REPORT
WATER SPECIALIST REPORT
FOR
THABO MOFUTSANYANA DISTRICT MUNICIPALITY
FOR THE

DEVELOPMENT OF ENVIRONMENTAL MANAGEMENT FRAMEWORKS FOR SIX DISTRICT MUNICIPALITIES IN FOUR PROVINCES

DEVELOPED BY:
MUVULEDZI CONSULTING
AUTHORED BY:
DIDIMALANG MASOABI

FOR:
Department of Agriculture, Land Reform and Rural Development
and
Department of Forestry, Fisheries and Environment

Date: May 2022

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

LIST OF ACRONYMS

CMB	Chloride Mass Balance
DALRRD	Department of Agriculture, Land Reform and Rural Development
DFFE	Department of Forestry, Fisheries and the Environment
DM	District Municipality
DWA	Department of Water and Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EIA	Ecological Water Requirement
EIA	Environmental Impact Assessment
EMF	Environmental Management Framework
GRA	Groundwater Resource Assessment
GDP	Gross Domestic Product
GVA	Gross Value Added
IDW	Inverse Distance Weighting
IDP	Integrated Development plan
LDM	Lejweleputswa District Municipality
LM	Local Municipality
mbgl	Meters below ground level
WMA	Water Management Area
WUL	Water Use License
WULA	Water Use License Application
WWTWs	Wastewater Treatment Works

EXECUTIVE SUMMARY

The Thabo Mofutsanyana District Municipality (TMDM) has embarked on the development of Environmental Management Framework (EMF). The Thabo Mofutsanyana EMF was initiated through a concurrent agreement between the national and provincial ministers responsible for environmental affairs in terms of Chapter 5 of the National Environmental Management Act (1998).

Thabo Mofutsanyana District Municipality, one of the five district municipalities of the free state province. Thabo Mofutsanyana shares a boundary with the province of KwaZulu-Natal and Mpumalanga on its south east and north east boundaries respectively. To its north west, Thabo Mofutsanyana shares its boundaries with Fezile Dabi District Municipality, Lejweleputswa District Municipality to its west and Mangaung to its south west. This municipality consists of six local municipalities namely Dihlabeng Local Municipality, Maluti-a-Phofung Local Municipality, Mantsopa Local Municipality, Nketoana Local Municipality, Phumelela Local Municipality and Setsoto Local Municipality.

The Free State region is characterised by warm to hot summers and cool to cold winters. The average annual highest temperature in Thabo Mofutsanyana District Municipality is 28.4°C (83.1°F), and the February 8th is the hottest day on average. The average annual lowest temperature in Thabo Mofutsanyana District Municipality is -0.5°C (31.1°F), and the July 16th is the coldest day on average. The wettest months in Thabo Mofutsanyana District Municipality are January and December.

Thabo Mofutsanyana District Municipality has its boundaries within three Water Management Areas, however, the majority of the District Municipality falls within the Upper Vaal WMA. In total, over 54% of the current available water in the water management area is supplied through transfers from other water management areas and Lesotho. Also noticeable is the re-use of return flows, which constitute 21% of the available water, with the remainder being supplied from surface and groundwater resources naturally occurring in the WMA.

The water quality in the Upper Vaal WMA varies from poor in the highly developed areas to good in the less developed areas. The water quality is impacted on by point discharges from industries, wastewater treatment works, mine dewatering, irrigation return flows and diffuse sources such as runoff from mining and industrial complexes, agriculture and urban areas. The value of the water resources within the district municipality is generated from agriculture which contributes 11.5% to the Gross Value Added (GVA) of the district.

Approximately 17.5% of the total GDP of Free State province is derived from TMDM. The district provided approximately 17.5% of the total GDP of Free State Province. The agricultural sector is crucial for Thabo Mofutsanyana. The value of the water resources within the district municipality is generated from agriculture which contributes 11.5% to the Gross Value Added (GVA) of the district.

Groundwater resources are available throughout the entire TMDM, but in varying quantities, depending upon the hydrogeological characteristics of the underlying aquifer. Thabo Mofutsanyane DM is area is underlain by intergranular and fractured (d) aquifer systems derived from the fracturing and weathering of the underlying geological formations. The yield potential of intergranular and fractured aquifer (d) systems within the district varies and are classified between d1 and d4, capable of supporting borehole yields between 0.1 and 5.0 L/s.

The groundwater development potential in the district can categorised as Low. Low development representing fractured and intergranular and fractured aquifer systems. However, due to large variability in borehole yields, an appreciable amount of boreholes will have to be drilled to obtain a yield at the high-end of the range, capable of abstracting 2 l/s for 8hrs per day.

The groundwater quality in the Thabo Mofutsanyane district is relatively good in satisfying the DWS water quality guidelines for domestic and agricultural supply. However, the mining activities, failing wastewater treatment plants and related industries are negatively impacting the quality of the groundwater resources.

Possible water pollution sources in the Thabo Mofutsanyane DM primarily relate to land use activities such as agriculture, cemetery, mining and industrial uses. In addition, it also relates to facilities where wastes are treated and disposed of, such as landfill sites and waste-water treatment works. Most (five) of the waste-water treatment works within Thabo Mofutsanyane district are reported to be failing and polluting both and groundwater resources in the areas in which are located.

The vulnerability of the aquifer systems within the district ranges from medium to high, with most of the aquifers vulnerability being classified as high and medium.

No detailed hydrocensus was conducted in TMDM area as part of the current study to verify the groundwater users and abstraction volumes. It is known that most of the farmers and communities within the municipal boundaries are using groundwater for agricultural and domestic purposes

1 INTRODUCTION

1.1 PROJECT MOTIVATION

The Thabo Mofutsanyana District Municipality (TMDM) has embarked on the development of Environmental Management Framework (EMF). The Thabo Mofutsanyana EMF was initiated through a concurrent agreement between the national and provincial ministers responsible for environmental affairs in terms of Chapter 5 of the National Environmental Management Act (1998). It was prepared as collaboration between the Department of Agriculture, Land Reform and Rural Development (DALRRD) and the Department of Forestry, Fisheries and the Environment (DFFE), Free State Province and the TMDM. The need for the EMF was driven by authority concerns in the District regarding the following issues:

- The pressures to deliver services and enhance development, list many potential project, however some might occur in sensitive environments and trigger the need for Environmental Authorisation (EIA Regulations, 2014);
- Currently individual projects require separate EIA processes and authorisation which consume financial resources and time to deliver;
- Conducting a district wide EMF saves time and funds spent on individual projects.
- EMFs maps sensitivities (constraints) and opportunities of the identified study areas.

Muvuledzi Consulting (PTY) Ltd has been appointed to conduct the EMF process on behalf of and in collaboration with the TMDM, Free State Province and other key role players in the District.

1.2 PURPOSE OF THE EMF

The National Environmental Management Act: EMF regulations 2010 and the EMF guidelines of 2012 outline the purpose of and set the legislated requirements for developing an EMF. The main purpose of an EMF is to streamline and facilitate efficient implementation of the EIA process. This is possible due to the pro-active nature of the EMF which allows for the anticipation and prevention of environmental damage before development proposals are evaluated.

In addition to the benefits associated with the EIA process, the EMF includes a strong spatial output, namely the Environmental Information Management System (EIMS), Environmental Management Framework Plan and the exclusion standards and implementation protocol, defined in this process as the Decision Support Tool (DST) as well as exclusion standards. The DST facilitates access to the EMF information and outputs by users of the EMF which includes developers, planners, decision makers and broader society.

