1. INTRODUCTION

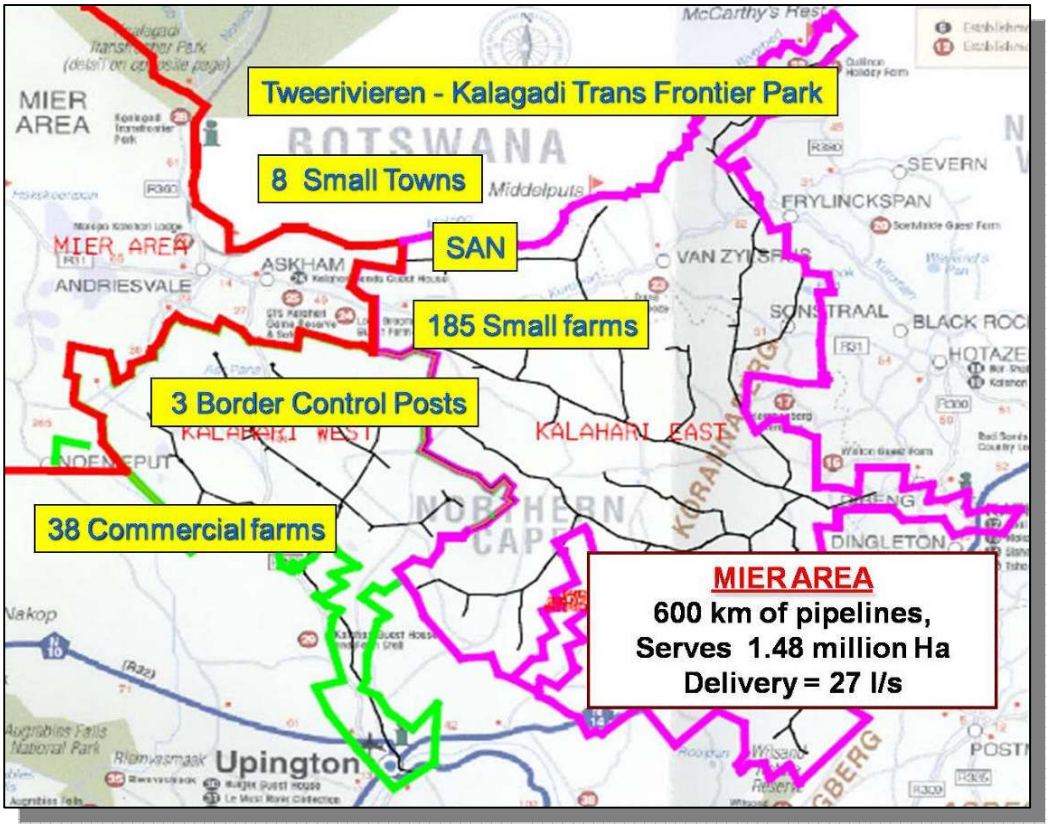
This study is an upgrade of a study completed in 2005 and focuses on the feasibility of a project to supply water from the existing Kalahari-East Water Supply system and possible other groundwater sources to the North-Western part of the Kalahari region of the Northern Cape Province of South Africa and small towns close to the border in the neighboring Botswana. The map below ***(MAP 1)*** shows the target area which lies mainly within the jurisdictional boundaries of the Mier Local Municipality as well as on the South-African-Botswana border.

MAP 1 : Location of study target area

2. FEASIBILITY STUDY SCOPE OF WORK

2.1 FEASIBILITY STUDY VERSION 1 : STUDY COMPLETED IN 2005

The main objective of the first study completed in 2005 was to investigate the feasibility and investment benefits as well as the socio-economic impact of a project to supply water mainly through the Kalahari-East Water Supply Scheme to the North-Western part of the Kalahari. This include all the human settlements in the Mier area, small and commercial farms, border control posts and the Kalagadi Trans Frontier park as shown on the map (***MAP 2)*** below.



MAP 2 : Target area

The scope of work covered in Study Version 1 was:

Phase 1: Gathering and verification of existing information and needs analysis

The current state of the Kalahari-East Stock Watering Scheme was determined. This included the Status Quo (User profile, legal aspects,

operation and maintenance as well as financial status) of the existing scheme. This data was used as a basis to determine changes that were implemented since 1994 when the scheme was completed.

Data from previous reports on the extension of the Kalahari East Stock Watering Scheme to the North-West Kalahari was studied and verified. This included a report by the then House of Representatives, Department of Water Affairs and Forestry and Department of Agriculture. Information available at the Kalahari East Water Board and BVi Consulting Engineers was also compared with the other sources.

This information was discussed with all the following role players at meetings in order to determine their needs before continuing to the next phase of the feasibility study:

- *Development Bank of Southern Africa*
- *Siyanda District Municipality,*
- *Mier Municipality,*
- *Dept. Water Affairs and Forestry,*
- *Dept. of Housing and Local Government,*
- *Dept. of Public Works,*
- *Dept. of Land Affairs,*
- *Dept. of Agriculture,*
- *National Parks Board (Kgalagadi Cross-Border Park),*
- *Kalahari East Water Board,*
- *Farmers Associations.*
- *Khomani San*

With all needs identified and inputs made, a desktop study was carried out to determine alternative water supply systems in order to meet the needs of all roll players.

Phase 2 : Field surveys

Further field surveys were carried out based on the above-mentioned information. This was necessary in order to verify technical information on site and to determine the feasibility of the alternative water supply systems.

A further objective was to involve the local community of the Mier area. Young local inhabitants of the different settlements, as well as the representatives of the Local Farmers Associations, assisted in the surveys reflecting the current situation and needs. BVi Consulting Engineers coordinated these surveys and did technical surveys themselves.

The field survey data was processed and incorporated into the feasibility study. Preliminary designs of the alternative water supply and cost estimates of the construction, as well as operation and maintenance costs of the alternatives, formed part of this process.

A co-ordination meeting was set up with all roll players for canvassing this processed information and to give them an opportunity for final inputs before the finalization of the Feasibility Report.

Phase 3 : Compilation and representation of the final Feasibility Study Version 1

A meaningful report with every roll player's input was compiled under Phase 3. The existing information and inputs of all the participating parties are compiled in this document.

The Feasibility Report was finally circulated to all roll players concerned for final approval.

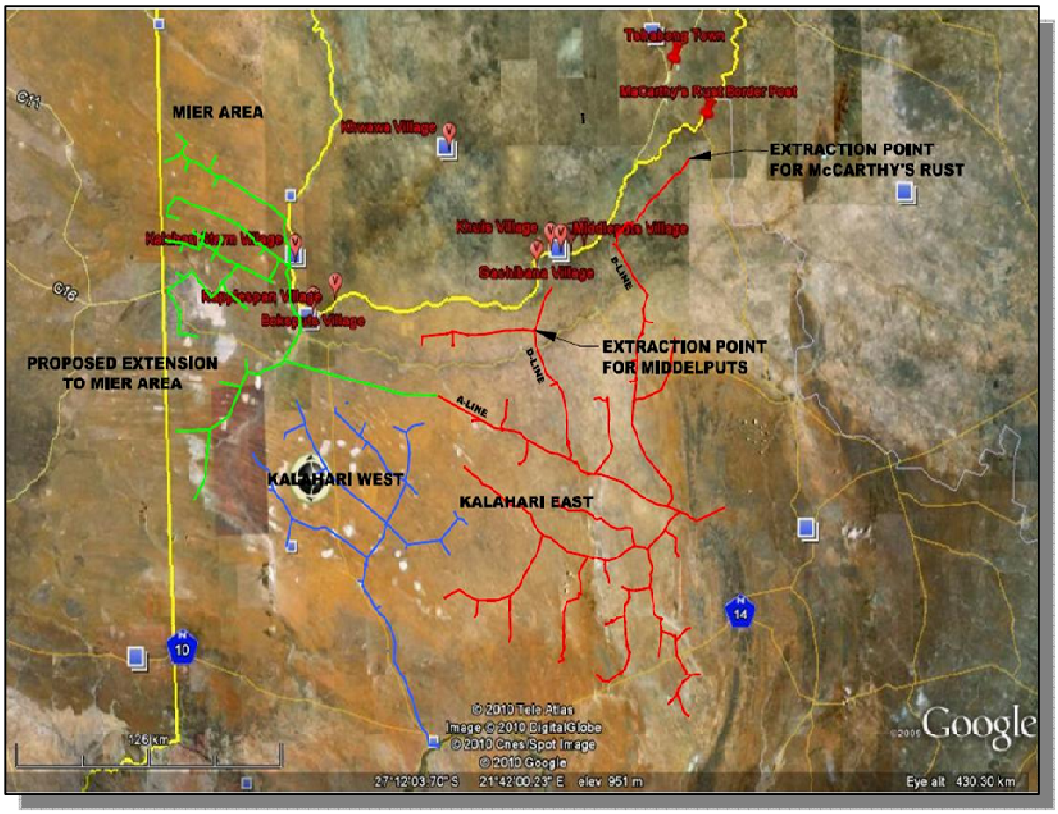
This Feasibility Study was also presented to the Northern Cape Economic Cluster in Kimberley as well as the Parliament Portfolio Committee during a visit to Mier.

2.2 FEASIBILITY STUDY VERSION 2 : UPGRADING OF 2005 STUDY

An official request for the provision of potable water through the Kalahari East and Vaal Gamagara water supply schemes to Botswana towns close to the South African/Botswana border from the Botswana Government to the South African Government triggered the upgrading of the feasibility study completed in 2005. The upgrading was to add the following to the existing report:

- *Updating of data used in Version 1 of the Feasibility Study*
- *Investigation into the possibility to provide water from the existing Kalahari- East Water Supply Scheme to Botswana towns in the Tsabong, Middelputs and Bokputs areas.*
- *Inclusion of the Mcartheysrest, Middleputs, Boksputs and Twee Rivieren Border Control Posts on the South African/ Botswana border into the study.*
- *Investigation into the possibility to provide water to Askham and Van Zylsrus.*
- *Investigation into possibilities to increase the capacity of the Kalahari-East Water supply scheme in order to satisfy the increased demand.*
- *Investigate possible institutional arrangements.*

The map below ***(MAP 3)*** shows the areas that were added as part of the upgrading of Feasibility Study Version 1.



MAP 3 : Botswana towns added as part of the feasibility study

3. BACKGROUND ON AND HISTORY OF AREA

3.1 SOUTHERN KALAHARI DESERT

The Kalahari Desert is part of the huge sand basin that reaches from the Orange River up to Angola, in the west to Namibia and in the east to Zimbabwe. The sand masses were created by the erosion of soft stone formations. The wind shaped the sand ridges, is typical of the landscape in the Kalahari and Mier area as shown on the photos below.

