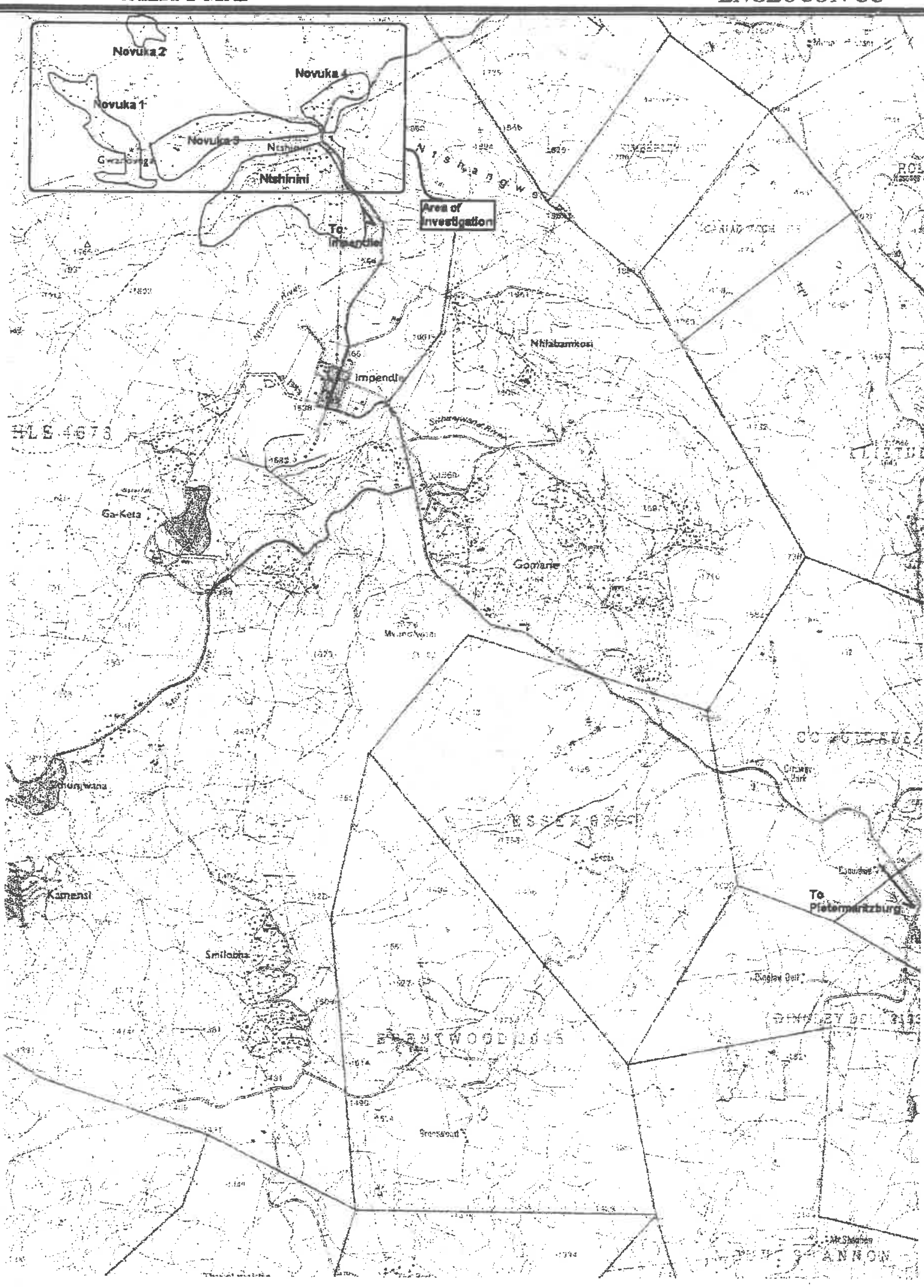
2.2(1781)

LL1153A

HYDROGEOLOGICAL INVESTIGATION
SPRINGS at KWANOVUKA
IMPENDLE LOCAL MUNICIPALITY



PROJECT - LL 1153	**LOCALITY MAP**	**KWANOVUKA**

PROVINCE: *KWAZULU-NATAL*
DISTRICT: *uMGUNGUNDLOVU*
VILLAGE: *IMPENDLE*
SITE: *KWANOVUKA*

SPRING SOURCES
SPRING 1 - SPRING 25

ENGEOCON cc
Reg. No. CK 05/08608/23

HYDROGEOLOGICAL INVESTIGATION - SPRINGS
KWANOVUKA – IMPENDLE LOCAL MUNICIPALITY

1. Introduction and Terms of Reference.

Following an appointment by the uMgungundlovu District Municipality, that was confirmed by Africon Consulting, on the 29th of August 2005, a hydrogeological investigation was conducted by Engeocon in the vicinity of the KwaNovuka village as indicated on the Locality Plan, Figure 1 on the opposite page.

KwaNovuka is situated some 3km north of the town of Impendle located approximately 70 km from Pietermaritzburg. At the time of the investigation, domestic water was being piped from springs to various plastic or concrete storage reservoirs and distributed from there to communal and in some instances self installed tap stands inside private residences. See Photo 1 below.

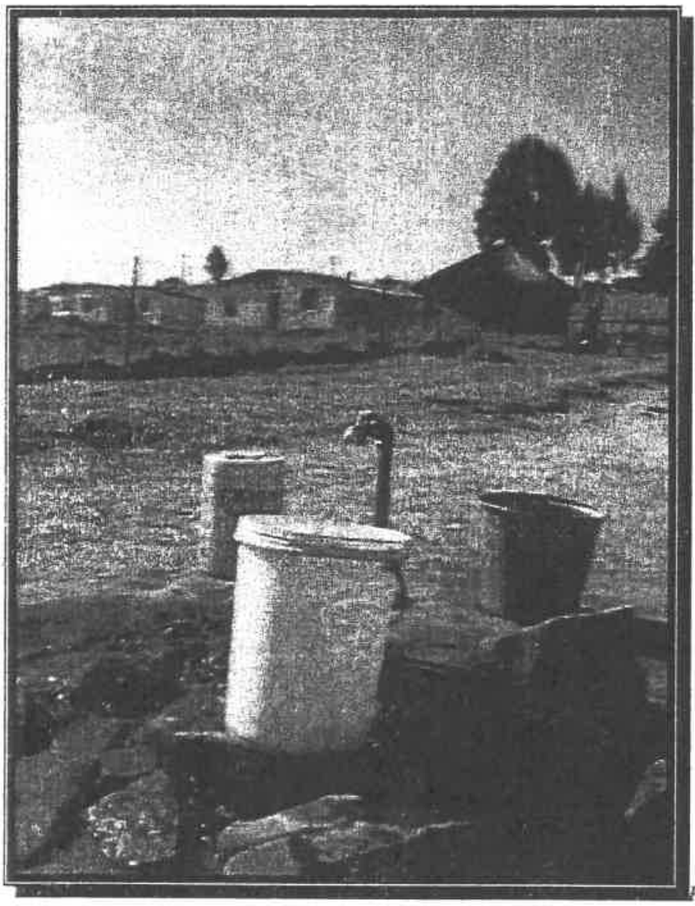


Photo 1: Existing Communal Tap

The terms of reference were to determine the following aspects for water supply with regards to all springs in the area:-

- the source location
- the current flow rate
- geology surrounding the source – brief description only
- the water quality - selected springs only.

The sustainability of these sources was the secondary objective, and the aspects mentioned above were used as a guide for determining the long-term sustainability of such a source. This report is a compilation of the geological and hydrogeological information inferred from the relevant maps as well as information gathered during two field visits in July and September 2005 respectively.

