “Red Book” viz.:

- **Minor Stormwater Drainage System**

A system that caters for frequent storms of a minor nature.

- **Major Stormwater Drainage System**

A system that caters for severe, infrequent storm events, that is supported by the minor system.

3.2 Analysis, Assessment and Design Criteria

The selection of the analysis, assessment and design criteria used for the compilation of this SWMP for Montagu are based on the guidelines given in Chapter 6, “Stormwater Management” of the **Red Book**. These guidelines give the applicable standards in terms of a recurrence interval (RI) or return period (RP) event based on land-use criteria (refer to **Section 3.1**, above) and drainage system category as described in **Section 4.1** above.

The RI/RP is the average interval between storm events, and is usually expressed in years and is the reciprocal of the annual probability of the storm event occurring. That is a 1 in 50 year RP storm event, has an annual probability of occurrence of 2%. It does not imply that such an event will necessarily occur every 50 years, but rather than over a much longer period, say that in 1 000 years, there are likely to be 20 events of equal or greater magnitude.

The objective of this SWMP is to assess and identify shortcomings of the existing stormwater drainage system as well as to provide remedial measures to address any short comings. In addition future development of the town is also to be considered in terms of either upgrading the existing drainage system and / or to plan future drainage systems to manage stormwater runoff emanating from these developments. Therefore the standards used for the analysis assessment and design for this SWMMP will be those given in **Table 6.1** and **6.2** of the **Red Book** and reproduced in **Table 3.1** below:

Table 3.1: Design Flood Programmes for Stormwater Drainage Systems

Land-use	Design Storm Return Period	
	Major Systems	Minor Systems
Residential	50 year	1 - 5 year
Institutional	50 year	2 – 5 year
General Commercial and Industrial	50 year	5 year
High Value Central Business District	50 – 100 year	5 – 10 year

In addition to these standards, The National Water Act (Act No 36 of 1998) with particular reference to Section 21 must also be taken into account.

3.3 Catchment Hydrological and Storm Water Drainage System Hydraulic Modelling

The PCSWMM 2015 Professional computer programme was used to compile the catchment hydrological and hydraulic storm water drainage system model to estimate peak flow rates and volumes to facilitate the compilation of this SWMMP. PCSWMM 2015 Professional is commercial software that utilises the Storm Water Management Model (SWMM) of the United States Environmental Protection Agency (EPA). SWMM is dynamic rainfall runoff simulation model for single or continuous simulation rainfall events and performs fully dynamic hydraulic routing of storm water conveyance and storage systems.

Three models were compiled for Montagu to determine the run-off peak flow rates and volumes emanating from the pertinent sub-catchment areas of the town as described below:

Table 3.2: Details and Applications of Compiled SWMM Models

Model Ref	Land-use Scenario	Average System Scenario	Application
EDES	Existing town and upstream catchment land-use as per Figure 2.	Existing stormwater drainage system as per Drawing No. J35378/SWMP-01 to SWMP-05	Estimate runoff peak flow rates and volumes for the various RP storm events. Assessment of existing drainage system
EDFS	Future town and upstream catchment land-use as per Figure 3.	Existing stormwater drainage system as per Drawing No. J35378/SWMP-06 to SWMP-10	Assess the ability of the existing system to manage increased runoff generated by future developments
FDFS	Future town and upstream catchment land-use as per Figure 3.	Proposed future storm water management systems as per Drawing No. J35378/SWMP-11 to SWMP-15	Preliminary layout planning and conceptual design of proposed future storm water management systems including remedial measures to the existing system.

The models were simulated for the 1 in 2 year, 1 in 5 year, 1 in 10 year, 1 in 20 year, 1 in 50 year and 1 in 100 year RP storm events.

The SWMM model results were verified by comparing these with sub-catchment hydrological analyses using the Rational Method, SDF Method and the RMF Method.

3.4 Model Verification and Calibration

The model simulation results for the compiled models were verified by comparing the peak flow rate at a pertinent outfall node and comparing with those obtained by the **SDF Method** (SDF), **Rational Method** (RAT) and the **RMF Method** (RMF), and then considers the catchment as a single entity at the same outfall node. The comparative existing development peak flow discharges emanating from the site are given in **Table 4.3** and **Figure 4.1** below:

Table 3.3: Existing Development Site Peak Discharges

Sub-Catchment	Peak Discharge (m ³ /s)			
	1 in 5 year	1 in 10 year	1 in 50 year	1 in 100 year
SDF	593	884	1659	2033
RAT	728	965	1664	2070
RMF	384	576	1727	2126
SWMM	435	691	1635	2264