Aim

In view of the above context, the specific aim of the EMF is to: ***Is to proactively support and integrate environmental considerations into decision-making and development planning across the District Municipality, by supporting sustainability, securing environmental protection and promoting cooperative environmental governance.***

Objectives

The following objectives need to be met in order to fulfil this aim:

i) Document and provide spatially referenced information indicating the location, sensitivity and value of resources and systems (Present State).

ii) Document the drivers, factors and trends responsible for the Present State and analyse these in determining the key sustainability issues.

iii) Establish the Desired Future State (DFS) and environmental management priorities in the area.

iv) Define opportunities and constraints for different land-uses and development activities.

v) Develop tools that provide for the effective application of the information and outcomes of the process at a planning and project level (EIA), and appropriate responses to address and manage the environmental issues identified.

1.3 THE LEGAL OVERVIEW OF ENVIRONMENTAL MANAGEMENT FRAMEWORK

A legislation and policy review has been undertaken to ensure that the EMF is “legally compliant” while facilitating development planning and decision making. The review included relevant policies and acts, categorizing them according to National, Provincial and Local levels of governance. All the legislation listed would not be equally important during the development of the EMF, but should be considered. The intention is that this baseline is built on in the next phase of the EMF development, by defining what the specific requirements or implications of the policies and acts are for the development and/or outcomes of the EMF.

WATER ACTS

The National Water Act (Act No. 36 of 1998) provides the legislative water management requirements in South Africa. The National Water Act, provides the legal framework for the effective and sustainable management of water resources. The National Water Act provides for the sustainable and equitable use and protection of water resources. It is founded on the principle that the National Government has overall responsibility for and authority over water resource management, including the equitable allocation and beneficial use of water in the public interest, and that a person can only be entitled to use water if the use is permissible under the NWA.

The Water Services Act (Act No. 108 of 1997) provides for the rights of access to basic water supply and basic sanitation. Sufficient water and an environment not harmful to health or well-being is necessary. Government has to ensure that water supply services and sanitation services are provided in a manner that is efficient, equitable and sustainable. The provision of water supply services and sanitation services, although an activity distinct from the overall management of water resources, must be undertaken in a manner consistent with the broader goals of water resource management.

This Act, among other things, also provide for the gathering and the distribution of information in a national information system and the promotion of effective water resource management and conservation, and both these acts will be applicable on the District Municipality.

2 PROJECT AREA

2.1 DISTRICT MUNICIPALITY

Thabo Mofutsanyana District Municipality, one of the five district municipalities of the free state province. Thabo Mofutsanyana shares a boundary with the province of KwaZulu-Natal and Mpumalanga on its south east and north east boundaries respectively. To its north west, Thabo Mofutsanyana shares its boundaries with Fezile Dabi District Municipality, Lejweleputswa District Municipality to its west and Mangaung to its south west. The District shares a border with Lesotho to its south. District covers a space of 32 734km² of the land surface of the province, making it the second largest in term of land size. This municipality consists of six local municipalities namely Dihlabeng Local Municipality, Maluti-a-Phofung Local Municipality, Mantsopa Local Municipality, Nketoana Local Municipality, Phumelela Local Municipality and Setsoto Local Municipality.

2.2 LOCAL MUNICIPALITY

Dihlabeng Local Municipality

The Dihlabeng Local Municipality is one of the six local municipalities within the Thabo Mofutsanyana District Municipality, along the eastern boundary of the Free State Province. The total extent of Thabo Mofutsanyana District Municipality covers 28 347km^2 in the extent of which Dihlabeng Local Municipality takes up 4 739km, which represents 17% of the District.

Phumelela LM

The Phumelela Local Municipality is a Category B municipality situated within the Thabo Mofutsanyana District in the Free State Province. It is the largest municipality in the district, making up a quarter of its geographical area. The Phumelela Municipality covers an area of approximately 8183 km^2, with the following major towns; Vrede, Warden and Memel as well as the rural; Riemland and Drakensberg. Phumelela municipality's head office is in Vrede ('at peace') and lies in the north-eastern Free State about 20km east of the N3, close to the Mpumalanga border.

Maluti a Phofung LM

The Maluti-A-Phofung Local Municipality is a Category B municipality situated within the Thabo Mofutsanyana District in the Free State Province. It is bordered by Phumelela in the north, the Kingdom of Lesotho in the south, the KwaZulu-Natal Province in the east, and Dihlabeng in the west. It is one of the six municipalities that make up the district.

Nketoana LM

The Nketoana Local Municipality is a Category B municipality situated within the Thabo Mofutsanyana District in the Free State Province. It is the second-smallest of six municipalities in the district, making up 17% of its geographical area. It was established in terms of Section 14 of the Local Government: Municipal Structures Act 11 of 1998, and was published in the Provincial Gazette No. 109 dated 28 September 2000. The Highlands water flows into the Caledon River, then into the As River, and continues into the Nketoana River near Reitz and Petrus Steyn. The river passing near Reitz/Petrus Steyn is called Nketoana in Sesotho.

Setsotso LM

The Setsoto Local Municipality is a Category B municipality situated in the eastern Free State Province within the Thabo Mofutsanyana District.

Mantsopa LM

The Mantsopa Local Municipality is a Category B municipality situated within the Thabo Mofutsanyana District in the eastern Free State Province. It borders Masilonyana and Setsoto to the north, the Kingdom of Lesotho to the east, and Mangaung Metropolitan Municipality to the west. It is the smallest of six municipalities in the district, making up 13% of its geographical area.

2.3 TOPOGRAPHY AND LAND FORMS

The Vaal River flows west in the upper catchment, then south west across the middle and lower Vaal catchment indicating the catchment slopes in the N - S and SE – NW directions. The stream density is high in the upper catchment as this region has the highest elevations. The highest elevation within the catchment, greater than 2,500 m, is at the extreme south of the upper catchment. The south eastern boundary of this part of the catchment also has high elevations due to the Drakensberg Range.

In general, the catchment slopes gently from 1,850 m east of upper catchment to 970 m above mean sea level near the confluence with Orange River. The higher altitudes comprise of mountainous terrain with rolling hills. The middle and lower parts of the basin is generally flat with slopes ranging from 0 to 7.5%.

2.4 CLIMATIC CHARACTERISTICS

The Free State region is characterised by warm to hot summers and cool to cold winters. This semi-desert area also brings fluctuations of temperature from day to night. Areas in the east experience frequent snowfalls, some of high precipitation, whilst the west can be extremely hot in summer.

The climatic conditions vary across the WMA, with the Mean Annual Precipitation (MAP) reducing from 800 mm in the headwaters to 500 mm at the Middle Vaal WMA boundary. This tendency is reversed when considering potential annual evaporation, which increases from 1300 mm in the Upper Vaal to 2800 mm in the West.

The average annual highest temperature in Thabo Mofutsanyana District Municipality is 28.4°C (83.1°F), and the February 8th is the hottest day on average. The average annual lowest temperature in Thabo Mofutsanyana District Municipality is -0.5°C (31.1°F), and the July 16th is the coldest day on average. The wettest months in Thabo Mofutsanyana District Municipality are January and December. Average annual rainfall for Thabo Mofutsanyana District Municipality is 690mm (27").

2.5 GEOLOGY AND SOILS

The area to the south of the Vaal River is underlain by fine sedimentary rocks of the Karoo system, as is the area to the north of the Vaal River, situated east of longitude 28° E. The Karoo system covers about 80 % of the Upper Vaal WMA. To the north of the Vaal River, west of longitude 28° E, igneous and metamorphic rocks predominate but there are extensive dolomitic exposures in the central areas which are mainly in the catchment of the Mooi tributary.

The stratigraphic relationship of these strata to another is presented in Table 1 and their distribution are shown in Figure 1.