Gedruk en Uitgegee in die Republiek van Suid-Afrika deur die Staatsdrukker, Pretoria, 1981
Printed and Published in the Republic of South Africa by the Government Printer, Pretoria, 1981

REFERENCE

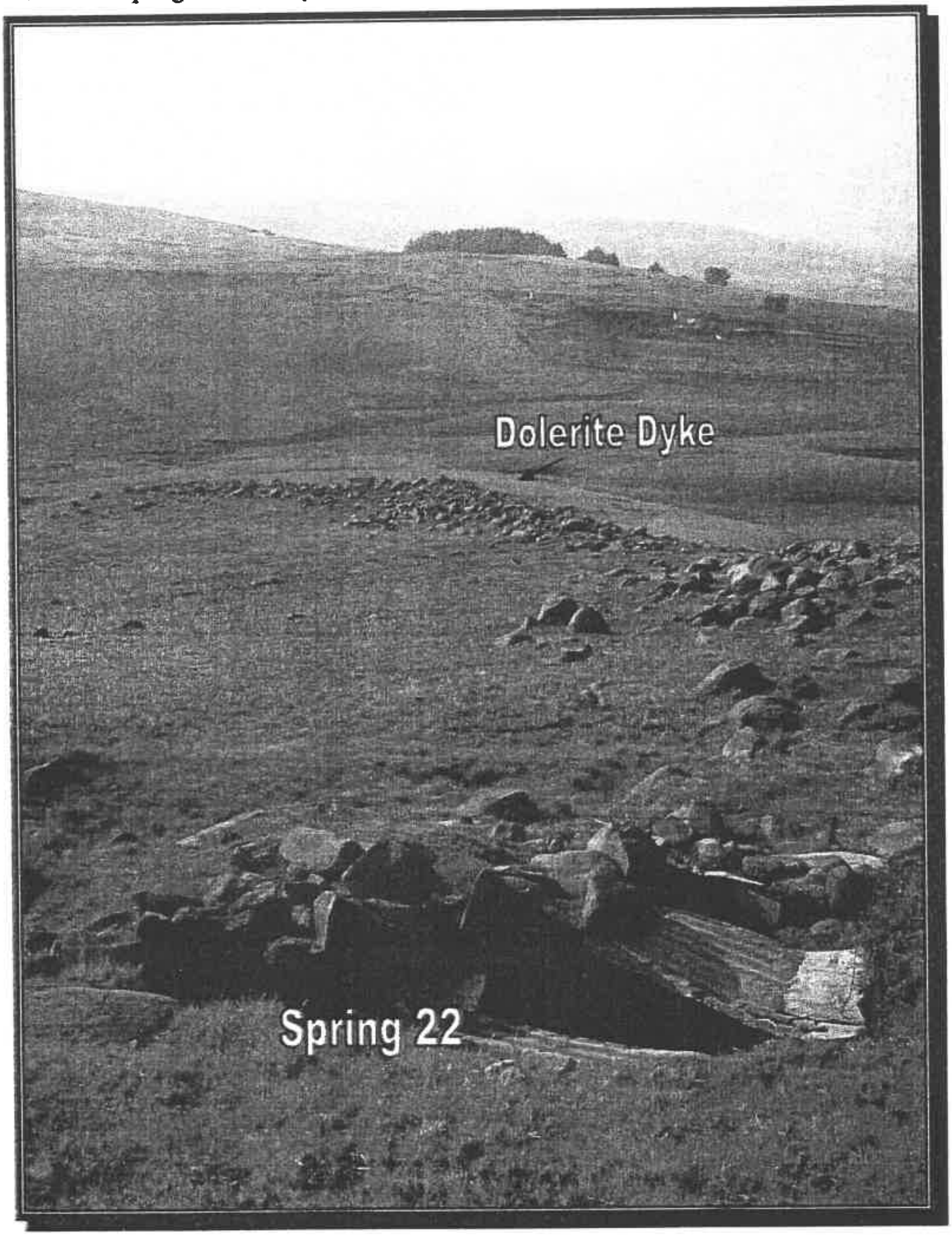
INDEKS VAN VELLE   INDEX TO SHEETS

Figure 2: 2928 Drakensberg Geological Series (1981) to a scale of 1:250 000

2. Site Soils and Geology

According to the geological map, 2928 Drakensberg Geological Series, the hard rock geology of the area comprises sediments of the Karoo Sequence, with the Estcourt and Tarkastad Formations the most widely spread. Younger dolerite sills capping the sediments are commonly found in the area, forming prominent landmarks.

Other prominent structural features such as two large Dolerite dykes intersect the site, one in a W-E and the other in a N-S direction respectively. These structural features are usually closely associated with springs and groundwater seeps and most of the springs in the study area are probably caused by this structure. See also Photo 2 below.



Based on experience elsewhere in the area with similar hydrogeological conditions, the Dolerite dykes are ideal targets for groundwater investigations and drilling of boreholes. An excerpt from the Drakensberg geological series has been included on the opposite page-Figure 2. More detailed geological descriptions of each spring source and its setting is given in section 5.

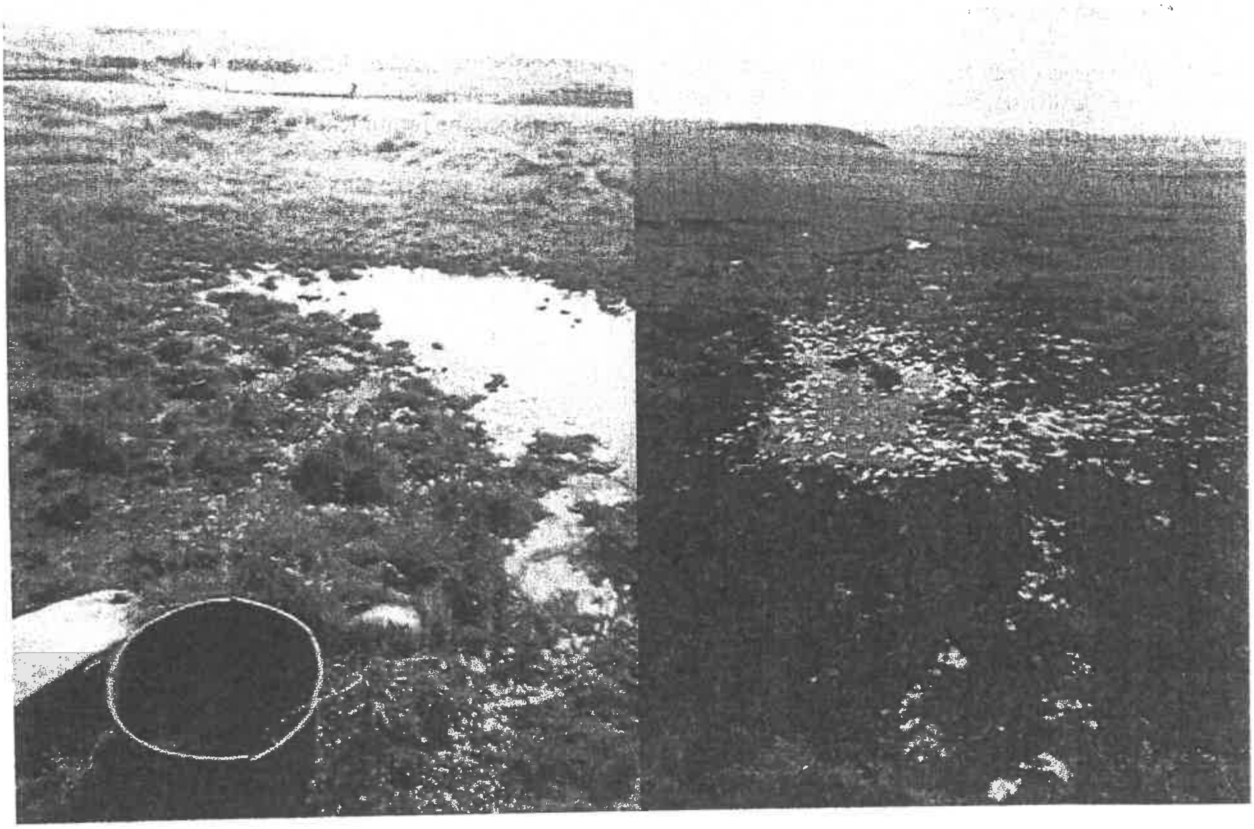


Plate 3: Trampled and polluted springs used for stock watering.