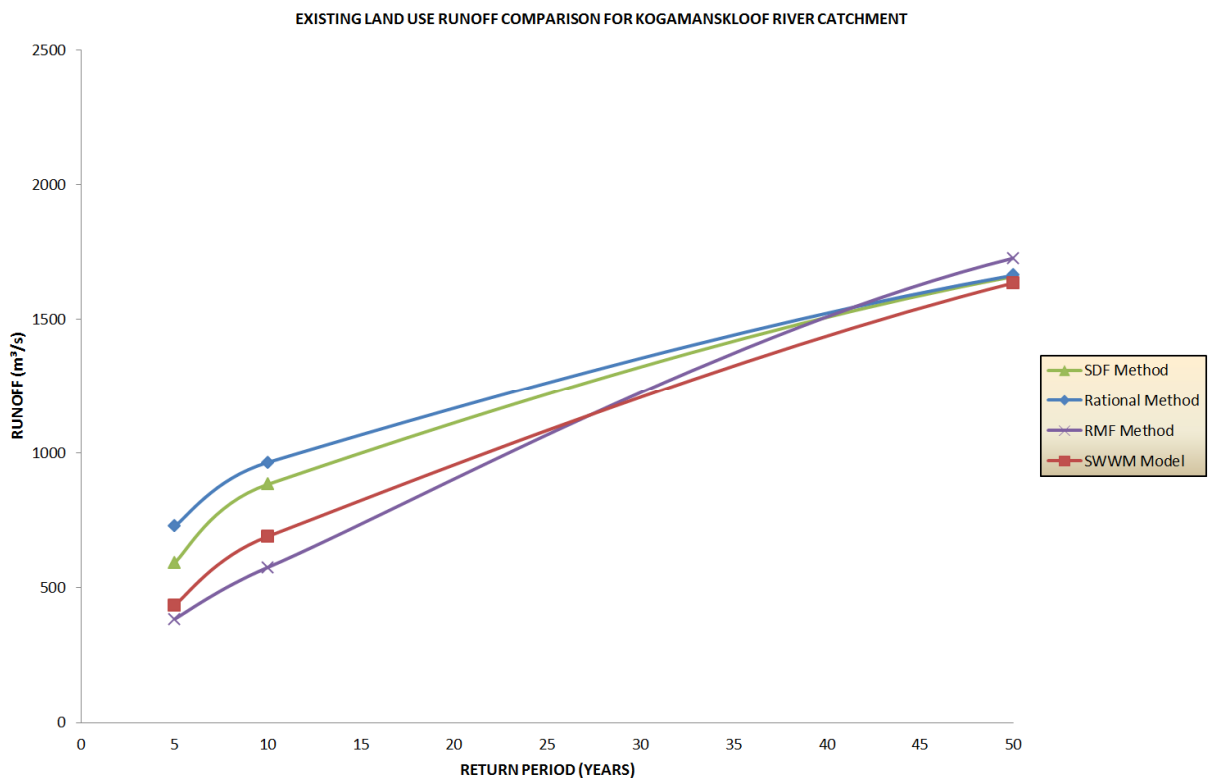


Figure 5: Existing Development Site Peak Discharges

The peak flow rates given in **Table 4.3** above compare favourably in terms of the hydrological analysis methods used and therefore the peak flows determined by PCSWMM 2015 are deemed representative of the catchment area.

Even though the peak discharge for 1 in 5 year and 1 in 10 year storm events, based on the SWMM Model is lower, it should be noted that PCSWMM 2015 allows for both catchment lag and hydraulic lag in the conduits. Similarly for the major storm events PCSWMM 2015 allows for effective overland routing, hence the higher discharge rate experienced at the model outlet.

4 Storm Water Drainage System Assessment

The risk assessment of the existing storm water drainage system serving Montagu has been completed by comparing the hydraulic characteristics of the major drainage systems conveyances with the estimated peak flow rates for the various RP storm events.

Two risk assessments were undertaken, the first was an analysis of the hydraulic capacity of the conveyances (e.g. pipes, channels, roadways, etc.) and assuming these to be free of sediment, debris and blockages. Secondly, because of the number of gravel roads and unlined storm water channels, an erosion risk assessment based on the flow velocities of the conveyances, was completed for selected reaches of the existing drainage system.