Only in recent geological history, 10 to 20,000 years ago, were the dunes stabilized through vegetation, so the area should actually be called a dry savannah. The dominant vegetation: grasses, thorny shrubs and Acacia trees, can survive long drought periods of more than ten months every year.

The Northern Cape Province of South Africa hosts the most southern part of the Kalahari. It is mostly used for nature conservation (Kalahari Gemsbok Park), game farming and stock farming.

The Kalahari National Park, together with the Gemsbok National Park in Botswana, is Africa's first Trans Frontier game park, known as the Kgalagadi Trans Frontier Park. It is one of the largest nature conservation areas in Southern Africa, and one of the largest remaining protected natural ecosystems in the world. The Park provides unfenced access to a variety of game between South Africa and Botswana, and has a surface area of more than 3.6 million hectares.

More than 26 000 tourists visited the Kalahari Gemsbok Park in 2009.

Farming activities can be divided into small farms (fewer than 3000 Hectares) in the Mier area and larger (over 6000 Ha) commercial farms more to the south and east.

The origins of the "Bushmen", also called the San, go so far back that they are lost in the mists of time. There have been a great many theories put forward about the beginnings of these mysterious little men whose remarkable way of life has gone on virtually unchanged for since the Stone Age. The Khomani San people lives currently on communal farms close to Witdraai and Askham.

3.2 MIER AREA

Mier, the name came from the Afrikaans word Meer, related to the dry lakes that situated around the area. The first Korana's called the place Haas, but later became Rietfontein because of the Kimberliet pipe and surface water (AH Cornelison, Wicar). Mier forms the most Northern part of the Northern Cape Province, a wedge between Namibia, Botswana and the Kgalagadi transfortier Park.

The largest village in the Mier area, Rietfontein is 280km away from Upington. The Mier area of more than one million hectares consists mostly of small farms.

The area has limited resources and is classified as a semi-desert. Borehole water, suitable for long term human consumption can only be found at Askham and Rietfontein.

4. GEOGRAPHY OF THE PROJECT TARGET AREA

4,1 GEOLOGICAL

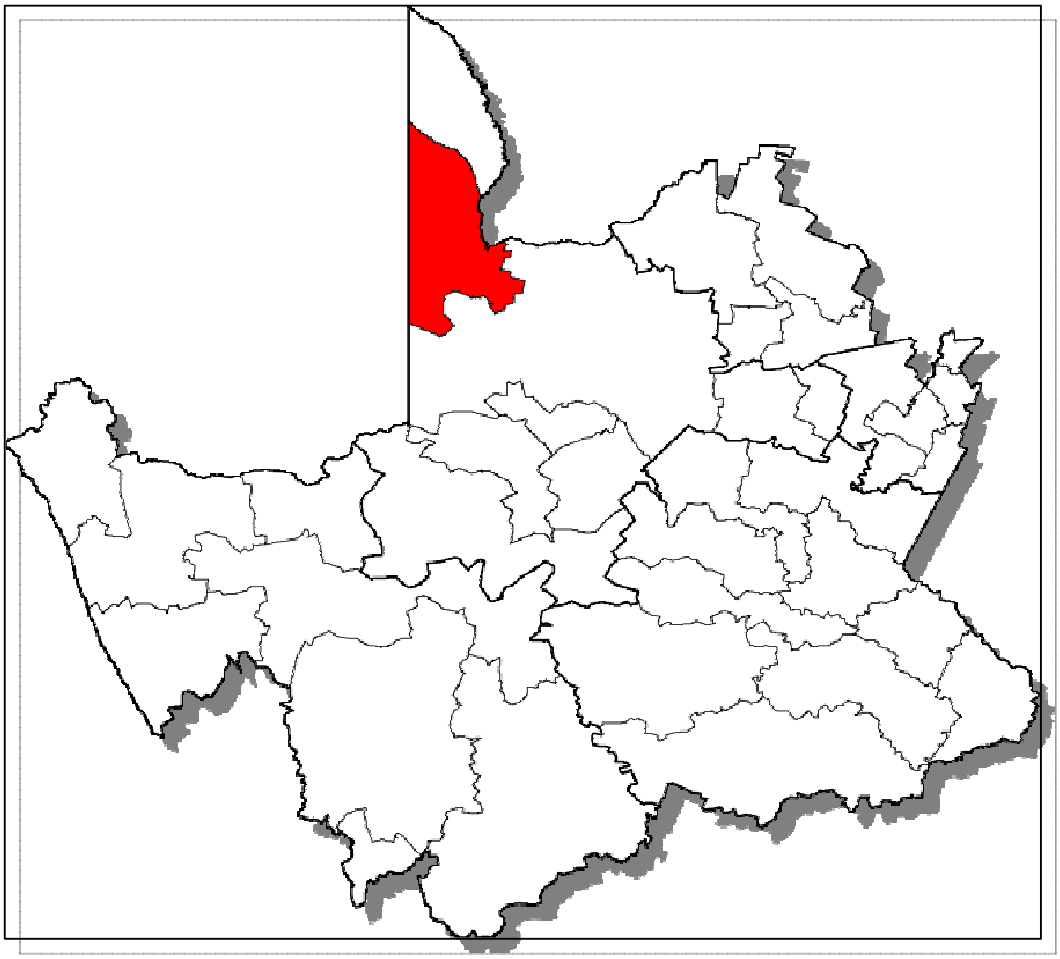
Geologically the Kalahari is a structural basin. When about 200 million years ago Southern Africa was still flat and unnamed, it was covered by a shallow sea, as evidenced by the sea shells still to be found everywhere in the arid interior. Then the upheavals came and massive volcanic surges created the mountains along the coasts. But what goes up must come down, and a huge dent in the earth's crust was to become the Kalahari. Gradually this enormous basin was filled through erosion of the surrounding rocks and although it is not known where the red sand originated from, enough rain must have fallen to wash down the colloidal deposits. Later prevailing winds formed the parallel dunes stretching in a northwesterly direction.

4.2 DEMOGRAPHY

The North Western part of the Northern Cape is very sparsely populated. The Mier rural area is situated 270km North North-West of Upington and covers more than one million hectares, just to the east of the Namibian border and to the south of the South African part of the Kgalagadi Trans Frontier Park. The Mier area consists of Rietfontein, smaller towns and approximately 130 farms with surface areas of less than 3,000 hectares per farm.

The area to the south and east of Mier is made up of larger commercial farms. The average size of these farms is approximately 8,000 hectares. Two small towns, Askham and Noenieput serve the farming community.

The Mier municipal area covers more or less the same area as the project target area. ***(MAP 4)***



MAP 4 : Mier Municipal Area

The last detailed official data was from the 2001 Census. A household survey was done in 2007. The summary results of these surveys are listed in the table below:

Persons		**Households**	
Census 2001	CS 2007	Census 2001	CS 2007
6844	7337	1578	1705
Population Growth	**1.2%/year**	**Household Growth**	**1.3%/year**

The population and household figures from the Census 2001 were adjusted by this percentage to predict the current figures are shown below:

EA	Population	Households
Groot Mier	472	110
Gordonia (farms)	3,901	1043
Philandersbron	884	192
Rietfontein	2,415	445
Total	**7,672**	**1,790**

This table shows that 49% of the Mier population lives in Rietfontein and other towns and 51% on farms in the municipal area.

The 2001 Census figures on the population groups in Mier were:

EA	Black African	Coloured	Indian or Asian	White	Total
Groot Mier	-	421	-	-	421
Gordonia (farms)	42	3180	-	261	3483
Philandersbron	41	748	-	-	789
Rietfontein	6	2150	-	-	2156
Total	**89**	**6499**	**0**	**261**	**6849**

It is clear from these figures that 96% of the population living in the Mier Municipal area is from the historically disadvantaged community. These figures give a good indication of the situation in 2011.

The next table shows movement of people over the last five years before 2001:

EA	1996	1997	1998	1999	2000	2001	Living in the same place	Total
Groot Mier	-	-	3	-	3	-	414	420
Gordonia (farms)	6	50	50	150	131	188	2899	3474
Philandersbron	15	3	3	6	6	3	759	796
Rietfontein	12	25	62	69	49	97	1843	2156
Total	**33**	**78**	**118**	**225**	**189**	**288**	**5915**	**6846**

According to this data 86% of persons lived in the same location within the Mier municipal boundaries over the last five years. There were no major contributing factors over the last few years that changed that tendency.

4.3 CLIMATE AND CLIMATE CHANGE

The dry season in the Kalahari is between April and September. Rainfall usually starts late in January, and stops towards the end of April. The average rainfall in the project target is 120 to 150mm per year in the project target area.

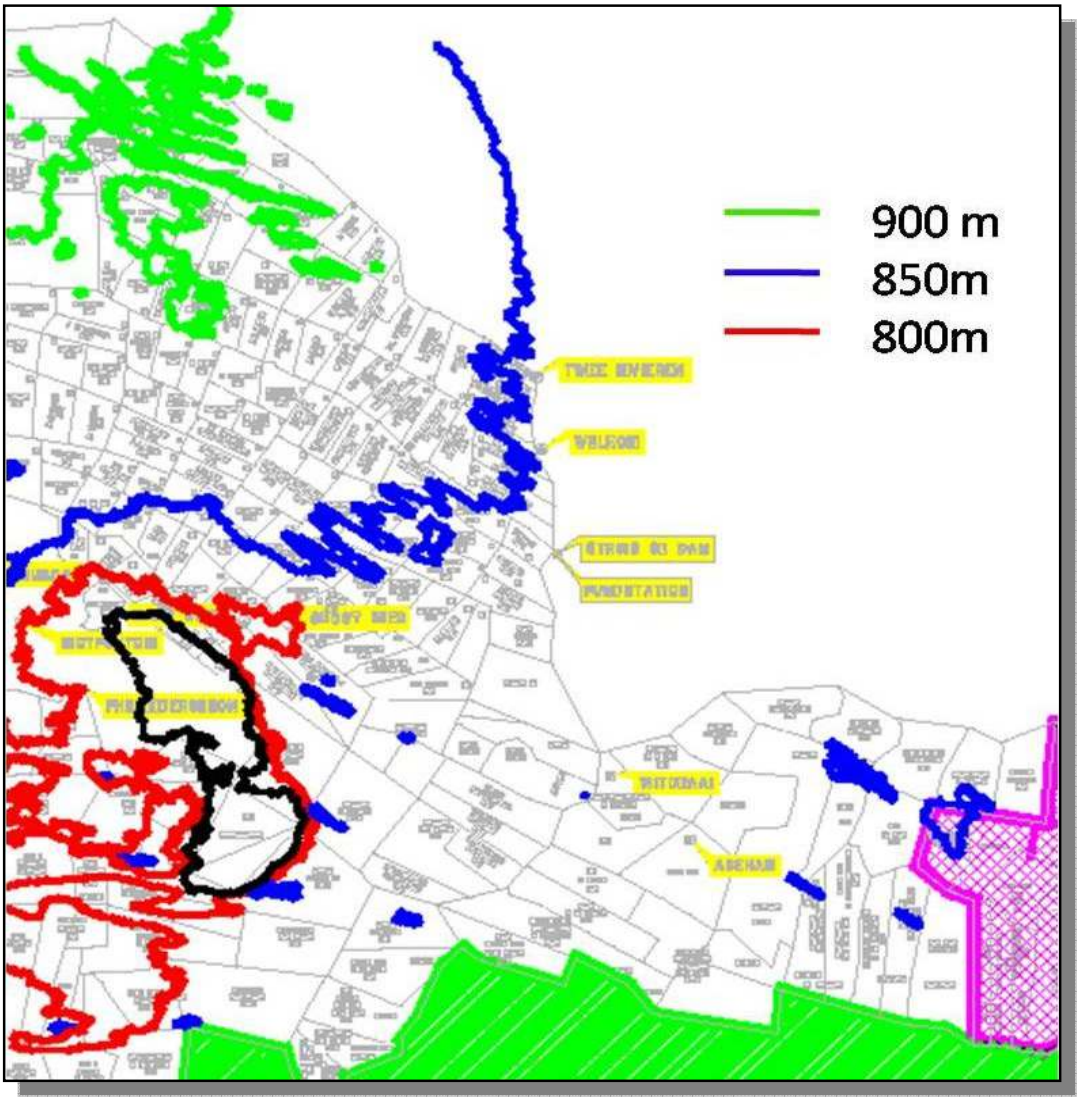
Maximum midsummer temperatures are between 35 degrees Celsius and 42 degrees with normal temperatures averaging between 30 and 35 degrees. During winter, daytime temperature is about 27 degrees Celsius, dropping to 0 degrees at night. It occasionally drops below freezing point to -6 degrees. Evaporation of 2900 millimeters per year in the area is the highest in South Africa.