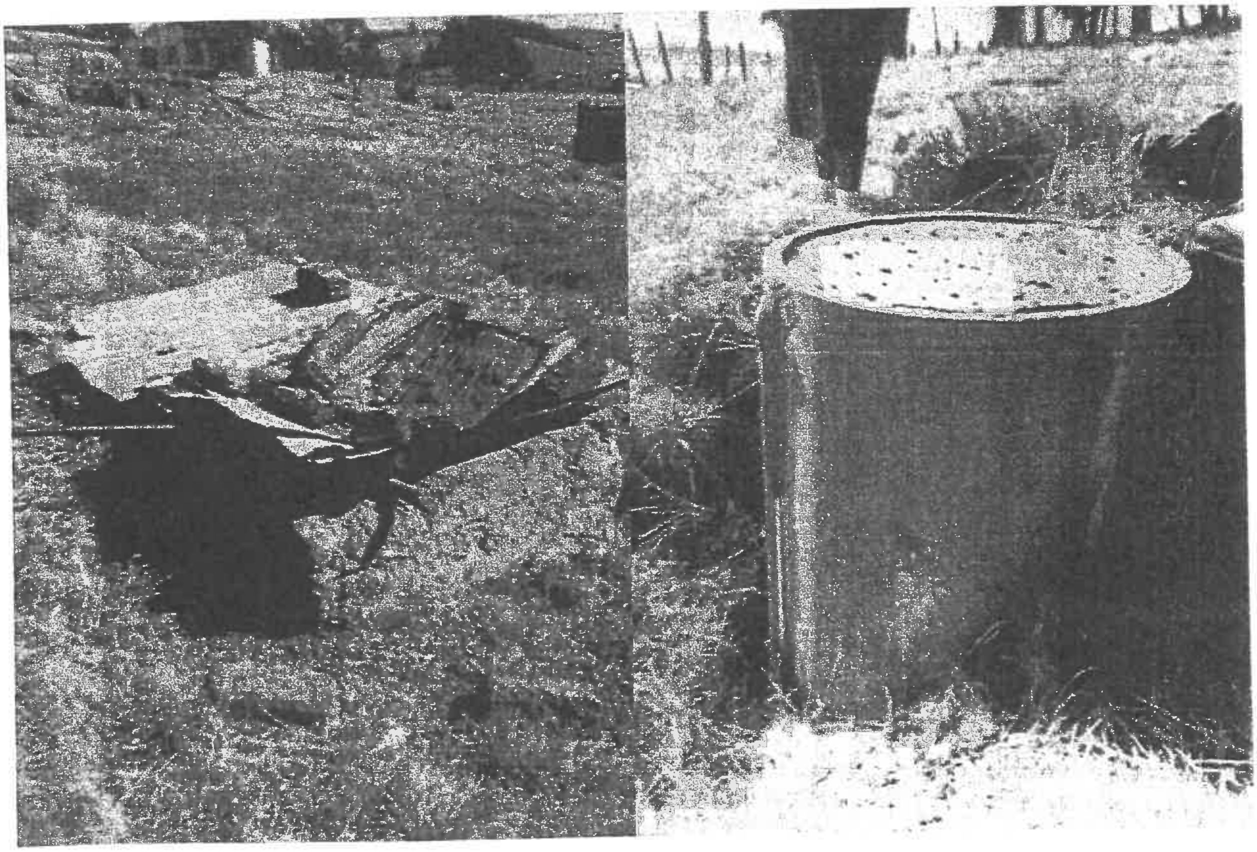


Plate 4: Self constructed v-box and reservoir systems for private use by one or two households only.

3. Site Hydrogeology

Groundwater flows in the sedimentary and intrusive bedrock are predominantly through fractured and jointed zones within the bedrock or in shallow weathered, discontinuous zones.

In the rugged, mountainous setting of KwaNovuka, springs are abundant in the high-lying areas and often the only source of potable water. Spring lines are usually found to emanate at the contact between the Karoo sediments and younger dolerite intrusions. Water from these springs is usually of excellent chemical quality but due to the wide spread usage by humans and animals, these sources are sometimes polluted and the water turbid, thus requiring extensive and properly designed protection and filtering systems.

Unfortunately, springs are susceptible to drought and several of the stronger flowing sources dwindle to mere trickles during the drier periods, only to be regenerated during high rainfall periods. This was confirmed by two flow measurements for each possible spring, one during and one at the end of winter.

4. Investigation Methodology

Initially a desktop study was undertaken with the aim of identifying spring or borehole water sources from existing records. The uMgungundlovu District Municipality's database indicated that no boreholes have been drilled, but numerous spring sources were reported in the area. These coordinate values were plotted and the next step was to verify these sources' existence on the one hand and secondly to determine there sustainability.

The site was then investigated by means of a drive-over survey and spring positions were verified in the field using a hand-held GPS. Where possible, the spring flows were measured and a brief description of the surroundings and geology were given. Selected springs were sampled for water quality purposes and the samples were submitted for chemical analyses at *Umgeni Water* in Pietermaritzburg.

5. Spring Census Results

A total of twenty one (21) possible springs were originally identified in the area through the desktop investigation. All of these locations were investigated during the first field visit that took place on the 20th of July 2005 and an additional 4 spring sources were added to the list. Quite a number of these springs are seasonal and had dried up with the stronger flowing perennial springs being reduced to trickles, but with the pending summer rains, these sources ought to be regenerated and increased flows can be expected - see Table 1 further in this segment.

During the second field visit on the 9th of September 2005, flows had decreased slightly and conditions had become worse with respect to clean potable water for use by the community. However, a positive factor to consider is that the springs currently flowing after such a long and extreme drought, are possibly the sources most likely to remain even in worst drought situations.

Spring sources located including those which have dried up even before the first field visit are listed in table 1 and a description of all the spring sources is included below:

Springs 1 – 6, 7, 9, 10, 13, 14, 21 and 24: These are seasonal springs located below the lowest part of the community, but some are within the community. Geologically these springs are not related to any dolerite dyke or sill intrusion and therefore mere seepage flows in the unsaturated zone. The majority of the springs are located in the sedimentary formations (shale). These springs are not sustainable and cannot be considered for protection.

Springs 8, 16, 17 and 18: These are springs currently used for stock watering mainly due to their location and yield. They are low yielding springs towards the lower sections of the community that has been damaged mainly by animals. See Plate 3 on the opposite page indicating a few of these sources.