The most dominating lithologies are the mudstones and shales of the Adelaide formation as well as the sandstones, siltstones and mudstones of the Tarkastad formation. These two formations underlain over 60% of the entire district. These formations have been intruded by the swarms of dolerite dykes and sills.

Table 1: Simplified lithostratigraphic subdivision of strata with Thabo Mofutsanyane DM

Basic lithology	Lithostratigraphic Unit		
	Formation	Group	Supergroup
Sand, red and grey Aeolian dune sand (Qs)	Quaternary		
Dolerite dyke (Jd)	Intrusive rocks		
Red mudstone and Sandstone (Tre)	Elliot		Karoo Sequence Supergroup
Sandstone, conglomerate and mudstone (Trm)	Molteno	Stormberg Group	
Fine to coarse grained feldspathic sandstone, subordinate siltstone and brown-red mudstone (Trt)	Tarkastad	Beaufort Group	
Fine to coarse grained Sandstone and Mudstone (Pne)	Escort Formation		
Mudstone and Sandstone (Pa)	Adelaide Formation		

Soil depths are generally moderate to deep with an undulating relief over the entire Upper Vaal WMA. There are three main soil types that predominate and these are distributed across the catchment as follows.

- Sandy Loam: In upper reaches of the Vaal and Wilge catchments and to north of the Vaal River along its central reaches.
- Clay Loam: In the Klip (Gauteng) and Suikerbosrand catchments and to the south of the Vaal River along its central reaches.
- Clay Soil: In the middle and lower catchments of the Wilge and Vaal catchments upstream of Vaal Dam. It also occurs to the west of the Vaal.

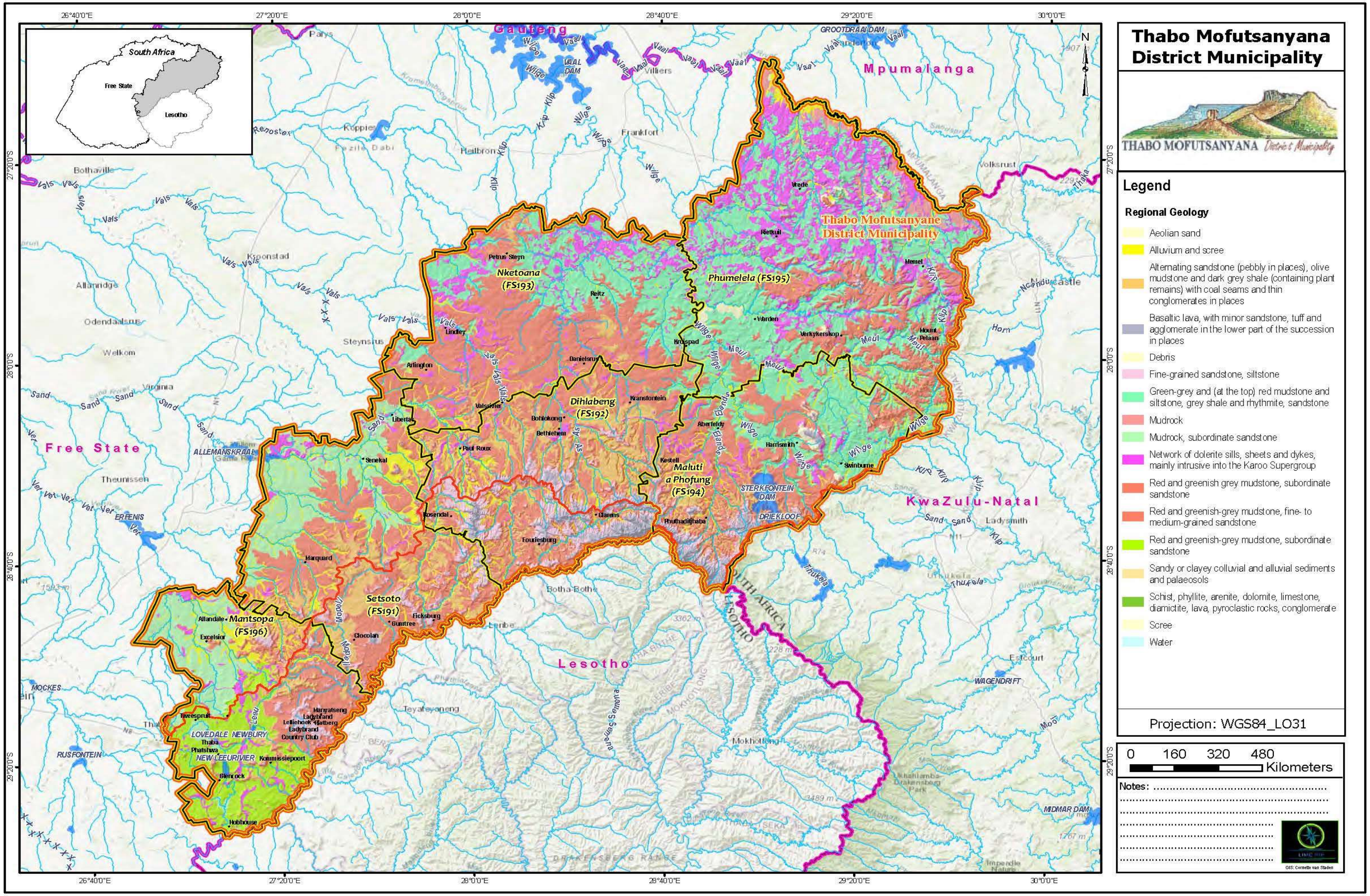

Figure 1: Regional geological settings of Thabo Mofutsanyane District Municipality

3 WATER RESOURCES

3.1 SURFACE HYDROLOGY

According to the Upper Vaal WMA Overview of Water Resources Availability Report, DWAF (2003a), the district municipality includes major rivers such as the, Wilge, Liebenbergsvlei and Caledon. The largest proportion (46%) of the surface flow in the district municipality is contributed by the Vaal River upstream of Vaal Dam, together with its main tributary the Klip River.

Water Management Area

Thabo Mofutsanyana District Municipality has its boundaries within three Water Management Areas, as indicated in Table 2. However, the majority of the District Municipality falls within the Upper Vaal WMA. The Upper Vaal WMA is located upstream of the confluence of the Vaal and the Mooi Rivers and extends to the headwaters of the Vaal, Klip, Wilge and Liebenbergsvlei rivers. This WMA includes the very important dams Vaal Dam, Grootdraai Dam and Sterkfontein Dam. It includes parts of Gauteng, Mpumalanga, Free State and North-West provinces. The Sterkfontein Dam is located within the district municipality.

The Middle Vaal WMA is located downstream of the confluence of the Vaal and the Rietspruit Rivers and upstream of Bloemhof Dam. It extends to the headwaters of the Schoonspruit River in the north and the Vet River in the south, covering a total catchment area of 52 563 km^2 . The Middle Vaal WMA includes parts of Free State and North-West provinces.

The water resources of the Upper Orange WMA consist of the main stem Orange River with the Kraai, Kornetspruit, Sterkspruit, Stormbergespruit, Seekoei River and Caledon River as its main tributaries. The tributaries contributing to the flow in the Caledon River are the Little Caledon River, Grootspruit, Meulspruit, Moperi River, Leeuspruit, Skulpspruit and the Sandspruit. The major river flowing through the district municipality is the Caledon with Brandwater and Leeu as the main tributaries. The smaller dams namely Armenia and Egmont Dams are located on the Caledon River system (Table 2).

Catchment overview

Catchment boundaries fall within WMAs and are, like the WMAs, based upon the topography of a region and do not follow administrative boundaries, hence the Water Management Areas do not fit into the district boundaries at all. Table 2 presents the quaternary catchments where the district municipality is located and major rivers flowing through the district municipality.