The last serious drought recorded was in the 1980's. Rainfall over the last 20 years was very consistent.

Better grazing and higher stock production as a result of this however cannot be utilized if there is a lack of water or the quality of water is bad.

4.4 TOPOGRAPHY

The targeted area's topography rises in a north-westerly direction from Witdraai (900 meters above sea level) to the confluence of the Namibian and Kgalagadi Trans Frontier Park Border (995 masl) as shown on the map below ***(MAP5)***.



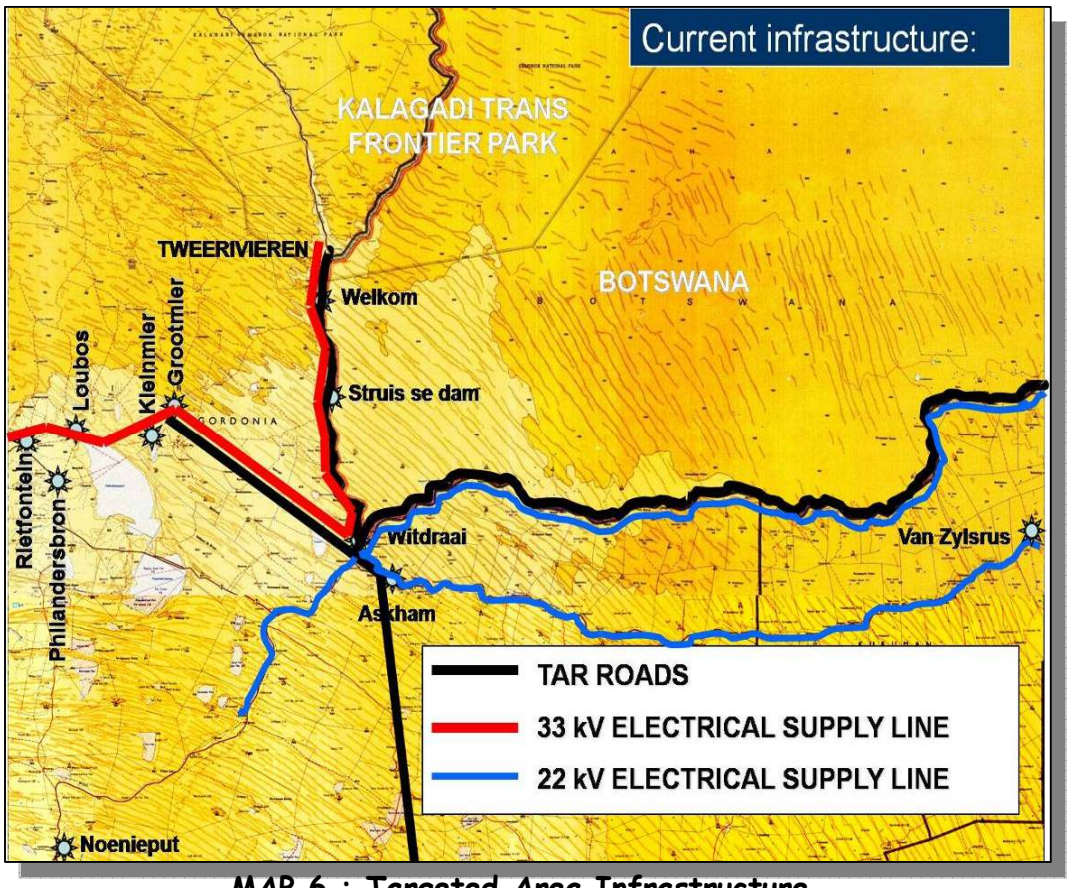
MAP 5 : Targeted area's topography

The topography falls from Witdraai in a westerly direction to 830 meters above sea level around the Rietfontein, Loubos and Philandersbron area. Very large salt pans are also typical of the environment. The height above sea level in the vicinity of Noenieput is around 820 meters.

The available pressure extraction point at the end of the Kalahari-East main water supply line on the farm Cramond is 950 meters above sea level. This implicates that water must be pumped in order to supply water to the biggest part of the Mier rural area.

4.5 INFRASTRUCTURE IN PROJECT AREA

Major infrastructure developments took place over the past 20 years in the Mier area in terms of electricity supply, roads and tourism. Current infrastructure played a very important role in the preliminary design of the water supply components as well as in operation and maintenance aspects. The map **(MAP 6)** below shows all current infrastructure:



MAP 6 : Targeted Area Infrastructure.

The area is much more accessible as a result of the road infrastructure that was created over the last 20 years. More tourists visited the Trans Kalagadi Trans-frontier Park and other tourist attractions over the last few years and figures are still rising.

4.5.1 Electricity

A 33 kV electrical supply line runs from the Namibian border at Rietfontein in an easterly direction through Groot and Klein Mier, along the tar road to the Molopo river and from there along the Botswana border in a northerly direction to the Twee Rivieren rest camp in the Kgalagadi Trans Frontier park. This line was completed round about 2001.

A 22 kV line supply electricity runs along the Molopo River forming the Botswana border to the east as well as along gravel roads as shown on the attached map.

4.5.2 Roads

The tar road from Upington to Groot Mier was completed during the early 1990's. Construction of the road from the intersection of the existing tar road and the Molopo River to the Twee Rivieren rest camp in the Kgalagadi Trans Frontier Park along the Botswana border was also finished in 2008. The total length of this road is 60km. Upgrading of the road from Groot Mier to Rietfontein was also completed in 2009 More travelers are using this alternative road to travel to Namibia.

Work on a 240 km road from Boksputs to Tsabong on the Botswana side of the border has been completed in 2010. Funding for this project was provided by the Botswana government.

4.5.3 Towns and farms

Infrastructure in the towns situated in the project target area is listed in the table attached as ***Annexure D.*** The non residential infrastructure in towns is limited to government buildings, which includes police stations, schools, clinics, normal municipal infrastructure and satellite offices of government departments.

According to Census 2001 the status of housing in the Mier municipality was as follows:

EA	House or brick structure on a separate stand or yard	Traditional dwelling/hut/structure made of traditional materials	Informal dwelling/shack NOT in back yard	Other	Total
Groot Mier	94	-	3	-	97
Gordonia (Farms)	582	161	168	9	920
Philandersbron	154	-	15	-	169
Rietfontein	356	9	9	15	392
Total	**1186**	**170**	**195**	**24**	**1578**

Infrastructure on farms is usually limited to a house occupied by the owner as well as a few labourer houses close by. The rest of the infrastructure on farms includes sheds, fencing and water related. Housing on farms in 2001 and 2011 should be approximately the same as most of the farms were developed before 2001. More houses were built in Mier towns and villages between 2001 and 2011.

A study focusing on the settlement of the San people on the communal farms close to Andriesvale is still under way. It is likely that 200 erven will be developed at Andriesvale in the near future.

4.5.4 Tourism

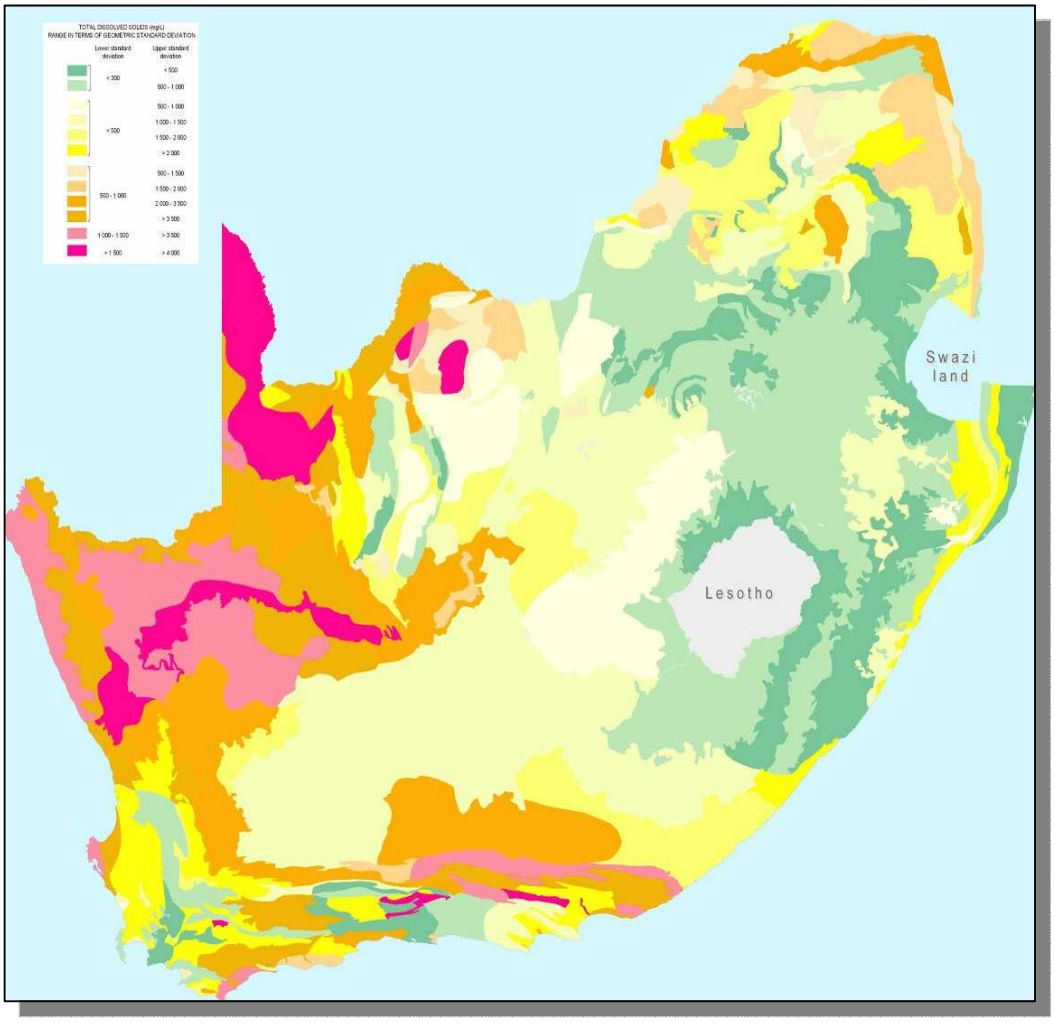
Eco tourism has blossomed over the last few years as a result of better infrastructure and better marketing of the area. Tarred roads make the area more assessable and a lot of development took place in the Kgalagadi Trans frontier park. The photos below shows some of the new rest camps which are of a very high standard.