Spring 11, 12 and 15: These spring sources are very low yielding spring sources that have been protected by some sort of device by the local community with the aim of supplying either one private household or the local community garden. Unfortunately these sources are capable of supplying a small household only. See Plate 4 on the opposite page.

Spring 19: This relatively strong flowing spring is located next to the road from Impendle to KwaNovuka. In contrast to almost all the other spring sources in the area, this spring drains southwards towards the lower lying village of Ntshinini.

The spring is unprotected and emanates as result of the major E-W striking dolerite dyke intruding into the older sedimentary shale formation. The fairly large catchment consists of mainly shale and sandstone sedimentary rocks surrounded by dolerite dyke and sill intrusions. The first flow measurement on the 20th of July was 450 l/hour. This remained constant and on the 9th of September 2005 the same flow of 450 l/hour was measured. Therefore it seems that the spring is sustainable and could be protected to supply the lower lying Ntshinini village. See Photo 5 below.

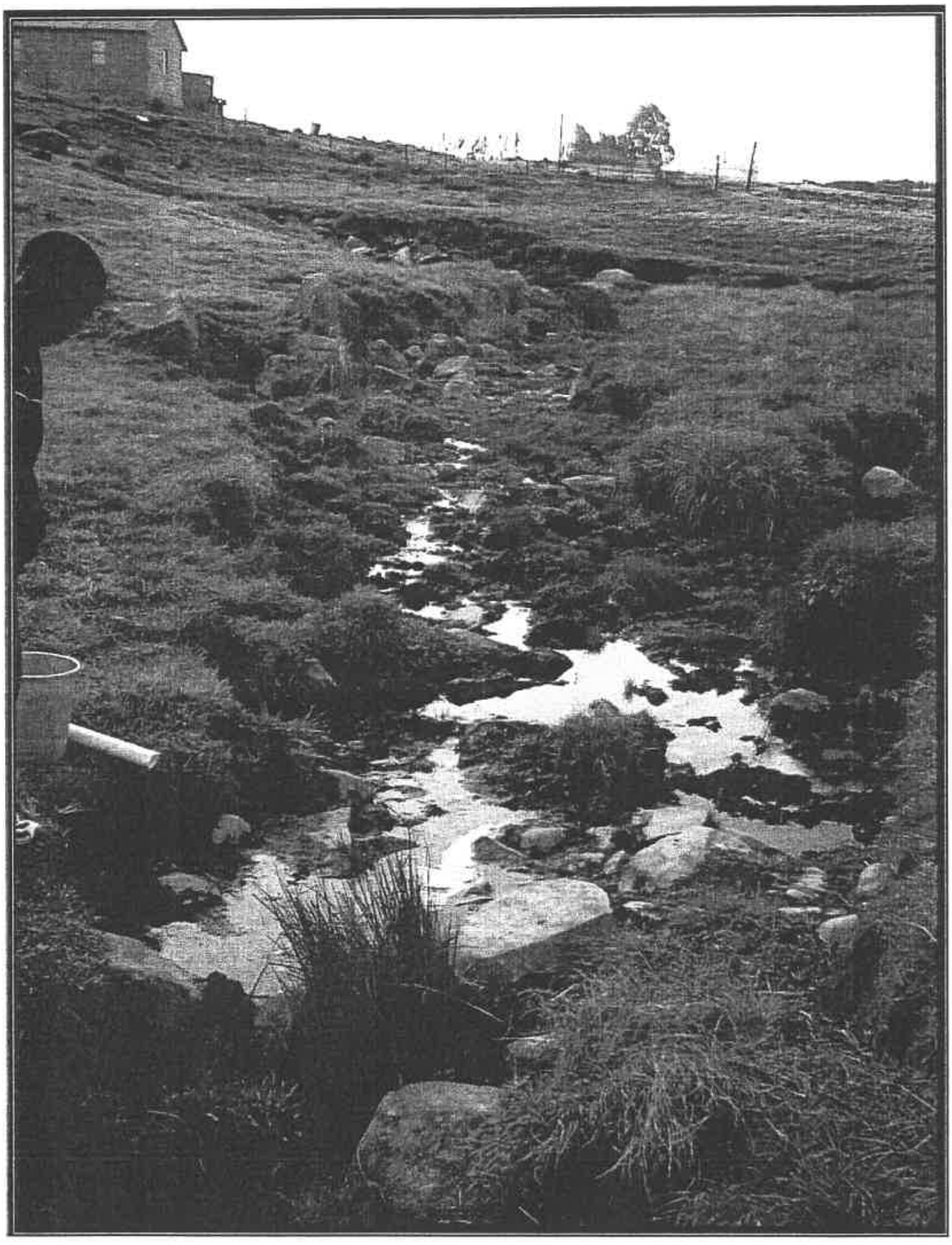


Photo 5: Spring 19 – unprotected and possibly contaminated.

Spring 20: This spring is relatively low flowing and has been poorly protected. See plate 6 below. The spring is located towards the northern section of Novuka 1. To the west of this village, a relatively large catchment drains to the north, but a small spring flows from the dolerite sill making up the eastern boundary of this catchment.