4.1 Hydraulic Capacity Risk Assessment

This assessment was based on the probability of failure of the conveyance's reach under scrutiny to safely convey the estimated peak flow for the various RP storm events. A flood risk category based on the RP has been utilised to determine the flood risk categories as defined below:

Table 4.1: Capacity Failure Risk Categorisation

Category	Capacity Exceeded (RP)	Note
Very High Risk	≤ 2 year	Conduit capacity reached or exceeded by the 1 in 2 year RP peak flow rates.
High Risk	> 2 year ≤ 5 year	Conduit capacity reached between the 1 in 2 year and 1 in 5 year RP peak flow rates.
Medium to High Risk	> 5 year ≤ 10 year	Conduit capacity reached between the 1 in 5 year and 1 in 10 year RP peak flow rates.
Medium Risk	> 10 year ≤ 20 year	Conduit capacity reached between the 1 in 10 year and 1 in 20 year RP peak flow rates.
Low Risk	> 20 year ≤ 50 year	Conduit capacity reached between the 1 in 20 year and the 1 in 50 year peak flow rates.
Minimal Risk	> 50 year ≤ 100 year	Conduit capacity reached by peak flow rates $>$ than the 1 in 50 year but less than the 1 in 100 year RP event.
No Risk	> 100 year	Conduit capacity greater than the peak flow rate of the 1 in 100 year RP event.

4.2 Erosion Failure Risk Assessment

This assessment was undertaken to identify the erosion damage potential of conveyance reaches under the various RP storm peak flows.

A matrix based on RP and corresponding flow velocities, determined using the hydraulic characteristics of the conveyance, and were devised to identify potential erosion problems. This assessment was necessitated by the prevalence of un-lined conveyances and the gravel roads that make up the majority of storm water drainage systems that serve Montagu.

The erosion risk ratings used to assess the drainage system are listed below:

- **High Erosion Risk**

Risk rating of greater than 46 units. Roadways / watercourses permissible flow velocities exceeded frequently leading to erosion damage of road surfaces and causing bank instability and base erosion of channels.

- **Medium Erosion Risk**

Risk rating of between 40 and 46 units. Erosion of roadways / watercourses to a lesser degree but may lead to severe damage over time, or require frequent maintenance / repair works.

- **Low Erosion Risk**

Risk rating of less than 40 units. Slight erosion of roadways / watercourses over a fairly long period of time, requiring minimal maintenance / repair works.

4.3 Drainage System Assessment Results

The results of both the capacity and erosion risk assessments are graphically shown on **Drawing No.'s J35378/SWMP-06 to SWMP-10** (refer to **Appendix F**) which should be read in conjunction with **Table 6.2** (refer to **Appendix G**) which gives the results of the hydraulic capacity failure risk assessment, and **Table 6.3** (refer to **Appendix H**) which gives the results of the erosion failure risk assessment.

5 *Remedial measures for flood and erosion control*

Having identified and prioritised the potential hydraulic capacity and erosion failure risks, remedial measures to upgrade the existing drainage system were planned and a conceptual design completed for these. The upgrades to the existing system were planned and designed taking into account the future developments as described in **Section 3.1.2**. In addition, extensions to and new major drainage systems were planned and sized for those proposed new developments not discharging into the existing drainage systems.

5.1 Existing Drainage System: Remedial Measures

The proposed remedial works to render the existing drainage system of Montagu free from flood and erosion risk, as shown on **Drawing No.'s J35378/SWMP-11 to SWMP-15** (refer to **Appendix I**) and detailed in **Table 7.1** (refer to **Appendix J**) will need to be implemented over time to suit the budgets and priorities of the Cape Winelands District Municipality.

5.2 Provision of Bulk Storm Water Infrastructure for Future Development

The proposed bulk storm water infrastructure required to accommodate the future development of Montagu (incorporating Ashbury) as per the “Langeberg Spatial Development Framework”, has been conceptually planned and designed.

The layout of the proposed bulk storm water infrastructure is shown on **Drawing No.'s J35378/SWMP-11 to SWMP-15** (refer to **Appendix I**) and the conceptual details and estimated capital costs are given in **Table 7.1** (refer to **Appendix J**).

5.3 River Management

It is also recommended that River Maintenance Plans for both the Keisies River and the Kingna River be compiled by a professional team consisting of an environmental practitioner a freshwater ecologist and a stormwater engineer/hydrologist. These plans once approved under the 2010 NEMA EIA regulations will enable the Langeberg Municipality to maintain these rivers to ensure they function optimally in terms of both ecological and flow function.

Appendix A

Figure 1: Catchment Map

Appendix B

Figure 2: Drawing No. J35378A/SWMP01 to SWMP05
Existing Storm Drainage Network

Appendix C

Table 5.1: Existing Storm Water Drainage System Details

Appendix D

Existing Storm Water System Assessment

Drawing No.'s J35378/SWMP-06 to SWMP-10

Appendix E

Table 6.2: Hydraulic Capacity Risk Analysis and Assessment Results

Appendix F

Table 6.3: Erosion Risk Analysis and Assessment Results

Appendix G

Remedial Measures and Future Systems

Drawing No.'s J35378/SWMP-11 to SWMP-15 Drainage System

Appendix H

Table 7.1: Remedial Measures Details and Capital Cost Estimate

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