More than 26 000 and 27 000 tourists visited the Kalahari Gemsbok Park in 2009 and 2010 respectively.

Guest - and hunting farms are becoming very popular and can be a great boost for the local economy.

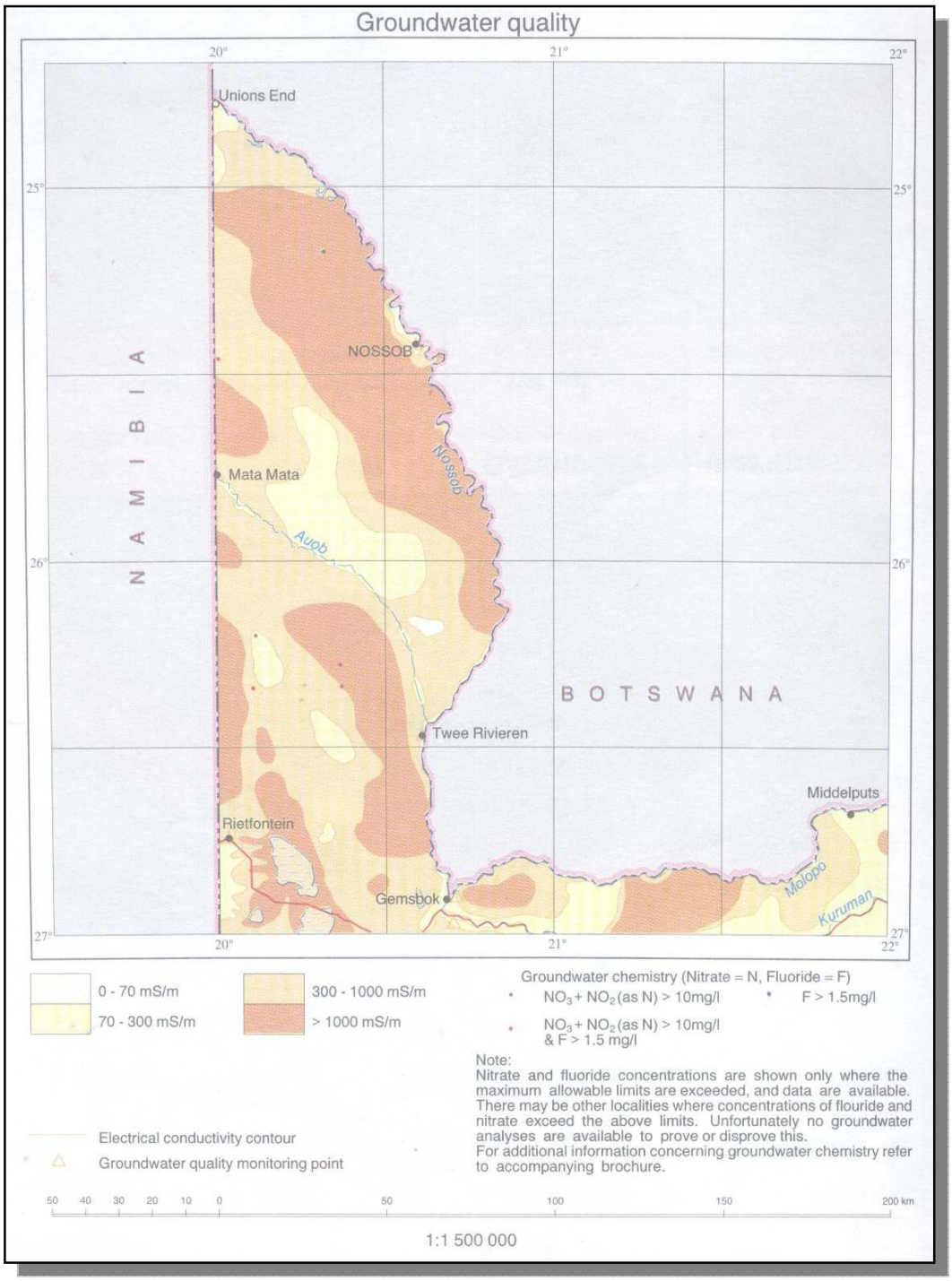
4.6 GEO-HYDROLOGY

The ground water quality in the Mier region is very poor as can be seen on the South African ground water quality map **(MAP 7)** below the dark pink color represents the poorest water quality.



MAP 7 : Water quality map of South -Africa

Geo Hydrology Maps of the project target area, which were compiled in 2002, were also obtained from the Department of Water Affairs and Forestry. The quality and occurrence of groundwater and distribution of boreholes are shown graphically on this map **(MAP 8)**.



MAP 8 : Water quality map of Mier area

Conductivity, which is an indication of the quality of the groundwater, ranges in the project target area as follows:

Conductivity (ms/m)	% of target area
70 to 300 ms/m *(448 to 1920 ppm)*	10
300 to 1000 ms/m *(1920 to 6400 ppm)*	60
Larger than 1000 ms/m *(>6400 ppm)*	30

SANS 241 -2001 states that a conductivity of 150ms/m is still acceptable but 370ms/m is the maximum allowable conductivity suitable for drinking water. The table above shows that only a small percentage of water is suitable for human consumption

The quality of water in the vicinity of the towns ranges from 70 to more than 1000ms/m.

Borehole yield ranges as follows in the project target area:

Borehole yield (liters per second)	% of target area
0.1 to 0.5 l/s	50
0.5 to 2.0 l/s	40
2.0 to 5.0 l/s	10

This data shows that poor quality as well as the availability of the water is a major concern.

4.7 ECONOMICAL AND SOCIAL ISSUES : MIER

Economically the project target area is to a large extent dependent on farming but tourism is also starting to play an important role.

The employment status of the population in the Mier area according to the 2001 Census is:

EA	Employed	Unemployed	Seasonal worker not working presently	Does not choose to work	Could not find work	Scholar or student	Home-maker or housewife	Pensioner or retired person/to old to work	Unable to work due to illness or disability	Not applicable (younger than 15 and older than 65)	Total
Groot Mier	54	18	3	48	3	27	64	6	6	199	427
Gordonia (farms)	826	269	89	93	353	94	288	86	47	1330	3473
Philanders-bron	36	-	9	15	108	55	111	15	27	421	797
Rietfontein	248	282	6	9	140	308	94	49	45	980	2161
Total	**1164**	**569**	**107**	**165**	**604**	**484**	**557**	**156**	**125**	**2930**	**6858**
Percentage	**17%**	**8%**	**2%**	**2%**	**9%**	**7%**	**8%**	**2%**	**2%**	**43%**	**100%**

The data shows that 83% of the population was not economically active at the time of the census. This figure should be approximately the same in 2011 as no major contributing factors changed this scenario dramatically. The level of education in the Mier municipal area at the time of the 2001 census was calculated as follows:

EA	Not applicable	No schooling	Some primary	Completed primary	Some secondary	Std 10/Grade 12	Higher	Total
Groot Mier	45	20	217	39	80	9	12	422
Gordonia (farms)	415	675	1127	308	607	282	71	3485
Philandersbron	127	114	394	46	96	9	3	789
Rietfontein	241	266	665	230	582	125	48	2157
Total	**828**	**1075**	**2403**	**623**	**1365**	**425**	**134**	**6853**
Percentage	**12%**	**16%**	**35%**	**9%**	**20%**	**6%**	**2%**	**100%**

It is interesting to note that only 8 % of the population has Grade 12 or higher education. This figure should improve slightly over the last ten year period.

The occupational status of the Mier Population was determined as follows:

EA	Legislators, senior officials and managers	Professionals	Technicians and associate professionals	Clerks	Service workers, shop and market sales workers	Skilled agricultural and fishery workers	Craft and related trades workers	Plant and machine operators and assemblers	Elementary occupations	Undetermined	Not applicable (not economically active)	Total
Groot Mier	-	-	12	6	-	36	-	-	3	-	370	427
Gordonia (farms)	21	12	15	36	57	144	24	12	379	144	2629	3473
Philandersbron	-	6	-	3	-	9	3	-	12	6	758	797
Rietfontein	12	15	46	27	30	9	6	3	87	24	1901	2161
Total	**33**	**33**	**73**	**72**	**87**	**198**	**33**	**15**	**481**	**174**	**5658**	**6858**
Percentage	**0%**	**0%**	**1%**	**1%**	**1%**	**3%**	**0%**	**0%**	**7%**	**3%**	**83%**	**100%**

The biggest percentage of the 17% economically active persons has elementary occupations (7%) or is skilled in agriculture (3%) These figures should be approximately the same in 2011 as it was in 2001

The annual household income in the Mier Municipal area was in 2001 as follows:

EA	No income	R1 - R4 800	R4 801 - R 9 600	R9 601 - R 19 200	R19 201 - R 38 400	R38 401 - R 76 800	R76 801 - R153 600	R153 601 - R307 200	R307 201 - R614 400	R614 401 - R1 228 800	R1 228 801 - R2 457 600	R2 457 601 and more	Total
Groot Mier	11	12	18	14	23	10	3	6	-	-	-	-	97
Gordonia (farms)	134	146	189	231	111	66	29	14	-	-	-	-	920
Philandersbron	52	24	36	39	9	3	3	-	-	-	3	-	169
Rietfontein	87	47	77	86	45	35	6	9	-	-	-	-	392
Total	**284**	**229**	**320**	**370**	**188**	**114**	**41**	**29**	**0**	**0**	**3**	**0**	**1578**
Percentage	**18%**	**15%**	**20%**	**23%**	**12%**	**7%**	**3%**	**2%**	**0%**	**0%**	**0%**	**0%**	**100%**

According to this table 76% of the households earned less than R19200 per annum or R1 600 per month in 2001.