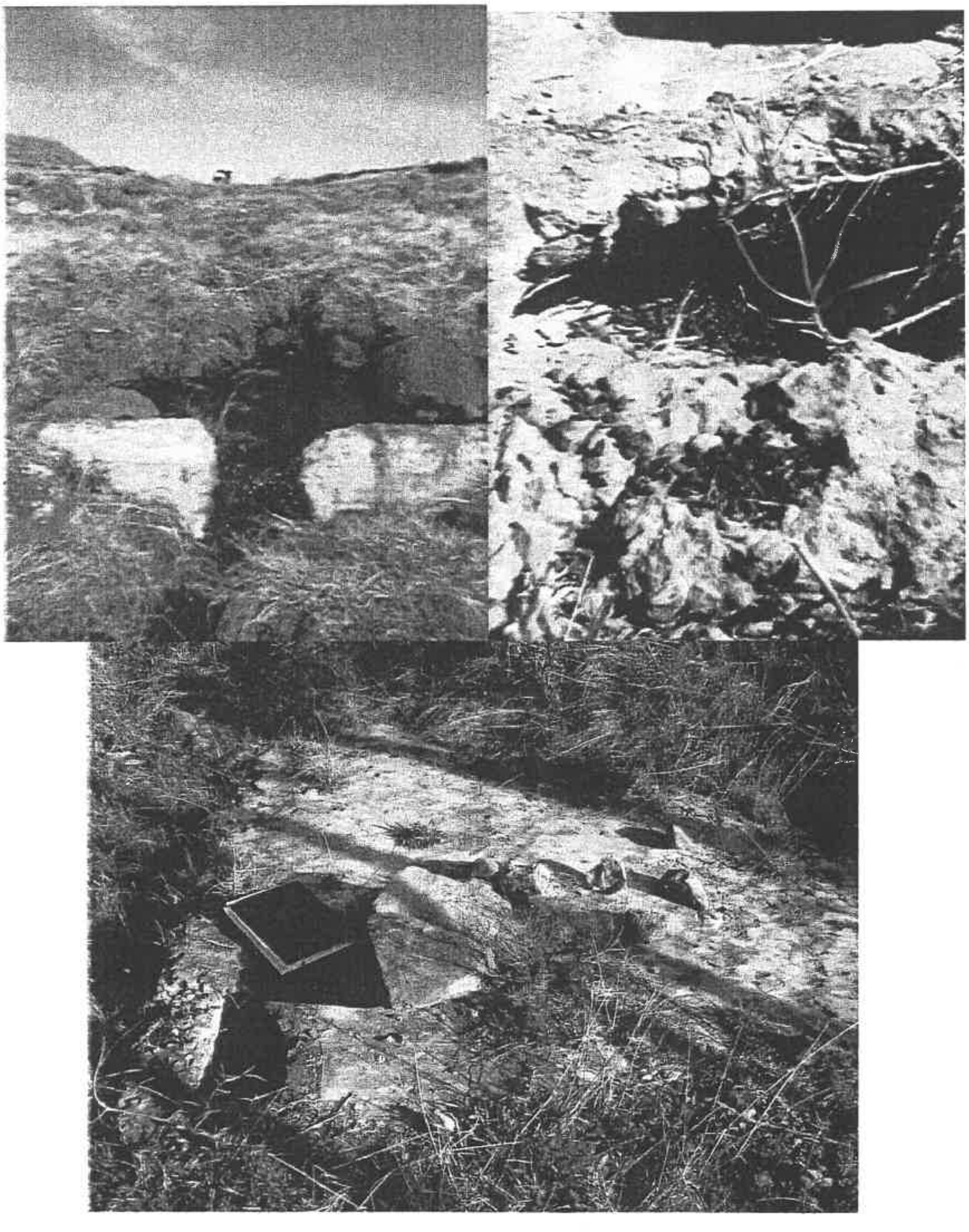


Plate 6: Cement dam structure flowing into concrete protection (broken). Also visible is the rat droppings underneath the sink lid and inside the cement chamber.

The spring is dammed but unprotected and water is gravity fed to a small concrete protection as can be seen in Plate 6 above. Both of these structures are broken and by the time of the second measurement on the 9th of September 2005, the flow could not be measured as the spring had dried up. Therefore it seems that the spring is unsustainable and could not be protected.

Spring 22: In 2002 this spring was protected as part of the drought relief programme after the KwaNovuka community identified it as the most suitable source of water supply in the village. Most of the other reliable spring sources in the village had previously been protected, but this spring was "protected" in such a manner that animals could gain access to the source a thus damaging and contaminating it. This protection was replaced and is currently still operational, but due to local intervention, the new protection was opened and the delivery line removed. The spring is still protected but susceptible to contamination while being captured lower down. See Photo 7 below. Also included in the appendix is the initial report of the completed project in 2002.

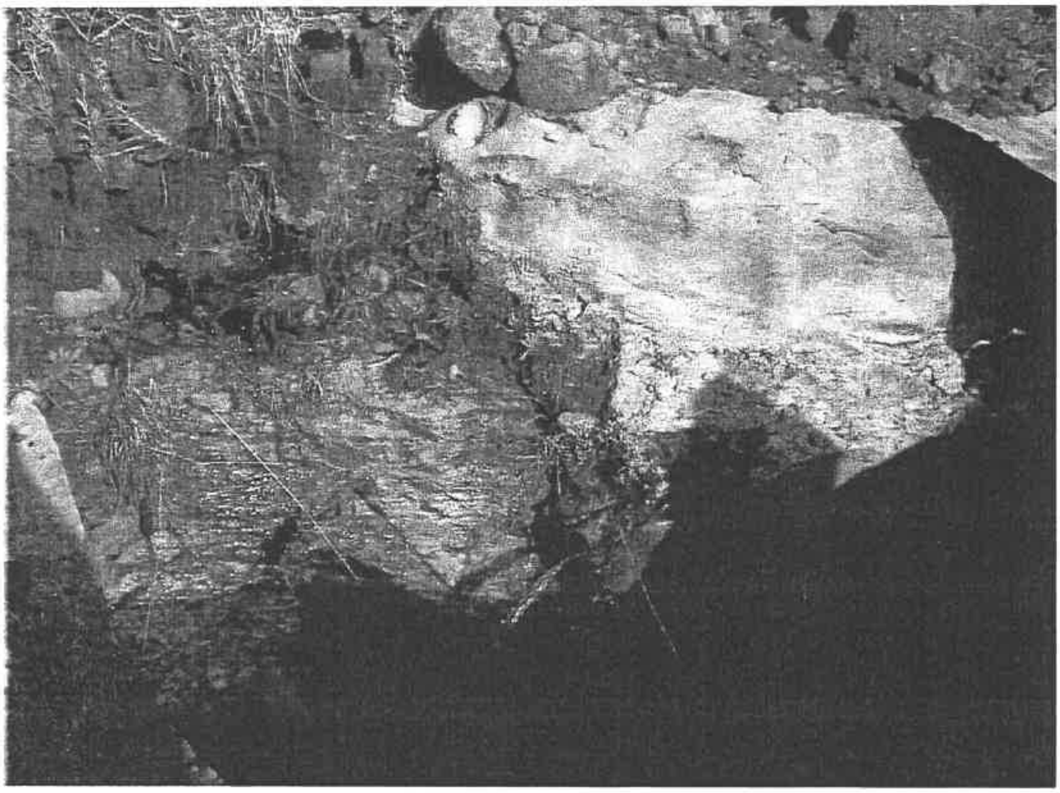


Photo 7: Existing protection at spring 22.

Two plastic tanks serve as storage reservoirs, but due to the location of the spring and the lack of hydraulic head, these are not easily filled. A further problem is the fact that the local community has made illegal connections to the supply line from the spring before it reaches the first reservoir. Most of the times, these illegal connection pipe lines are not properly closed by means of a valve or tap, but are merely folded back or blocked.

Geologically, the spring is situated on the side of a large E-W striking Dolerite dyke. As is the case in most instances in this village, the dolerite intruded into the older sedimentary rocks causing fracturing and brittle contact zone material. This zone is the preferred pathway for groundwater movement through the subsurface and results in a spring line where the perched water table reaches this zone. The flow measured on the 20th of July and the 9th of September remained relatively constant at around 800-1000 l/hour. Therefore the spring seems to be sustainable and the existing protection should be repaired and upgraded.

Spring 23: In principle, this spring is caused similarly to spring 22 in that hydrogeologically it is formed as a result of the same dolerite dyke as discussed in spring 22 above. Located slightly lower down from spring 22, it feeds a cement reservoir located some distance lower down at spring 20. Water is gravity fed from the position near spring 22 to one 5000 liter plastic reservoir. From here water is piped to the cement protection discussed in spring 20 (see plate 6). This "protection", with rat droppings in the cement chamber, allows water to be fed to the storage reservoir without a lid as indicated in the Plate 8 on the following page.

The initial protection of spring 23 was done by the local community and although no apparent contamination takes place, the cover of corrugated iron sheets is insufficient and could result in the spread of water bourn deceases if the source is not properly protected. See Plate 8 below for current protection of the spring eye.