Table 2: Major Rivers and Drainage areas

WMA	Quaternary Catchments	Rivers	Municipality
Upper Vaal	C82A, C82B, C82E, C82F, C12A, C13D, C13E, C13F, C13G,	Wilge, Cornelis	Phumelela
	C81B, C81E, C81F, C81H	Wilge, Elands	Maluti a Phofung
	C82D, C82G, C82G, C83G, C83F, C60B	Liebenbergsvlei	Nketoana
Middle Vaal	C41A, C42B, C42C, C42D, C42E, D22A, D22B, D22D	Klipspruit/ Sandsloot	Setsoto
Upper Orange	D21D, D21F, D21G, C83A, C83B, C83C, C83D	Caledon, Brandwater	Dihlabeng
	D22G, D22L, D23C, D23D, D41C	Caledon, Leeu	Matsopa

Water Flows

The water in the Middle Vaal WMA flows from the Upper Vaal, across the Middle Vaal, Lower Vaal and Lower Orange WMAs before reaching the Atlantic Ocean near the town of Alexander Bay in the western corner of the country.

The water in the Lower Vaal WMA flows from the Upper Vaal, across the Middle Vaal, Lower Vaal and Lower Orange WMAs before reaching the Atlantic Ocean near the town of Alexander Bay in the western

Water use

The land-use in the area is primarily rural agricultural based, with an urban setting in the nearby town of Amersfoort (Eskom, 2013):

- Agriculture (covering the majority of the proposed development route);
- Mining
- Mix urban use (in town approximately 7km from proposed development area); and
- Energy production (at Majuba opposite the proposed project area)

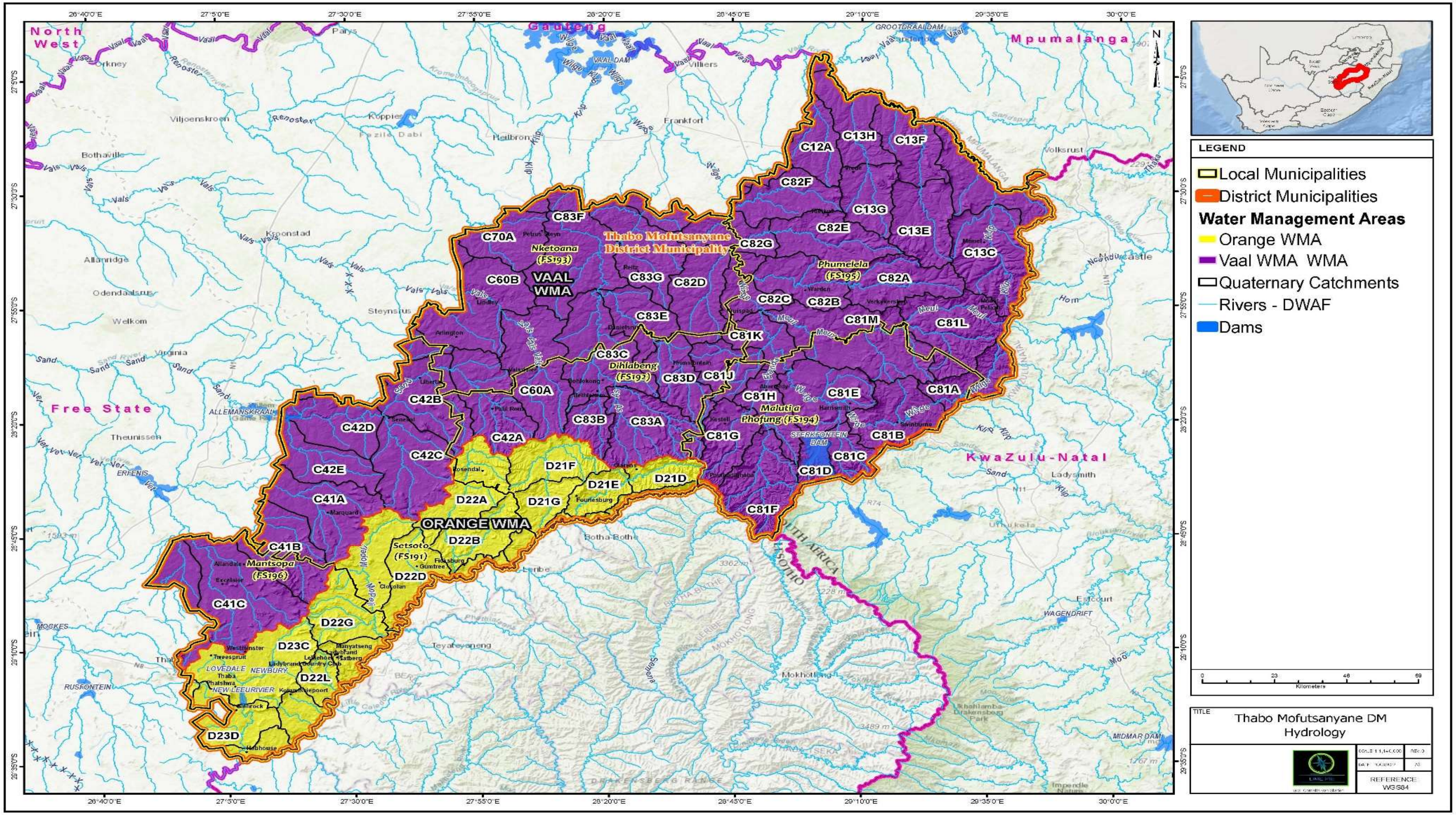

Figure 2: Surface water including catchment areas within Thabo Mofutsanyana DM

3.2 WATER AVAILABILITY

In total, over 54% of the current available water in the water management area is supplied through transfers from other water management areas and Lesotho. Also noticeable is the re-use of return flows, which constitute 21% of the available water, with the remainder being supplied from surface and groundwater resources naturally occurring in the WMA (DWAF, 2004).

The largest proportion (46%) of the surface flow in the water management area is contributed by the Vaal River upstream of Vaal Dam, together with its main tributary the Klip River. The Wilge River and the Liebenbergsvlei River contribute 36%, with the remaining 18% originating from the tributaries downstream of Vaal Dam.

The Upper Vaal Water Management Area: Internal Strategic Perspective (DWAF, 2004), details the total water available for use in the Upper Vaal water management area at the year 2000. See Table 3.

Table 3: Available water in year 2000 (million m3/a)

Sub-area	Natural resource		Usable return flow			Total local yield (1)	Transfers in	Grand Total
	Surface Water	Ground-Water	Irrigation	Urban	Mining and bulk			
Wilge	46	4	2	7	0	**59**	0	**59**
Upstream of Vaal Dam	154	8	3	11	8	**184**	118	**302**
Downstream of Vaal Dam	399	20	7	325	138	**889**	1 224	**2 113**
Total	**599**	**32**	**12**	**343**	**146**	**1 132**	**1 310**	**2 442**

Many factors, which influence the requirements for water. These include climate, nature of the economy (i.e. irrigated agriculture, industrialised) and standards of living. Of these, climate is relatively stable, while in most cases control can be exercised over the growth in irrigation water requirements. Based on the scenarios for population and economic growth, initial estimates of possible future water requirements were made for the period until 2025.

In addition, provision was made for known and probable future developments with respect to power generation, irrigation, mining and bulk users as described under the respective sub-areas where applicable. Table 4 presents the projected water requirements for year 2025.