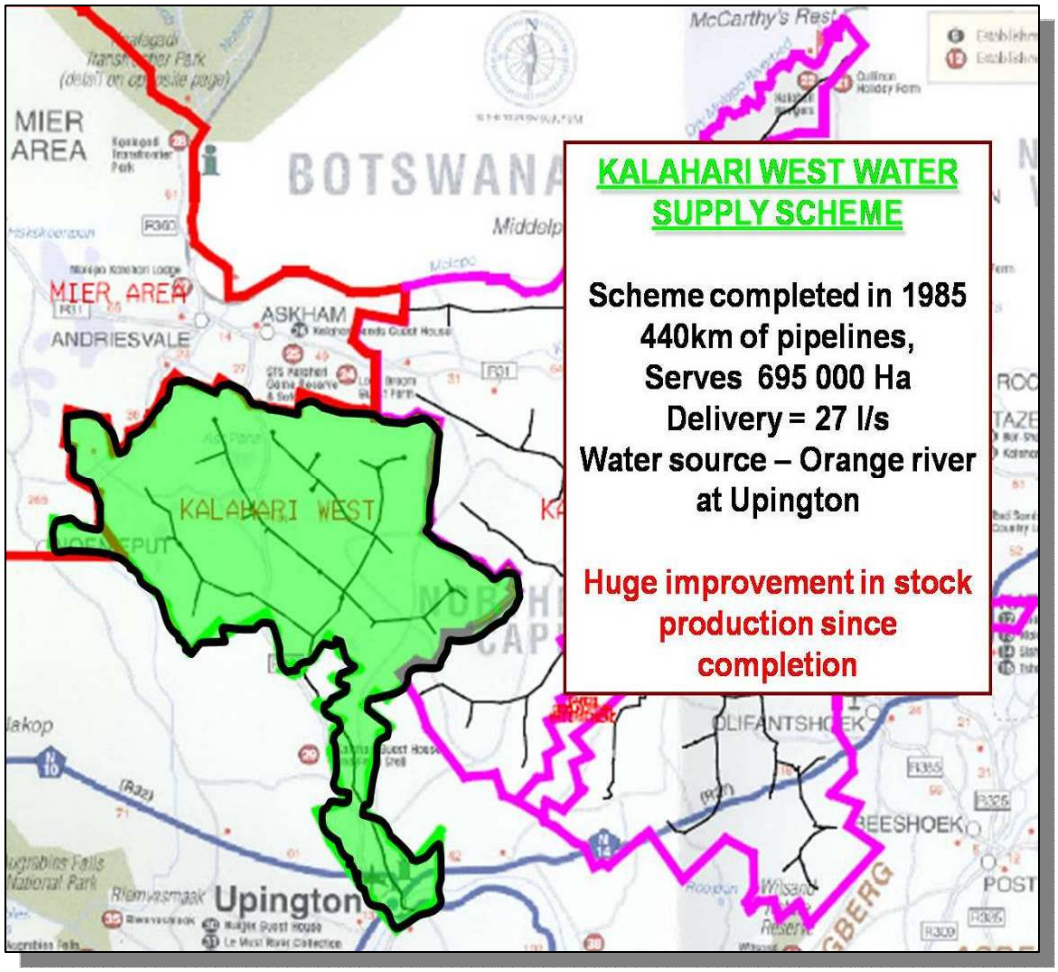
It is clear from the tables above that most of the population in the Mier municipal area was not economically active and not highly skilled, which had a huge impact on the socio economics of the area in 2001. This situation hasn't changed since 2001 in real terms as contributing factors such as inflation and higher income canceled each other.

4 CURRENT WATER SUPPLY SYSTEMS IN THE KALAHARI

5.1 KALAHARI-WEST WATER SUPPLY SCHEME

5.1.1 History and demographics

The Kalahari-West water supply scheme was completed in 1985. The scheme was constructed as a result of the extreme poor quality and availability of ground water in this area. The map below **(MAP 9)** shows detail of this water supply scheme.



MAP 9 : Kalahari-West Water Supply Scheme

5.1.2 Current users

The scheme provides water to only to commercial stock farms for agriculture as well as human use.

5.1.3 Institutional

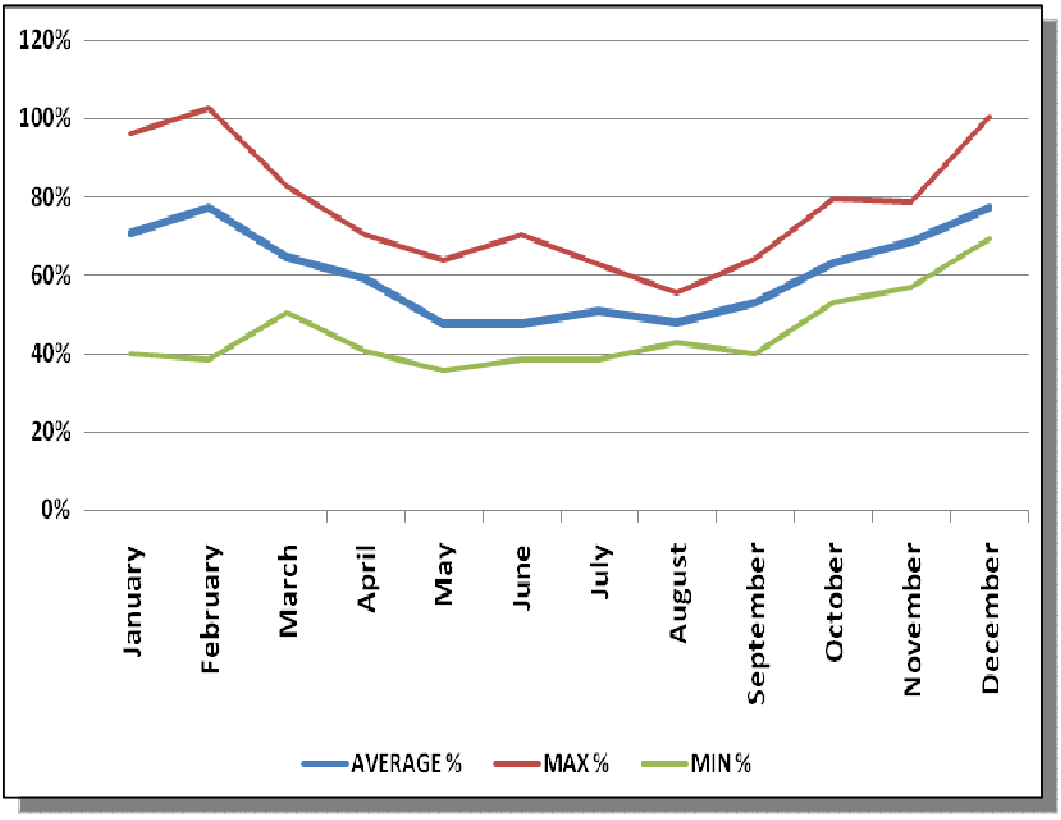
This water supply scheme is run by the Kalahari West Water Users Association

5.1.4 Source

Water from the Orange River is abstracted, purified and conveyed through the Upington Municipality bulk water supply lines to reservoir 25km northwest of Upington, from where it gravitates further into the Kalahari-West service area.

5.1.5 Current water supply profile

The monthly usages of the Kalahari West Water Supply System over the last 8 years as a percentage of the maximum capacity (27 l/s) can be seen on the graph below:



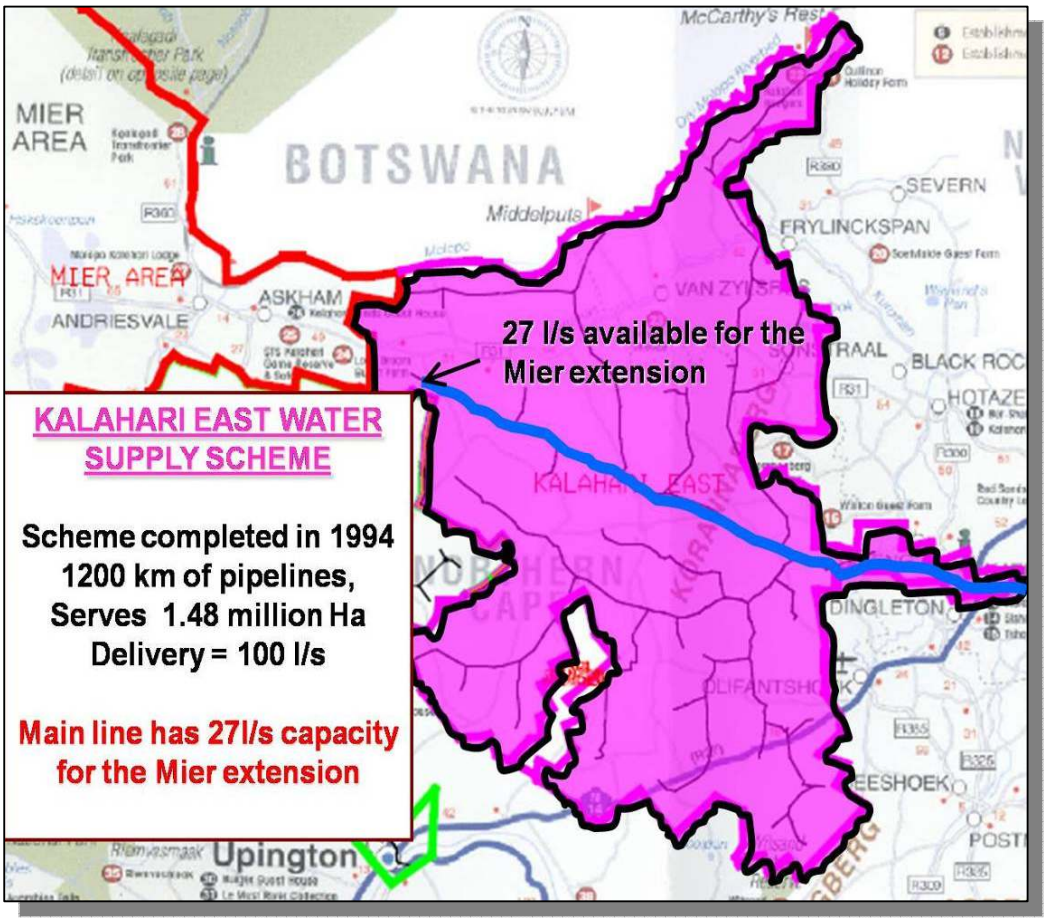
It is clear that the scheme is operated sometimes to its maximum capacity over the warm summer months.