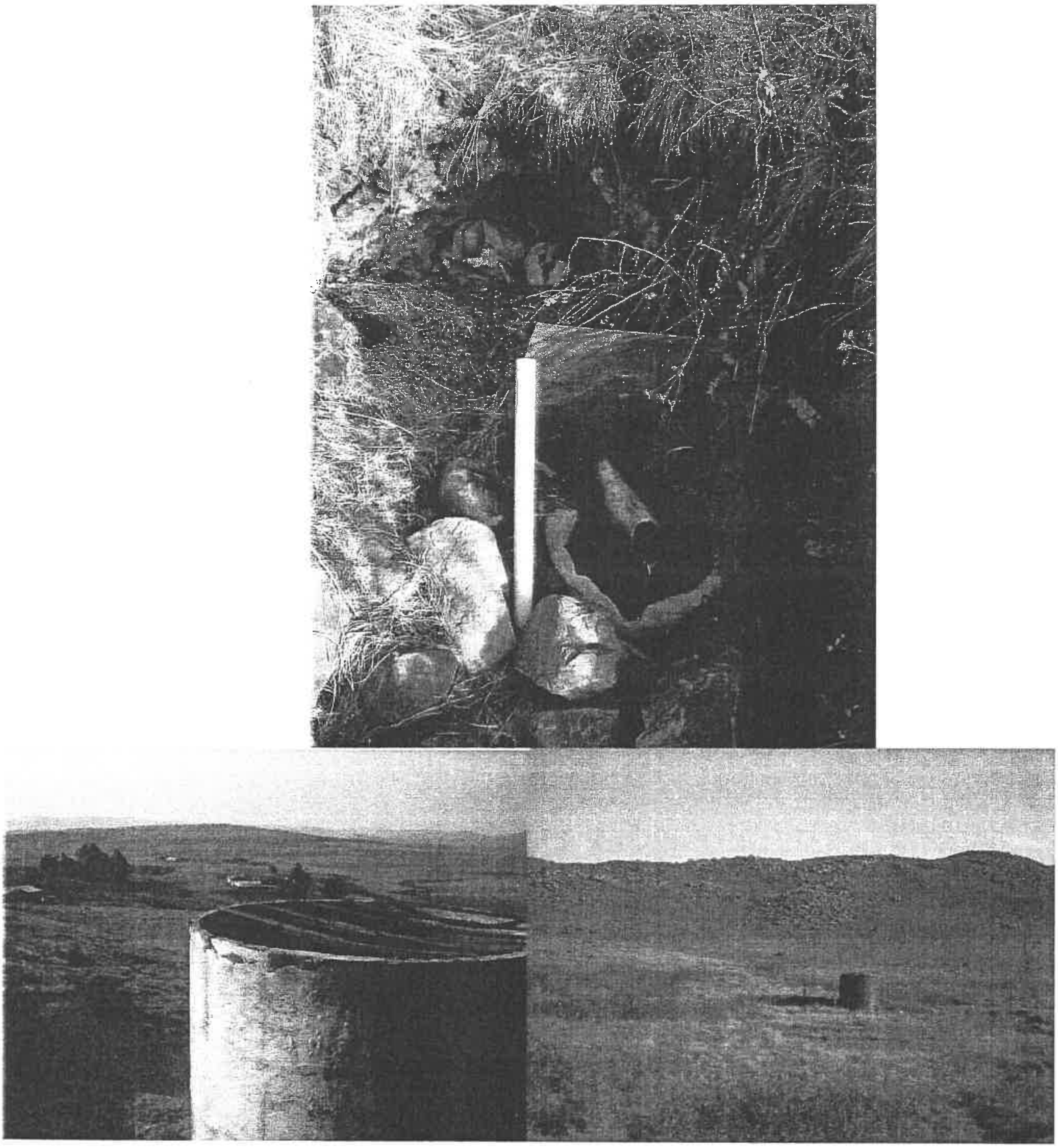


Plate 8: Existing home made protection, plastic tank and cement reservoir.

The flow measured on the 20th of July and the 9th of September remained relatively constant at around 700 l/hour. Therefore the spring seems to be sustainable and the existing protection and supply scheme should be repaired and upgraded.

Spring 25: Situated high above the Novuka 4 community on the side of the Ntshangwe mountain, the spring consists of a old v-box protection, 2 x cement reservoirs that are badly damaged and approximately 4 taps. The spring emanates from the side of the mountain where the impermeable dolerite sill causes a perched water table and together with the steep topography results in the discharge of this relatively constant flowing spring. See photo 9 below.

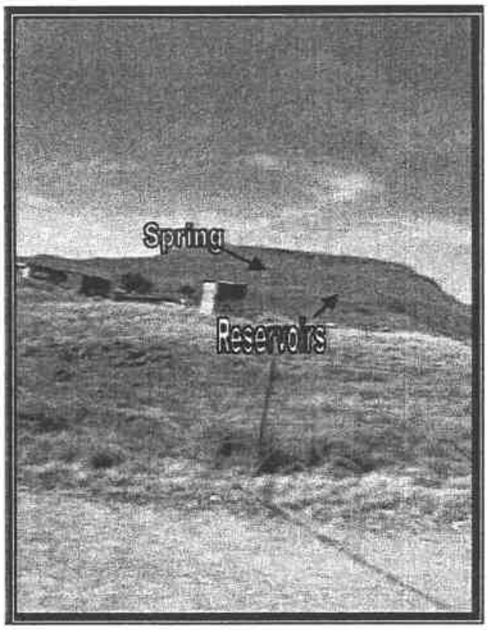


Photo 9: Spring 25 and 2 x cement reservoirs side of Ntshangwe

Even though the flow rate could not be measured at the spring eye, the flow into the reservoirs was estimated at 300 l/hour on both occasions (20th of July and 9th of September 2005). This amount of water is not capable of filling these two reservoirs mainly due to the demand and water basically enters the reservoirs and exits within a few seconds. Photo 9 below indicates the 2 x cement reservoirs with the KwaNovuka community below and the large dolerite dyke discussed in spring 22 and 23 in the background.

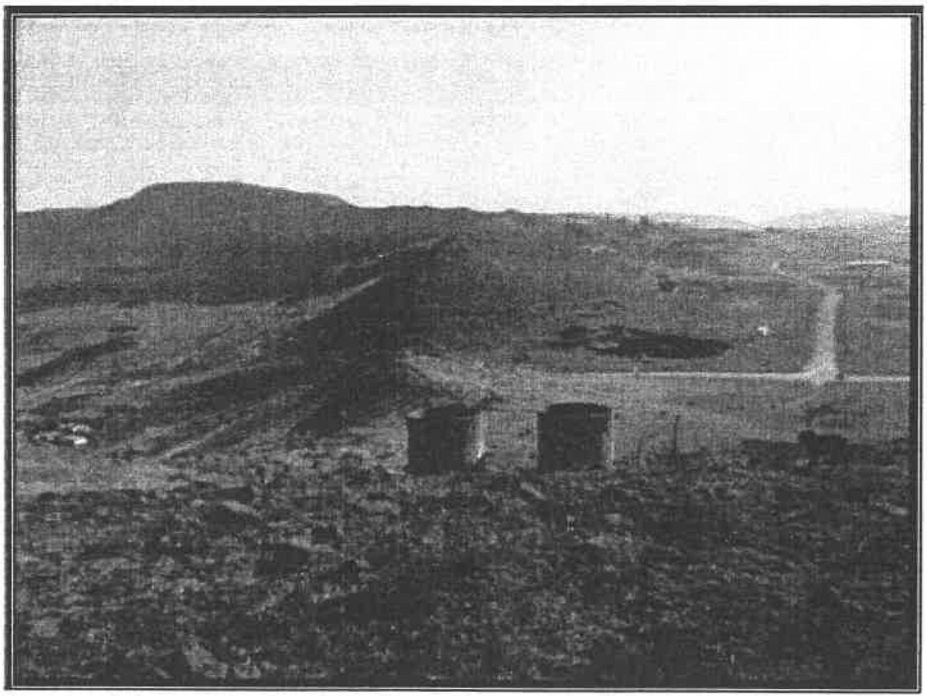


Photo 9: Above the 2 x cement storage reservoirs at spring 25.

The discussion of each of the springs located and verified in section 5 above have been summarized and is represented in Table 1 on the following two pages.