Table 4: Projected water requirement in year 2025 (million m3/a)

Sub-area	Irrigation	Urban (1)	Rural (1)	Mining and bulk industrial (2)	Power generation (3)	Affore-station (4)	Total local requirements	Transfers out	Grand Total
Wilge	18	47	13	0	0	0	**78**	0	**78**
Upstream of Vaal Dam	29	52	17	99	75	0	**272**	74	**346**
Downstream of Vaal Dam	67	1197	10	74	43	0	**1 391**	2 067	**3 458**
Total	**114**	**1 296**	**40**	**173**	**118**	**0**	**1 741**	**2 140**	**3 881**

3.3 WATER QUALITY

Water quality status quo in Thabo Mofutsanyane DM

The water quality in the Upper Vaal WMA varies from poor in the highly developed areas to good in the less developed areas. The water quality is impacted on by point discharges from industries, wastewater treatment works, mine dewatering, irrigation return flows and diffuse sources such as runoff from mining and industrial complexes, agriculture and urban areas. The area is also subject to atmospheric deposition due to emissions from coal fired power stations and industry in and around the catchment.

Ecological water quality status

Ecological water requirements is defined as the flow patterns (magnitude, timing and duration) and water quality needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to both the quantity and quality components.

The ecological condition within the Phumelela LM is in a C condition. The 7 site is in an A/B condition. EWR 7 is the only node that represents the wetland and its A/B EC is representative of the wetland. It is recommended that the development and operation of the proposed Braamhoek pump-storage scheme, which could impact on the wetland, should therefore accommodate and maintain the integrity of the wetland at an EC of A/B.

The ecological requirement in the Setsoto LM is mostly in a degraded condition of a D or even lower. The focus therefore was to identify nodes in the tributaries to ensure that these can function as important refuge areas. Two of the nodes are in a B/C condition ecological condition and therefore requires improvement to a B condition. This improvement will be related to addressing agricultural practices, i.e., non-flow related aspects. Improving flow is unlikely to achieve the improved condition.

Table 5: Ecological water requirements for the rivers

WMA	Municipality	Quaternary Catchments	EWR site	PES	REC
Upper Vaal	Phumelela	C82A, C82B, C82E, C82F, C12A, C13D, C13E, C13F, C13G,	EWR 7	A/B	A/B
	Maluti a Phofung	C81B, C81E, C81F, C81H			
	Nketoana	C82D, C82G, C82G, C83G, C83F, C60B	UD.4	B/C	C
Middle Vaal	Setsoto	C41A, C42B, C42C, C42D, C42E, D22A, D22B, D22D	ME1	C/D	B/C
Upper Orange	Dihlabeng	D21D, D21F, D21G, C83A, C83B, C83C, C83D	UD		
	Matsopa	D22G, D22L, D23C, D23D, D41C			

Modelled water quality risk data
The Vaal WMA are predominantly of low to no water quality risk, however, numerous significant risk areas were established and directly correlate with the extent of modification of water sources or areas. Significant risk areas were predominantly established downstream or within close proximity of urban centres, cultivated areas, mining developments as well as WWTWs.

WWTWs are especially of great concern as it is dominated by unacceptable to tolerable levels of most or all selected water quality parameters especially in terms of Faecal coliform. Most of the WWTWs facilities do not comply with set standards and can be attributed to these facilities being mismanaged, inadequate or in need of proper maintenance or upgrading (du Plessis A, 2019).

Mining affects fresh water through heavy use of water in processing ore, and through water pollution from discharged mine effluent and seepage from tailings and waste rock impoundments. Increasingly, human activities such as mining threaten the water sources on which we all depend.

Socio-economic and Conservation Value of the Resource
The value of the water resources within the district municipality is generated from agriculture which contributes 11.5% to the Gross Value Added (GVA) of the district.

Approximately 17.5% of the total GDP of Free State province is derived from TMDM. The district provided aapproximately R 29 billion (constant 2010 prices) or 17.5% of the total GDP of Free State Province. The agricultural sector is crucial for Thabo Mofutsanyana. Not only is the agricultural sector important for food security, it has a high labour absorption rate compared to other economic sectors. Thabo Mofutsanyana produces 90% of the country`s cherry crops. Its northern parts has many sunflower-seed farms. Seed potatoes are produced in the Reitz, Kestell, Memel, Bethlehem and Fouriesburg. Tweespruit is a major sunflower seed production centre.

Mining had a low contribution at 2.0%. Uranium mining potential exist in the towns of icksburg and Phuthaditjhaba, diamonds in Senekal, sandstone in Phuthaditjhaba and limestone in Ficksburg. There is also discrete uranium zones that can be explored in Setsoto and Dihlabeng local municipalities (District Development Model, 2020).

Condition of the Resource and Drivers of Change
Possible drivers of water quality in the Lejweleputswa DM relate to land-based activities such as agriculture, mining and industrial uses, waste-water treatment works and agricultural runoff enriched with fertilizers.
Another major contributor is climate change. Increased water temperatures will cause eutrophication and excess algal growth, which will reduce water quality.

Mining contributes pollutants such as salts and heavy metals that are released when rocks are crushed and minerals extracted, silt from tailing storage facilities, as well as chemicals used in the mining process.

3.4 GROUNDWATER

Geohydrological features

Groundwater resources are available throughout the entire TMDM, but in varying quantities, depending upon the hydrogeological characteristics of the underlying aquifer. The rocks underlying the Eastern Highveld (28), Northern Highveld (32) and Southern Highveld (33) Hydrogeological Regions (Vegter, 2001), which covers the major parts of the TMDM, are predominantly sedimentary of nature and mostly belong to Karoo Supergroup and were intruded by dolerite swarm. The hydrogeological map of the area is shown in Figure 3.

The 1:500 000 General Hydrogeological maps for the Republic of South Africa published by the Department of Water Affairs and Forestry (DWAF, 2000) and the Groundwater Resource Assessment Phase 2 (GRA 2 – DWAF, 2005) database has been used to assess hydrogeological conditions of the study area.

Most of the area within the district are located within Kroonstad 2726 hydrogeological map (Baran and Jonck, 2000). Thabo Mofutsanyane DM is area is underlain by intergranular and fractured (d) aquifer systems derived from the fracturing and weathering of the underlying geological formations (Figure 3).

a. Intergranular and Fractured aquifers

This aquifer system occurs practically in the entire district area. The action of tectonic forces together with the subsequent processes of weathering, created two hydraulically interconnected different zones that occur in a vertical profile namely: A shallower, weathered zone, where the original rock structure has been changed to a mass of more or less loose rock fragments, in a matrix of fine products of weathering, mostly sand, silt and clay.

A fractured zone, down to a depth where the rock is becoming solid and fresh in appearance. The transition to this deeper zone is usually gradual. The lateral movement of groundwater in the top zone is very slow and boreholes tapping it are weak

The yield potential of intergranular and fractured aquifer (d) systems within the district varies and are classified between d1 and d4, capable of supporting borehole yields between 0.1 and 5.0 L/s (**Error! Reference source not found.**).

Recharge

The precipitation is the main source of recharge in the area and the mean annual rainfall for the district has been estimated to be between 500 and 800 mm per annual. According to the DWS data for recharge estimations using Chloride Mass Balance (CMB), the mean annual recharge to the groundwater system in Thabo Mofutsanyane DM is estimated to be between 20 and 100 mm per annum, (GRA II 3aC, 2005). The study by Musekiwa and Majola (2013) estimated the recharge to be between 10 and 50 mm per annum.

Hydrochemistry

The scarcity of available data for the area, did not allow the assessment team for a more detailed analysis of hydrochemistry and groundwater quality. The assessment by DWS (2000) shows that the groundwater in the area is dominated by water with electric conductivity between 0 – 70 mS/m. The fluoride and nitrates are reported to be above 1.5 mg/l and 10 mg/l, respectively.