5.1.6 Extension possibilities

After completion of the scheme in 1985, more farms were attached to the end of the distribution lines to such an extent that that the system is operated close to 100% over the warm summer months. There are no possibilities to extend this scheme.

5.2 KALAHARI-EAST WATER SUPPLY SCHEME

5.2.1 History and demographics



MAP 10: Kalahari-East Water Supply Scheme

The Kalahari-East Water Supply Scheme is the biggest of the three and serves 278 farms covering 1 480 624 hectares of land. The total length of the pipelines is more than 1200 kilometers. The main line running in a

westerly direction was designed to supply water at a rate of 26 liters per second to the North Western part of the Kalahari in South Africa.

5.2.2 Current users

The scheme provides water mainly to commercial stock farms for agriculture as well as human use. Bo-Plaas school and the Kheis grounds also receive water from the pipe line.

5.2.3 Institutional

This water supply scheme is run by the Kalahari East Water Users Association

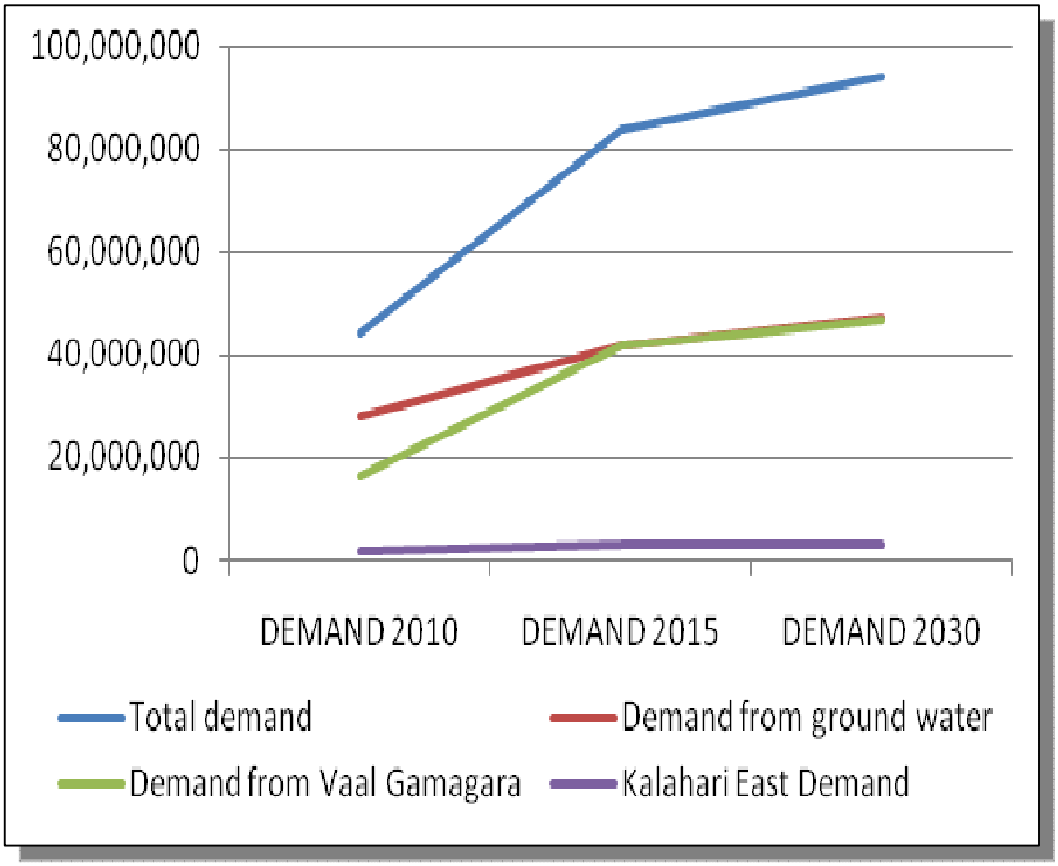
5.2.4 Sources

Currently water is pumped from the Sishen mine into the Vaal Gamagara pipeline from where the Kalahari-East water supply scheme withdraws water at a maximum rate of 103 liters per second. The Vaal Gamagara Pipeline is used to supplement water shortages.

Water supply though the Vaal Gamagara pipeline will become problematic in the near feature as the demand is set to double over the next five years as can be seen from the table below. This table formed part of a feasibility study completed recently by KV3.

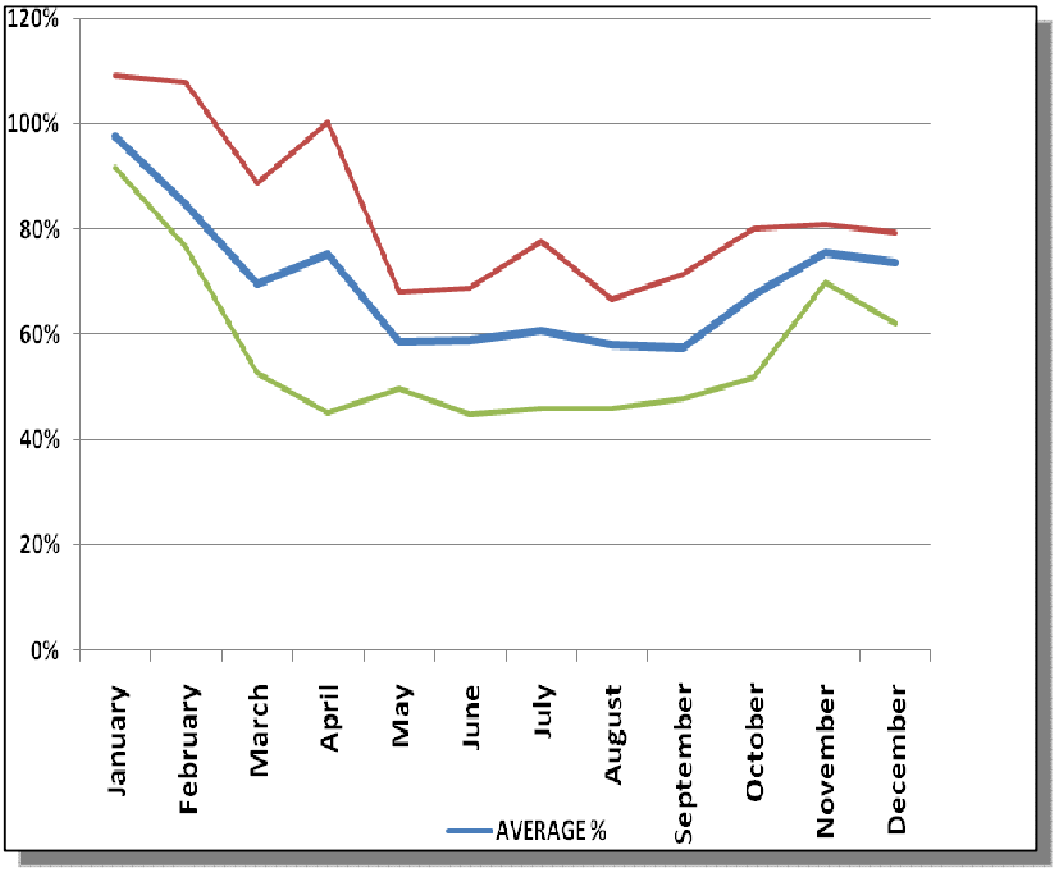
WATER DEMAND (million kub.m)	AUTHORISED ABSTRACTION	BILLED CONSUMPTION 08/09	DEMAND 2010	DEMAND 2015	DEMAND 2030
Total demand	21.61	12.08	44.23	83.71	94.30
Demand from ground water	-	-	27.94	41.76	47.37
Demand from Vaal Gamagara	-	-	16.29	41.95	46.93
Kalahari East Demand	1.80	2.31	1.80	3.25	3.25

It is also clear from the table that the current authorized volume is 80% more than the billed consumption in 2008/09. This is an indication that there is a serious over commitment



5.2.5 Current water supply profile

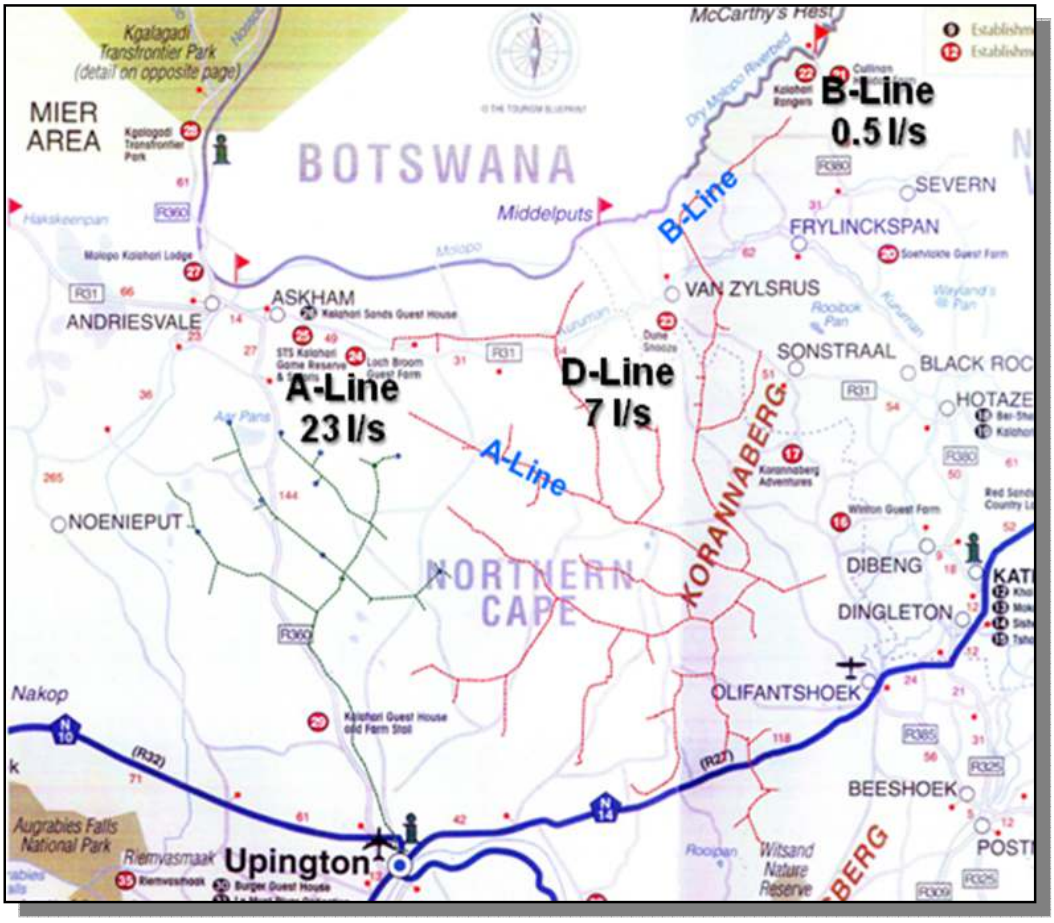
The monthly usages of the Kalahari-East Water Supply System over the last 8 years as a percentage of the maximum capacity (75l/ without 23l/s allocated to Mier) can be seen on the graph below:



It is clear from the graph that the scheme is also operated sometimes to its maximum responsibility to current users (75l/ without 27l/s allocated to Mier) over the warm summer months.