Table 1: Hydrocensus sheet of all springs at KwaNovuka

Source Name	Source Type	Latitude	Longitude	Setting	Existing Protection	Flow Rate Estimated	Condition	Current Application	Sustainability	Water Quality
Spring 1	Spring	29.56708	29.83603	Well below community	None - Seasonal spring	None	Dry	Not Used	Not Sustaibable- Dry in winter	Not Sampled
Spring 2	Spring	29.56694	29.83489	Well below community	None - Seasonal spring	None	Dry	Not Used	Not Sustaibable- Dry in winter	Not Sampled
Spring 3	Spring	29.56672	29.83419	Well below community	None - Seasonal spring	None	Dry	Not Used	Not Sustaibable- Dry in winter	Not Sampled
Spring 4	Spring	29.56428	29.83503	Well below community	None - Seasonal spring	None	Dry	Not Used	Not Sustaibable- Dry in winter	Not Sampled
Spring 5	Spring	29.56550	29.83294	Well below community	None - Seasonal spring	None	Dry	Not Used	Not Sustaibable- Dry in winter	Not Sampled
Spring 6	Spring	29.56556	29.83614	Well below community	None - Seasonal spring	None	Dry	Not Used	Not Sustaibable- Dry in winter	Not Sampled
Spring 7	Spring	29.57017	29.83664	Well below community	None - Seasonal spring	None	Dry	Not Used	Not Sustaibable- Dry in winter	Not Sampled
Spring 8	Spring	29.57022	29.84714	Marshy area below community	Unprotected Spring trampled by cattle	(1) 300 l/hr (2) 300 l/hr	Poor condition due to trampling of spring by livestock	Livestock Watering	Not Sustaibable- Dry in winter	Not Sampled
Spring 9	Spring	29.57097	29.84272	Below Spring 24	None - Seasonal spring	None	Dry	Not Used	Not Sustaibable- Dry in winter	Not Sampled
Spring 10	Spring	29.57350	29.84094	Below Spring 24 & Spring 12's tanks	None - Seasonal spring	None	Dry	Not Used	Not Sustaibable- Dry in winter	Not Sampled
Spring 11	Spring	29.57631	29.84325	Side of donga - inside community	Old V-box and small 500 l tank	20 l/day	Working	Single household uses this spring	Not Sustaibable- Dry in winter	Not Sampled
Spring 12	Spring	29.57600	29.84200	Below Spring 24 above Community Garden	Unprotected - pipe in stream taking water to 10000 l tank	None	Not Working	Suplies water to community garden lower down-dry now	Not Sustaibable- Dry in winter	Not Sampled
Spring 13	Spring	29.57622	29.84058	Inside community	None - Seasonal spring	None	Dry	Not Used	Not Sustaibable- Dry in winter	Not Sampled
Spring 14	Spring	29.57492	29.83836	Inside community	None - Seasonal spring	None	Dry	Not Used	Not Sustaibable- Dry in winter	Not Sampled
Spring 15	Spring	29.57408	29.84797	Inside community	Private Protection	100 l/hour	Working	Private household - Domestic Water Supply	Sustainable for small number of people only, private use.	Not Sampled
Spring 16	Spring	29.56361	29.84733	Well below community - far from community	Unprotected, Marshy area trampled by livestock - no measurable flow .	Seepage	Not Working	Livestock Watering	Not Sustaibable- Dry in winter	Not Sampled

Source Name	Source Type	Latitude	Longitude	Setting	Existing Protection	Flow Rate Estimated	Condition	Current Application	Sustainability	Water Quality
Spring 17	Spring	29.56969	29.86936	Above community	Unprotected, Marshy area trampled by livestock - low flow	200 l/hour	Not Working	Livestock Watering	Not Sustaibable-Dry in winter	Not Sampled
Spring 18	Spring	29.56633	29.86864	Below Community	Unprotected, Marshy area trampled by livestock - low flow	200 l/hour	Not Working	Livestock Watering	Not Sustaibable-Dry in winter	Not Sampled
Spring 19	Spring	29.57256	29.86458	Next to main road inside community	Unprotected, strong spring, flowing SW towards Ntshini community	(1) 450 l/hr (2) 450 l/hr	Working	Not Used	Sustainable for lower portion of Ntshini community.	Class 3 – Health Class 2 – Aesthetic
Spring 20	Spring	29.57381	29.83656	Above community	Protected spring with concrete dam, v-box and concrete 10 000 l reservoir	Approx. 400 l/hour closed v-box not measured	Working	Domestic Water Supply	Sustainable for Novuka 2 and NE portion of Novuka 1 Community	Not Sampled
Spring 20	Reservoir	29.57156	29.83725							
Spring 21	Spring	29.59583	29.83861	Above community	None - Seasonal spring	None	Not Working	Not Used	Not Sustaibable-Dry in winter	Not Sampled
Spring 22	Spring	29.57917	29.83853	Above community	Protected spring with v-box and concrete 2 x 5 000 l reservoirs	(1) 1080l/hr (2) 808l/hr	Working - Maintenance required	Domestic Water Supply	Sustainable for Novuka 1 Central and southern portions	Class 2 – Health Class 0 – Aesthetic
Spring 23	Spring	29.57822	29.84028	Above community, slightly lower than spring 22	Partially protected spring source with 5000 l tank serving also tank at spring 20.	(1) 675 l/hr (2) 708 l/hr	Working	Domestic Water Supply	Sustainable for Novuka 2 and NE portion of Novuka 1 Community	Class 0 – Health Class 0 – Aesthetic
Spring 24	Spring	29.57736	29.84169	Inside community	Unprotected flow possibly from leakage in delivery pipeline from spring 22	100 l/hour	Not Working	Not Used	Not Sustaibable-Dry in winter	Not Sampled
Spring 25	Spring	29.57233	29.87025	High above Community	Protected spring high above Novuka 4 Community with 2 x 3000 l concrete tanks that leaks	300 l/hour	Working	Domestic Water Supply	Sustainable for Novuka 4 community	Class 0 – Health Class 0 – Aesthetic
Spring 25	Reservoirs	29.57278	29.86753							