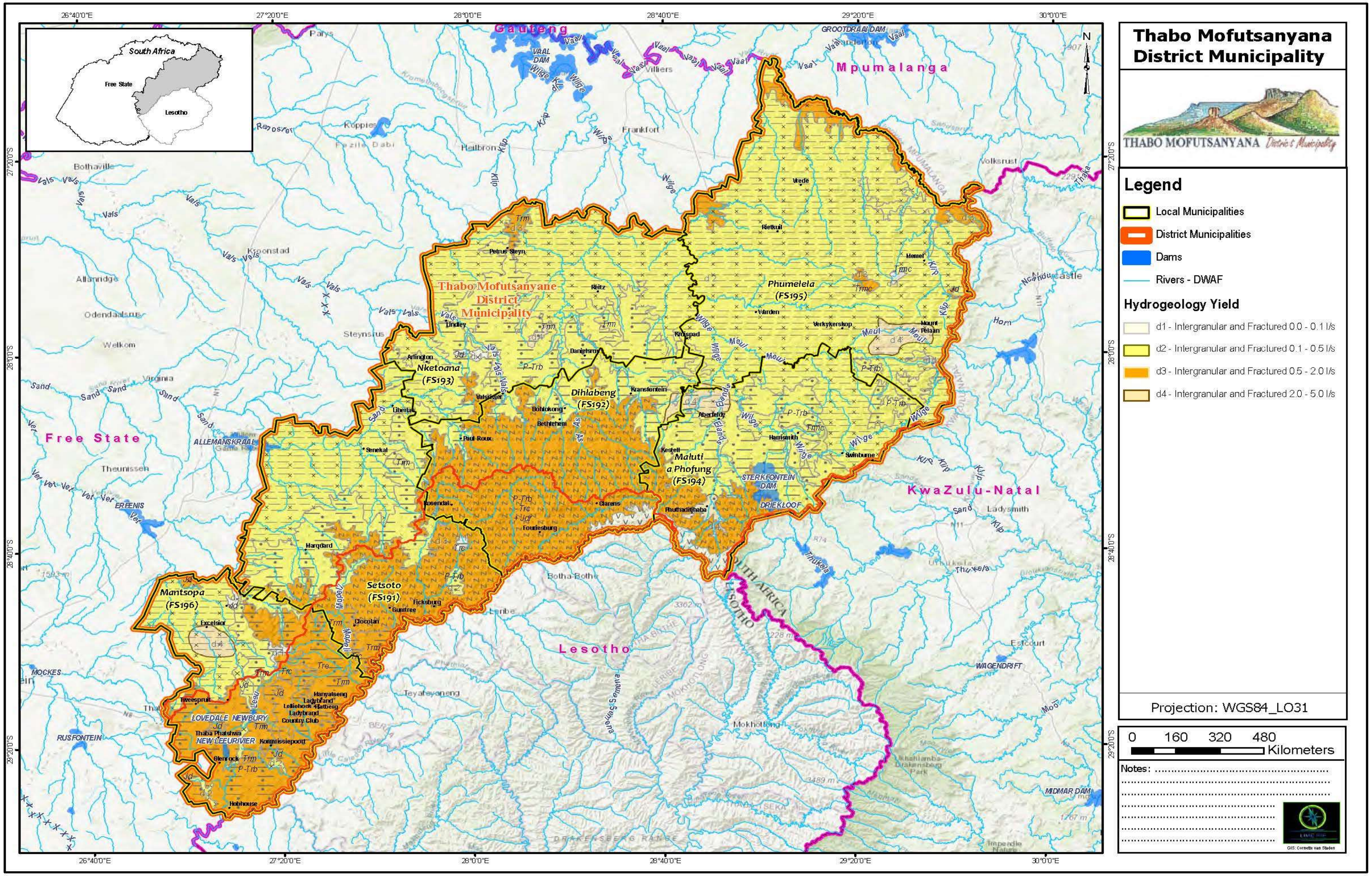

Figure 3: Hydrogeological settings of Thabo Mofutsanyane District Municipality

Groundwater Drainage, Transmissivity, Storativity

The groundwater occurrence in the area is controlled by weathering, fracturing and dissolution of the dolomitic rocks. The groundwater flow is controlled by the topographical settings of the area as well as secondary geological features such as fault zone. The transmissivity and hydraulic conductivity of the underlying hydrostratigraphic units can be classified as low to intermediate.

The estimated hydraulic conductivity values for aquifer systems within the district are presented Table 6 (Musekiwa and Majola, 2013). These approximate values were taken from geology literature which lists typical values for different geology types. There were no field measurements conducted to verify these values.

Table 6: Hydraulic conductivities of different aquifers

Aquifer type	Estimated hydraulic conductivity
Integranular and fractured aquifer	$1 \times 10^{1} - 1 \times 10^{-1}$

Groundwater Development Potential

The groundwater yield potential of the fractured aquifers system is classified as:

- Integranular and fractured aquifer system: classified as d1 to d4 capable of supporting yields between 0.1 and 5.0 L/s.

The groundwater occurrence in these aquifer systems is generally associated with zones of deep weathering and fracturing as well as dissolution of dolomitic formations. Groundwater is often encountered in the weathered formation and the transition zone between weathered/fraction and fresh rocks and in karsts. The zones of deep weathering and fracturing normally coincide with the drainage pattern.

Although the intergranular and fractured aquifer types have a low to medium development potential, it can supply basic water to small rural settlements, with at least some capacity for community gardens. Many rural settlements in this region are, in all probability dependent on groundwater.

The groundwater development potential in the district can categorised as Low. Low development representing fractured and intergranular and fractured aquifer systems. These aquifer system supports borehole yields enough for water for either hand- and/or wind pumps, i.e. small supplies for small communities and/or stock watering or single households can easily be achieved. Additional groundwater for community gardening or other poverty alleviation actions will be available. At the high-end of the yield range larger communities from single boreholes and wellfields supplying large communities would be possible. However, due to large variability in borehole yields, an appreciable amount of boreholes will have to be drilled to obtain a yield at the high-end of the range. Pumping at 2l/s for 8hours per day, 2000 persons, @25l/day can be supplied comfortably.

Groundwater quality

The groundwater quality in the Thabo Mofutsanyane district is relatively good in satisfying the DWS water quality guidelines for domestic and agricultural supply. However, the mining activities, failing wastewater treatment plants and related industries are negatively impacting the quality of the groundwater resources.

A total of 6 125 boreholes are reported to exist with the district area of jurisdiction. The existing information shows that majority of boreholes, 6 011, in the area lack water quality data. Only 90 boreholes were reported to have ideal and good water quality, suitable for use without treatment (DWS, 2012).

Pollution

Possible water pollution sources in the Thabo Mofutsanyane DM primarily relate to land use activities such as agriculture, cemetery, mining and industrial uses. In addition, it also relates to facilities where wastes are treated and disposed of, such as landfill sites and waste-water treatment works.

Various forms of crop production whether dry land or under irrigation, can result in increased silt loads, due to soil erosion. Agricultural runoff enriched with fertilizers also contribute to eutrophication, while it can also lead to pollution with toxic substances such as herbicides and pesticides.

Other major contributors to eutrophication include runoff that originates from domestic sources, as well as the discharge of untreated or improperly treated wastewater into the rivers. On top of the discharge of nitrates and phosphates, domestic wastewater also contains substances such as endocrine disrupting compounds and faecal pollution.

Mining contributes pollutants such as salts and heavy metals that are released when rocks are crushed and minerals extracted, silt from tailing storage facilities, as well as chemicals used in the mining process.

Most (five) of the waste-water treatment works within Thabo Mofutsanyane district are reported to be failing and polluting both and groundwater resources in the areas in which are located (DWS, 2020).

Groundwater vulnerability
Vulnerability of groundwater is a relative, non-measurable and dimensionless property, which is based on the concept that some land areas are more vulnerable to groundwater contamination than others. Maps showing groundwater vulnerability assist with the identification of areas more susceptible to contamination than others (Musekiwa and Majola, 2013).