5.2.6 Overview on extension possibilities

The Kalahari-East water supply scheme was designed to provide water to the end users at a maximum rate of 103 l/s through the main supply pump line. The A-line of the scheme has an additional capacity of 23l/s available for the North western part of the Kalahari (Mier area).



MAP 11 : Available water on the Kalahari-East Water Supply Scheme

Attached in ***Annexure A*** are graphs of the hydraulic energy line that show the current capacity of the scheme clearly. ***Graph No.1*** simulates the current situation at 100% (75l/s without 22l/s allocated to Mier). The second one ***(Graph 2)*** simulates the situation with the original 27l/s allocation to Mier. (103l/s)

Any additional water to be conveyed with the Kalahari-East water supply scheme will result in construction work such as changes to the pipelines and pump stations.

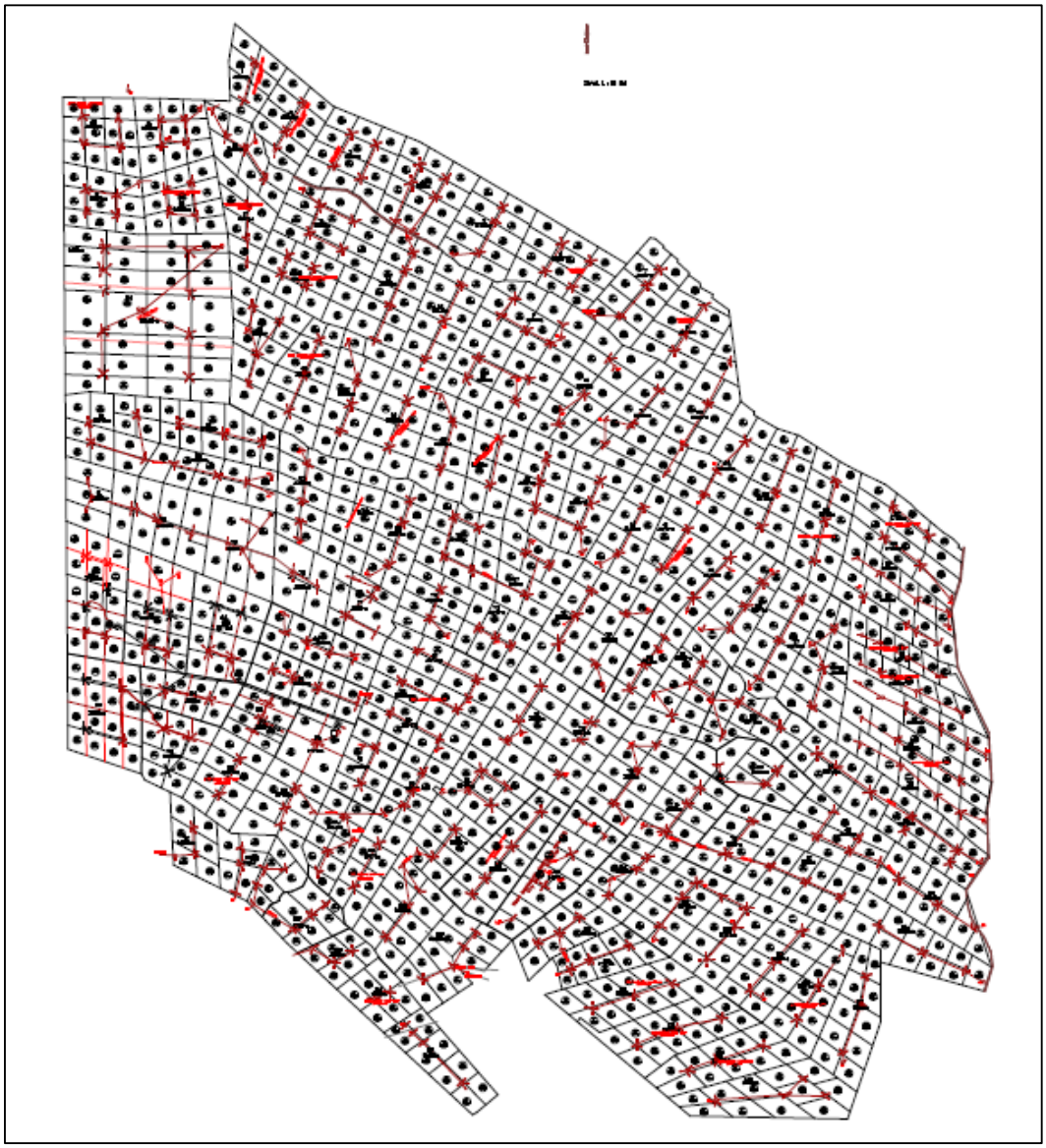
All three schemes were designed to supply water at a constant flow rate over 24 hours to the farms.

5.3 UNDERGROUND WATER : AGRICULTURAL

5.3.1 Current water supply systems

Most of the farms in the area are dependent on their own systems which either consists of windmills or diesel engines to abstract borehole water. The photos below show typical installations.

Local distribution water supply schemes on farms in the Mier area were planned a few years back by the Department of Agriculture. The map below shows these schemes. There are only three of the local distribution networks serving more than one farm that were completed after this planning exercise.

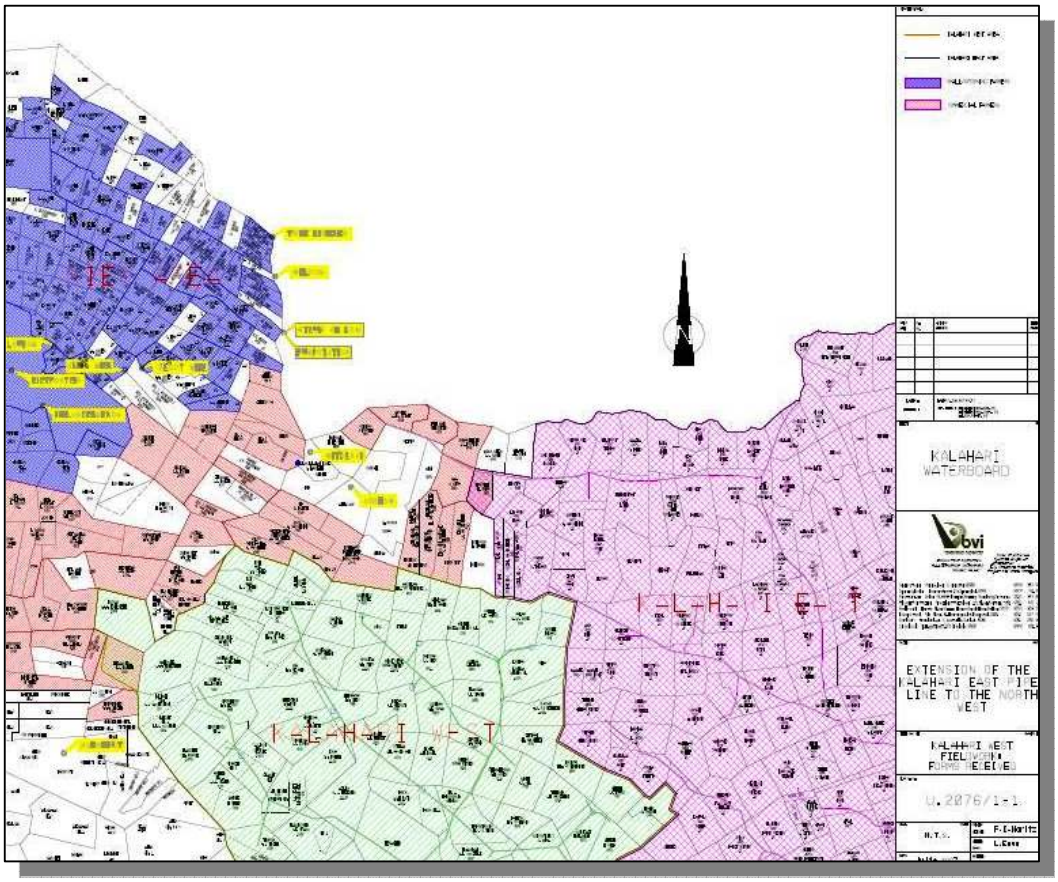


There are already problems on these schemes due to boreholes that cannot deliver the required volumes.

5.3.2 Field Investigation

A field investigation was executed in order to determine what the situation on farms in the project target area is according to the owners. A standard questionnaire was prepared and distributed to the commercial farms through the Oranje River Farmers Union. The Mier information on the questionnaires was completed with the help of two of the leaders in the Mier farming community and local Grade 12's. 168 owners of 223 farms completed the forms and returned it. This is a percentage of 75.3% which can be interpreted as representative of the area.

Farms that took part in the investigation by filling in the questionnaires are shown on the map below **(MAP 12)**:



MAP 12: Farms that took part in the field investigation

5.3.3 Results of Field Investigation

Results of the Field Investigation on farms of which completed questionnaires were received back from are:

Ownership and occupational status:

Number of farms	Full time owners	Part time owners	Full time tenant	Part time tenant
168	48	69	13	38
100%	29%	41%	8%	23%

It is interesting to note that there is only 37% of owners and tenants living on the farms fulltime with their families.