Aquifer susceptibility is a qualitative measure of the relative ease with which a groundwater body can be potentially contaminated by anthropogenic activities and which includes both aquifer vulnerability and the relative importance of the aquifer in terms of its classification. The aquifer vulnerability map for aquifers within the district is shown in Figure 4.

The vulnerability of the aquifer systems within the district ranges from medium to high, with most of the aquifers vulnerability being classified as high and medium. Most of the aquifer system in the area are vulnerable to many pollutants except those strongly absorbed or readily transformed in many pollution scenarios.

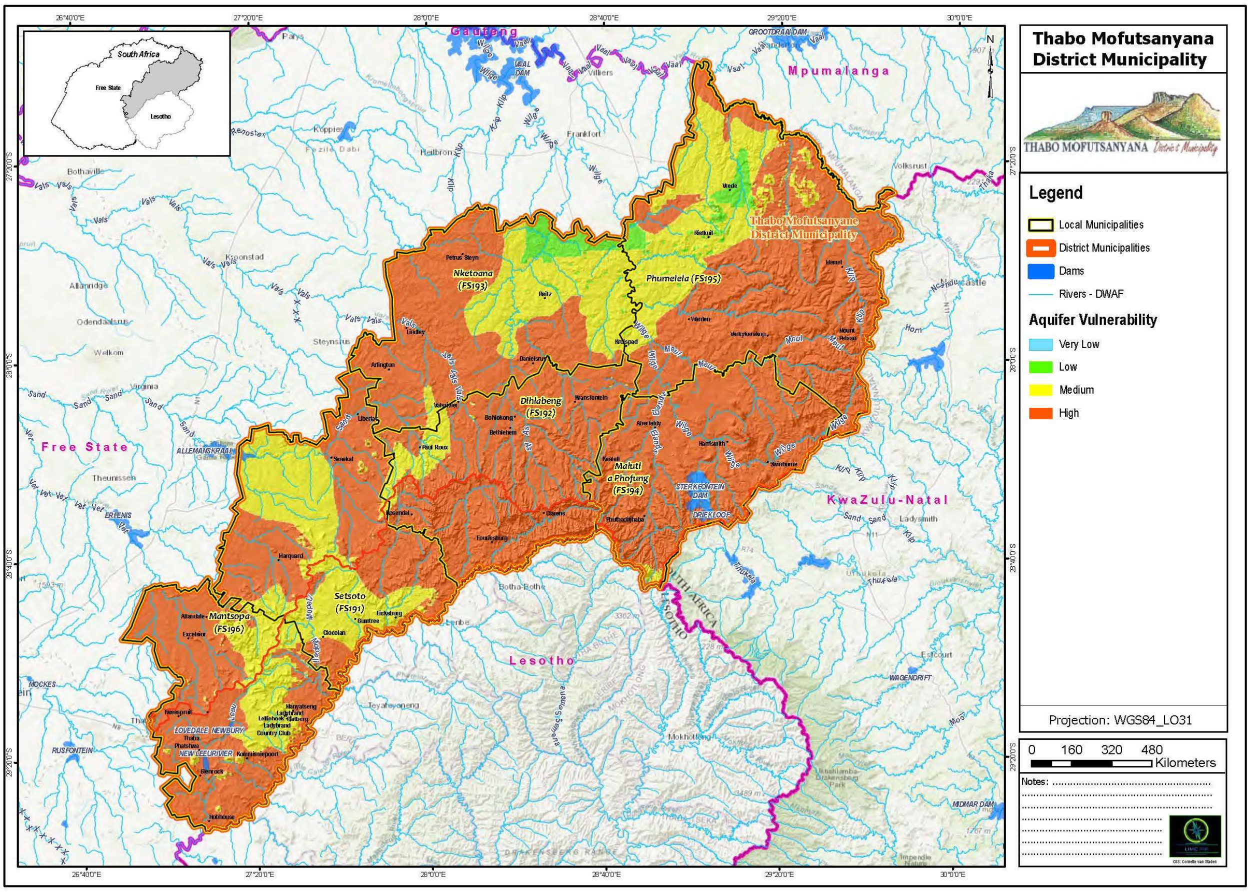

Figure 4: Aquifer vulnerability map of Thabo Mofutsanyane District Municipality

Depth to groundwater

DWS is monitoring groundwater level fluctuations in several boreholes within the district as part of the department national groundwater monitoring programme. The groundwater level map developed by Musekiwa and Majola (2013) based on data from the National Groundwater Database (NGDB) and using inverse distance weighting (IDW) shows that the groundwater levels in the area ranges between 5 and 30 meters below ground level (mbgl).

It should be noted that around the mines where there are active dewatering's, the depth to the groundwater level is influenced by the dewatering activities in the area.

Groundwater users

No detailed hydrocensus was conducted in TMDM area as part of the current study to verify the groundwater users and abstraction volumes. It is known that most of the farmers and communities within the municipal boundaries are using groundwater for agricultural and domestic purposes.

4 SUMMARY OF FINDINGS

The water quality in the Upper Vaal WMA varies from poor in the highly developed areas to good in the less developed areas. The water quality is impacted on by point discharges from industries, wastewater treatment works, mine dewatering, irrigation return flows and diffuse sources such as runoff from mining and industrial complexes, agriculture and urban areas. The current available water in the water management area is supplied through transfers from other water management areas and Lesotho.

Numerous significant risk areas directly correlate with the extent of modification of water sources or areas were established. Risk areas were predominantly established downstream or within close proximity of urban centres, cultivated areas, mining developments as well as WWTWs. These areas should be properly managed so as to reduce the risk to water quality pollution.

Groundwater resources are available throughout the entire TMDM, but in varying quantities, depending upon the hydrogeological characteristics of the underlying aquifer. Thabo Mofutsanyane DM is area is underlain by intergranular and fractured (d) aquifer systems derived from the fracturing and weathering of the underlying geological formations. The yield potential of intergranular and fractured aquifer (d) systems within the district varies and are classified between d1 and d4, capable of supporting borehole yields between 0.1 and 5.0 L/s.

The groundwater development potential in the district can categorised as Low. Low development representing fractured and intergranular and fractured aquifer systems. However, due to large variability in borehole yields, an appreciable amount of boreholes will have to be drilled to obtain a yield at the high-end of the range, capable of abstracting 2 l/s for 8hrs per day.

The groundwater quality in the Thabo Mofutsanyane district is relatively good in satisfying the DWS water quality guidelines for domestic and agricultural supply. However, the mining activities, failing wastewater treatment plants and related industries are negatively impacting the quality of the groundwater resources.

Possible water pollution sources in the Thabo Mofutsanyane DM primarily relate to land use activities such as agriculture, cemetery, mining and industrial uses. In addition, it also relates to facilities where wastes are treated and disposed of, such as landfill sites and waste-water treatment works. Most (five) of the waste-water treatment works within Thabo Mofutsanyane district are reported to be failing and polluting both and groundwater resources in the areas in which are located. The vulnerability of the aquifer systems within the district ranges from medium to high, with most of the aquifers vulnerability being classified as high and medium.

No detailed hydrocensus was conducted in TMDM area as part of the current study to verify the groundwater users and abstraction volumes. It is known that most of the farmers and communities within the municipal boundaries are using groundwater for agricultural and domestic purposes.

5 OPPORTUNITIES AND CONSTRAINTS

The water Status Quo findings of the project, presented in the sections above have generated a baseline description of the water conditions of the Thabo Mofutsanyane DM. Based on the baseline description the water resources Thabo Mofutsanyane DM, opportunities were identified for the enhancement of Thabo Mofutsanyane DM and are presented in Table 7, which also includes the summary of identified constraints of water resources in Thabo Mofutsanyane DM.

Table 7: Opportunities and Constraints for Thabo Mofutsanyane District Municipality

Commodity	Attributes	Significant Strategic Issues	Opportunities	Constraints
GROUNDWATER	**Availability and development**	Groundwater resources are available throughout the entire TMDM, but in varying quantities, depending upon the hydrogeological characteristics of the underlying aquifer. Thabo Mofutsanyane DM is area is underlain by intergranular and fractured (d) aquifer systems derived from the fracturing and weathering of the underlying geological formations. The yield potential of intergranular and fractured aquifer (d) systems within the district varies and are classified between d1 and d4, capable of supporting borehole yields between 0.1 and 5.0 L/s.	Development of Groundwater resources to augment or supplement the current water supply sources or as a sole water source to supply communities can be developed in high groundwater potential aquifer systems.	Impacts of climate change in the availability of groundwater resources due to reduced groundwater recharge.
		The groundwater development potential in the district can categorised as Low. Low development representing fractured and intergranular and fractured aquifer systems. However, due to large variability in borehole yields, an appreciable amount of boreholes will have to be drilled to obtain a yield at the high-end of the range, capable of abstracting 2 l/s for 8hrs per day.	All abstractions above Schedule 1 should be authorised/licensed (WUL) by DWS.	Water use licence authorisation (WULA) backlogs
			Groundwater resources is available to meet the domestic and agriculture demand	
	Pollution	The groundwater quality in the Thabo Mofutsanyane district is relatively good in satisfying the DWS water quality guidelines for domestic and agricultural supply. However, the mining activities, failing wastewater treatment plants and related industries are negatively impacting the quality of the groundwater resources	The quality of groundwater in most of the area away from potential contamination generating areas is good	Groundwater in some areas is contaminated. Pollution of groundwater resources primarily due to land use activities such as mining and failed waste-water treatment works.
		Possible water pollution sources in the Thabo Mofutsanyane DM primarily relate to land use activities such as agriculture, cemetery, mining and industrial uses. In addition, it also relates to facilities where wastes are treated and disposed of, such as landfill sites and waste-water treatment works. Most (five) of the waste-water treatment works within Thabo Mofutsanyane district are reported to be failing and polluting both and groundwater resources in the areas in which are located.	Improve treatment of wastewater and strict management of industrial and domestic effluent	Pollution of groundwater resources primarily due to land use activities such as agriculture, cemetery and industrial uses as well as facilities where wastes are being treated and disposed of, such as landfill sites and waste-water treatment works.
	Vulnerability	The vulnerability of the aquifer systems within the district ranges from medium to high, with most of the aquifers vulnerability being classified as high and medium.	Implement required groundwater protection in-line with the aquifer vulnerability classifications to adhere DWS water quality objectives.	Poor maintenance of water treatment works.
	Utilisations and management	No detailed hydrocensus was conducted in TMDM area as part of the current study to verify the groundwater users and abstraction volumes. It is known that most of the farmers and communities within the municipal boundaries are using groundwater for agricultural and domestic purposes		Over exploitation of groundwater in some areas.
				Current abstractions by agricultural practices is not known and this might lead to groundwater mining.
			Groundwater resources is available to meet the domestic and agriculture demand	Current abstractions by agricultural practices is not known and this might lead to groundwater mining.
			Implement re-verification and rectification of water uses.	Poor data management by municipality and DWS. No readily available information regarding groundwater resources in the area
SURFACE WATER	**Water quality**	The water quality in the Upper Vaal WMA varies from poor in the highly developed areas to good in the less developed areas.	• There is an opportunity to enforce water quality management regulations for the water users. • An opportunity to enforce the Green Drop Certification. • Control can be exercised over the quality in irrigation water requirements	• The water quality is impacted on by point discharges from industries, wastewater treatment works, mine dewatering, irrigation return flows and diffuse sources such as runoff from mining and industrial complexes, agriculture and urban areas. • Most of the WWTWs facilities do not comply with set standards and can be attributed to these facilities being mismanaged, inadequate or in need of proper maintenance or upgrading

Commodity	Attributes	Significant Strategic Issues	Opportunities	Constraints
	Water availability	The current available water in the water management area is supplied through transfers from other water management areas and Lesotho. The largest proportion of the surface flow in the water management area is contributed by the Vaal River upstream of Vaal Dam, together with its main tributary the Klip River.	There is opportunity to increase the re-use of return flows, which currently constitute 21% of the available water.	Poor water quality impact on irrigation water quality requirements
	Socio-economic	The value of the water resources within the district municipality is generated from agriculture which contributes 11.5% to the Gross Value Added (GVA) of the district. Not only is the agricultural sector important for food security, it has a high labour absorption rate compared to other economic sectors	Good quality irrigation water will result in high labour absorption rate	Poor water quality impact on irrigation water quality requirements
	Climate change	Climate change is another driver of change identified within the District	Opportunity to implement climate change strategies within the District	Increased water temperatures will cause eutrophication and excess algal growth, which will reduce water quality.

6 REFERENCES

Baran, E. and Jonck, F., 2002, 1: 500 000 Hydrogeological Map, Kroonstad 2726. Department of Water Affairs, Pretoria South Africa

Department of Water Affairs, 2002, Upper Vaal Water Management Area: Water Resources Situation Assessment, Report No: P08000/00/0101, Volume 1 of 3

Department of Water Affairs, South Africa, September 2011. Classification of Significant Water Resources (River, Wetlands, Groundwater and Lakes) in the Upper, Middle and Lower Vaal Water Management Areas (WMA) 8, 9, 10: Status Quo Report, Report No: Report No. RDM/WMA8,9,10/00/CON/CLA/0211

Department of Water Affairs and Forestry, South Africa. 2004. Upper Vaal Water Management Area: Internal Strategic Perspective. Prepared by PDNA, WRP Consulting Engineers (Pty) Ltd, WMB and Kwezi-V3 on behalf of the Directorate: National Water Resource Planning. DWAF Report No P WMA 08/000/00/0304

Department of Water Affairs and Forestry, 2005, Groundwater Resource Assessment: Task 1BC Groundwater Quantification, Methodology for Groundwater Quantification (Project No. 2003-150). Methodology Report. Department of Water Affairs and Forestry, Pretoria, South Africa

Department of Water Affairs and Forestry, 2005, Groundwater Resource Assessment: Subsystem 3A-Recharge. Methodology Report (3aC). Project No. 2003-150. Department of Water Affairs and Forestry, Pretoria, South Africa

Department of water and Sanitation, 2012, Water Infrastructure Status and Intervention Plans: Thabo Mofutsanyane District Municipality. Directorate Planning and Information. Department of Water, Pretoria, South Africa

Department of water and Sanitation, 2020, Briefing the Department of Water and Sanitation's Free State District Implementation Plan. Presented to the Portfolio Committee on the Department of Water and Sanitation's Free State District Implementation Plan for 2020/21, by Acting Director General, 25 August 2020.
DWS (2014) Determination of Resource Quality Objectives in the Upper Vaal Water Management Area (WMA8): Resource Quality Objectives and Numerical Limits Report, Report No: RDM/WMA08/00/CON/RQO/0214

Musekiwa C., and Majola K., 2013, Groundwater Vulnerability Map for South Africa, Council for Geoscience, Bellville and Department of Water Affairs, Pretoria. South African Journal of Geomatics, Vol. 2, No. 2, April 2013

Vegter, J. R., 2001, Groundwater development in South Africa and an introduction to the hydrogeology of groundwater regions. Report no. TT 134/00. Pretoria: Water Research Commission.