Labourers with families living on farms:

Number of farms	Full time labourers	Part time labourers	No Labourers
168	37	34	97
100%	22%	20%	58%

Response in relation to boreholes:

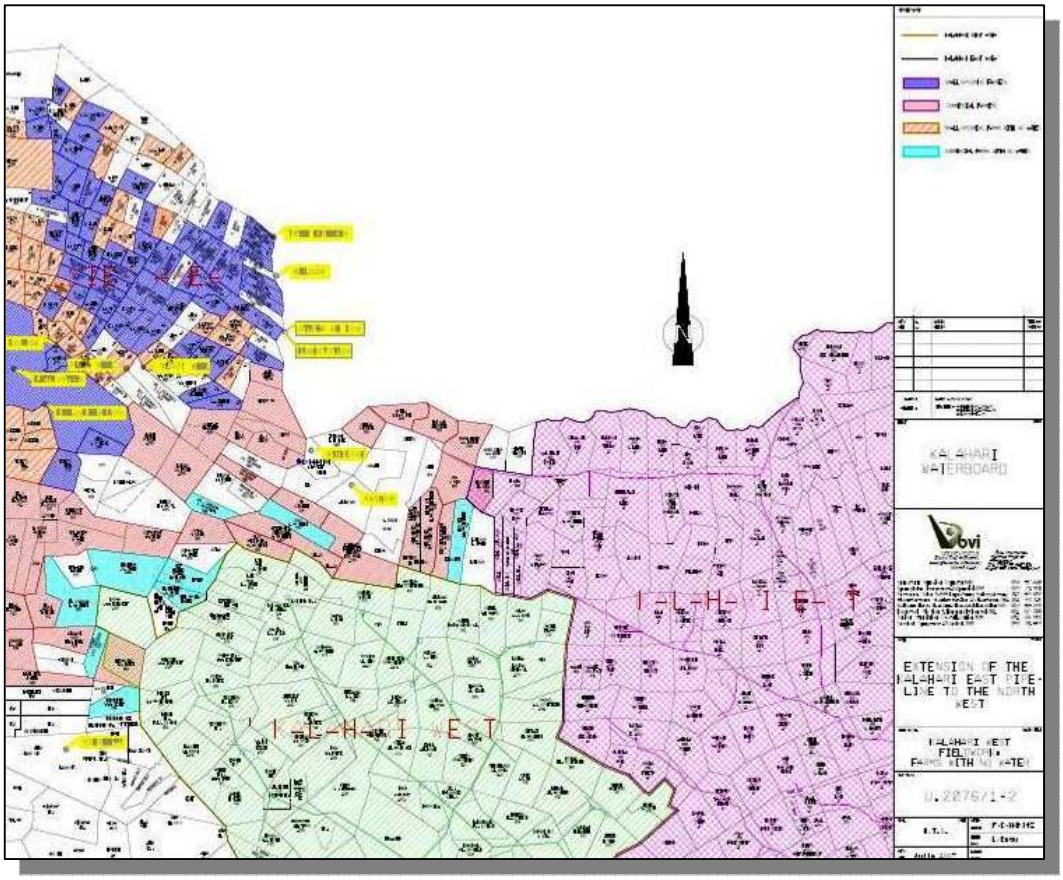
In total 28 farms have no water and use water from other sources. Information received on boreholes in use on the remaining 140 farms is:

Boreholes Total	Very poor	Poor	Reasonable	Good
191	1	160	22	8
100%	1%	84%	12%	4%

If one takes into account that there are 28 farms that have no water, the need for drinkable water on farms are 91% as shown in the table below:

Farms Total	No water	Poor	Reasonable	Good
168	28	125	7	8
100%	**17%**	**74%**	**4%**	**5%**

The map below **(MAP 13)** shows farms without water (Small farms – brown with stripes and Commercial Farms – Light Blue).



MAP 13 : Farms without water in Mier Municipal area

The depths of boreholes in use are:

Total	<50 meters	50-100 meters	>100 meters	No data
191	59	63	30	39
100%	31%	33%	16%	20%

Yield of boreholes in use is:

Total of boreholes	<1000 l/hour (0.27 l/s)	>1000 liters/hour	No data
191	88	59	44
100%	46%	31%	23%

There are 261 boreholes on the 168 farms that are not in use and 650 boreholes that are dry.

It must be stressed that the above figures are the response of farmers in the target area and may be subjective. Officials of the Department of Agriculture working in the area stated however that some of the farms cannot be used at all due to a lack of water while others cannot be utilized to its full potential due to insufficient water

Spending on water related issues

The table below shows the response with reference to a question on the percentage of total expenses spent on water related issues.

Total Farms	0-20%	21-40%	41-60%	61-80%	81-100	No data
168	17	28	47	47	2	27
100%	10%	17%	28%	28%	1%	16%

According to the table 56% of respondents spend between 40% and 60% of their budget on water related issues which is a very high percentage.

Influence of water quality on the mortality and condition of stock

Water is an essential nutrient for all animals. It is important for both animal welfare and business profitability that sheep and cattle have an adequate supply of good quality water. Amount and quality of water required vary between species of livestock, between classes of stock within the species, and in response to the environment in which the stock are kept.

The main factor which determines the suitability of water for stock is the concentration of dissolved salts in the water. Dissolved salts in water are expressed in parts per million (ppm) or in terms of the electrical conductivity of the water, measured in milliSiemens per metre (mS/m). (1 mS/m is equivalent to about 6.4 ppm).

Livestock	No adverse effects on animals expected	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production.	Loss of production and decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually.
Beef cattle	0–4000	4000–5000	5000–10 000
Dairy cattle	0–2500	2500–4000	4000–7000
Sheep	0–4000	4000–10 000	10 000–13 000[(a)]
Horses	0–4000	4000–6000	6000–7000
Pigs	0–4000	4000–6000	6000–8000
Poultry	0–2000	2000–3000	3000–4000

Reference: ANZECC and ARMCANZ (2000), adapted from ANZECC (1992).

Attached in ***Annexure B*** also finds an extract on the Effects of Total Dissolved Solids from the South African Water Quality Guidelines, 2nd edition 1996, Volume 5: Agricultural use – Livestock watering.

It is clear from the reports that the quality of water does play a very important role in the profitability of sheep and stock farming. The Department of Water Affairs and Forestry Geo Hydrology Maps of the project target area shows the quality of water as follows:

Conductivity (ms/m)	% of target area
70 to 300 ms/m *(448 to 1920 ppm)*	10
300 to 1000 ms/m *(1920 to 6400 ppm)*	60
Larger than 1000 ms/m *(>6400 ppm)*	30

It is difficult to determine exactly what the effect of the water quality on the production of stock in the project target area is. This is due to the fact that the figures are not presented on the same scale and that the effects are not exactly quantified.

The respondents indicated in the questionnaire that under the current circumstances 15% of sheep and 10% of cattle will die before being ready for the market. They feel that this rate can be brought down with 5% to the optimum of 10% and 5% respectively if the water situation is improved.

Furthermore the respondents feel that they produce 30% less lamb and 20% less cattle due to lower reproduction as a result of the current water situation. They also think that they can improve the quality of meat with 60% through water with better quality and a more reliable water supply.

According to the response of farmers the maximum benefit as a result of good quality water will be:

	Improvement in mortality	Improvement in reproduction	Improvement in quality of meat (price)	Total benefit
Cattle	105%	130%	103%	141%
Sheep	105%	120%	103%	130%

It must be stressed again that the figures in the table above are the response of farmers in the target area and may be subjective.

5.4 UNDERGROUND WATER : HUMAN SETTLEMENTS IN MIER AREA

5.4.1 Current water supply systems to towns

Al the towns in the Mier municipal area are dependable on water from boreholes close to town. A pipeline from the Rietfontein area supply water to Klein and Groot Mier.

5.4.2 Water quality

Data on the ground water quality on boreholes supplying water to towns in the Mier Municipal area is summarized in the table below (Recent tests are indicated in blue): The accuracy of old data cannot be verified.

TOWN	HOUSEHOLDS BILLED	TOTAL POPULATION	CALCULATED USE PER DAY (kl)	LITERS PER HOUSEHOLD PER DAY	CALCULATED USE PER PERSON / DAY	CLASS	COLIFORM	CONDUCTIVITY	Na	F	Cl	So_4	$No_3 + No_2$
ASKHAM 1 borehole in use	267	800	60.46	226.50	75.60	I	326			0.24	148	38.88	6.85
ASKHAM 29-Sep-10						**I**	**210**	**98.4**		**0.41**	**167**	**22**	**5.3**
ANDRIESVALE – Erin						II	420	195		0	375	106	4.4
ANDRIESVALE - Molopo Lodge						II	82500	233		0.5	375	128	5.8
ANDRIESVALE – 24 May 2005`1948						II		175		0.54	310	76	3.3
ANDRIESVALE – 24 May 2005`1949						I		148		0.24	275	47	4.5
ANDRIESVALE - 25km to Welkom						IV		1323		8.11	2579	2489	36
ANDRIESVALE - 47km to Welkom						IV		1959		9.15	3299	3299	161
ANDRIESVALE – 12 June 2009						**II**				**0.8**	**409.72**	**85.29**	**5.98**
WELKOM - 1 boreholes in use	161	689	31.67	196.77	54.98	I	548						
WELKOM – 29-Sep-10						**III**	**133300**	**420**		**0**	**692**	**385**	**6.4**
NOENIEPUT		159				II	67			1.4	323.37	254	26.96
MIER (Groot & Klein)	**234**	**1208**	**80.40**	**343.59**	**66.56**	**IV**	**5**	**375**		**1.58**	**610.66**	**248.87**	**21.41**
MIER Pure Borehole						**III**		**202**		**0.83**	**242.32**	**186.81**	**2.22**
GROOT MIER- Shop						**III**				**1.46**	**281.96**	**170.65**	**23.32**
RIETFONTEIN - Pipeline to Mier						**III**		**215**		**0.6**	**257**	**245**	**1.76**

TOWN	HOUSEHOLDS BILLED	TOTAL POPULATION	CALCULATED USE PER DAY (kl)	LITERS PER HOUSEHOLD PER DAY	CALCULATED USE PER PERSON / DAY	CLASS	COLIFORM	CONDUCTIVITY	Na	F	Cl	So_4	$No_3 + No_2$
RIETFONTEIN - In town						III				0.82	227.8	171.22	0.02
RIETFONTEIN - 0404 ` 28 May 2004						III		231		1.6	40	15	0.86
RIETFONTEIN - 0410 ` 28 May 2004						II		192		0.45	410	136	2.1
PHILANDERSBRON 1 boreholes in use	289	1102	32.40	112.11	29.40	II	15			1.08	23.79	43.94	10.46
PHILANDERSBRON Clinic						II	127						
PHILANDERSBRON 29-Sep-10						I	28	114		0.56	63.9	146	6
PHILANDERSBRON Vetrivier						III	510	125		0.41	103	690	4.8
RIETFONTEIN - 2 boreholes in use	679	2544	44.92	66.17	17.66	I	27						
RIETFONTEIN - 29 September 2010						I	25			0.87	98.69	72.21	9.55
RIETFONTEIN - Fontein (open)						II	735	153		0.86	190	231	5.9
RIETFONTEIN - Gemeentes Dam						IV	2900	489		1.3	767	410	64.1
LOUBOS 29 September 2010	286	1129	77.73	271.89	68.88	II				1.07	13.22	39.21	4.24
LOUBOS 2 boreholes in use						I	82						

CLASS O	Life long use
CLASS I	Good quality
CLASS II	Conditional use
CLASS III	Not for use without treatment
CLASS IV	Not for use