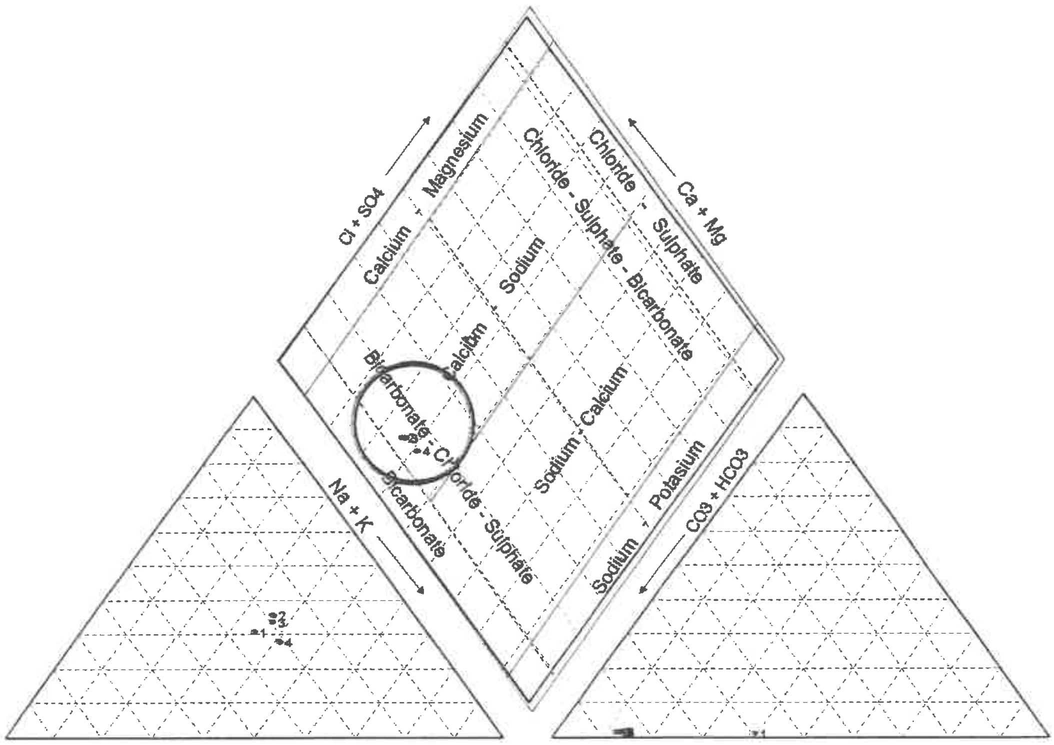
6. Water Quality Results

The chemical composition of the groundwater in the project area is influenced by topographical, climatologically and to a larger extent by mineral composition of the geological units.

Water samples were collected from the four (4) most suitable spring sources for analysis by Umgeni Water Laboratory in Pietermaritzburg. These sources are Spring 19, Spring 22, Spring 23 and Spring 25. A summary of the results is indicated in Table 1 above and full details are included in the Appendix.

In general, the water sampled and tested of the four springs can be classified as Class 0 in terms of health and Class 0 in terms of Aesthetic value. The exception is for spring 19 where the E-coli count is 12 and to a lesser extent Spring 22 where an E-coli count of 1 was observed. This is caused mainly by the unprotected state of the springs and as a result of the contamination caused by animals sharing the water source as well as unsafe sanitation practices. The risk factor is high especially towards infectious disease transmission. Other than that only one substance is found in excess namely Fe at spring 19. Upon closer inspection of the spring source it became clear that some metal wreckage located at the spring eye could be the cause of these high values. See also Photo 5 in the top left corner. The remainder of the other sources' water is generally regarded to be of good quality and suitable for long term domestic use without any detrimental effects. The Piper diagram shown below indicates the chemical distribution of the four springs tested and analyzed to be water of good quality. The center plot of the diagram indicates that there is no excessive concentration of mineral salts and based on this, could be considered a Calcium – Bicarbonate water. This is further evidence that the water is recently recharged and therefore relatively fresh. The classification details of the chemical analyses are also attached in the Appendix.

PIPER DIAGRAM



1	Spring 19
2	Spring 22
3	Spring 23
4	Spring 25

7. Conclusions and Recommendations

The four (4) spring sources namely; Spring 19, Spring 22, Spring 23 and Spring 25 have been identified as sustainable and could potentially provide a large number of people with potable water. The total estimated yield from these 4 springs amount to **54000 liters / day**. This is the estimated low flow volume and yields will increase drastically during the summer rainy season. The total amount of people that can be served from these sources is estimated at **2160 persons** at a volume of 25 l/day. The major difficulty is getting the water from the spring sources to the required height elevation in order to reticulate successfully to all parts of the various communities.

Alternatively, potentially high yielding aquifers could be identified for drilling, by means of a thorough geohydrological investigation. This would include a detailed desk study of available information, aerial photographic interpretation and a thorough geophysical field investigation.

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J. Du Preez Pr.Sci.Nat.

APPENDICES

WATER QUALITY RESULTS
ANALYSIS BY UMGENI
WATER LABORATORY

2005-1335

Date of Sampling	08-09-05	**Customer Code**	1160
Date Received	12-09-05	**Page Number**	1 of 1

Sample Description		**Kwa Novuka Spring 19**	**Kwa Novuka Spring 22**	**Kwa Novuka Spring 23**	**Kwa Novuka Spring 25**	**Method Number**
Customer Number		**40**	**41**	**42**	**43**	
Determinand	**Units**					
Appearance*	Descriptive	Slightly turbid brown	Clear Colourless	Clear Colourless	Clear Colourless	7
Odour*	Descriptive	Nil	Nil	Nil	Nil	7
Turbidity	NTU	9.16	2.14	0.452	1.13	69
Colour	°H	1.7	<1	<1	1.1	19
Conductivity	mS/m	5.66	2.27	2.42	2.83	21
pH	pH units	6.47	6.94	7.02	7.28	46
Alkalinity*	mg $CaCO_3$/L	<10	<10	<10	<10	1
Total hardness	mg $CaCO_3$/L	15.8	<7.4	<7.7	<8.7	27
Calcium	mg Ca/L	3.34	1.30	1.43	1.82	30
Magnesium	mg Mg/L	1.82	<1.00	<1.00	<1.00	30
Sodium	mg Na/L	3.24	1.31	1.46	2.18	30
Potassium	mg K/L	<1.00	<1.00	<1.00	<1.00	30
Iron	mg Fe/L	0.33	0.03	0.02	0.04	30
Manganese	mg Mn /L	0.02	<0.01	<0.01	<0.01	30
Soluble organic carbon	mg C/L	1.16	<0.7	<0.7	<0.7	68
Chloride (soluble)	mg Cl/L	4.20	0.83	0.89	0.93	5
Nitrite (soluble)	mg N/L	<0.05	<0.05	<0.05	<0.05	5
Nitrate (soluble)	mg N/L	2.85	0.12	0.14	0.07	5
Sulphate (soluble)	mg SO_4/L	<0.16	<0.16	<0.16	<0.16	5
Fluoride	µg F/L	<100	<100	<100	<100	94
Total coliforms	Count per 100mL	1986	436	3	>2419	121
E.coli	Count per 100mL	12	1	0	0	121

20-09-05

CLASSIFICATION OF WATER

DWAF MINIMUM GUIDELINES;

SABS 242 and

QUALITY OF DOMESTIC

WATER SUPPLY

QUALITY ANALYSIS

Borehole No.:	Spring 19	**CO-ORDINATES**		
Project No.:	LL1153	Lat:	29.57256	**Combination of :** **DWAF Minimum Standards document**
Village:	KwaNovuka	Long:	29.86458	**DWAF Design Criteria** **South African Drinking Standards**
District;	Impendle			

SABS

Quality of Domestic Water Supplies

Volume 1: Assessment Guide
Second Edition - 1998

(Drinking)
[DWAF, WRC, Dep Health]

SUBSTANCE	UNIT OF MEASURE	Value test	Class 0	Class 1	Class 2	Class 3	COMMENTS
Faecal coliform *	counts/100 ml	12	0	0-1	1 - 10	> 10	Class 3 Risk of infectious disease transmission with continious use; slight risk with occasional exposire.
Total Dissolved Solids (TDS) *	(mg/l)	36.224	0 - 450	450-1000	1000 - 2450	> 2450	
Electrical conductivity EC *	mS/m	5.66	0 - 70	70 - 150	150 - 370	>370	
Total Alkalinity	mg/l	9	-	-	-	-	
Total Hardness **	mg/l	15.8	-	<100	100-300	>300	Soft
Precipitation Potential			-	-	-	-	
pH *	pH units	6.47	6 - 9	5 - 6 or 9 - 9.5	4 - 5 or 9.5 - 10	<4 or >10	
Turbidity	NTU	9.16	-	-	-	-	
Arsenic (As) *	mg/l As		0 - 0.01	0.01 - 0.05	0.05 - 0.2	> 0.2	
Cadmium (Cd) *	mg/l Cd		0 - 0.005	0.005 - 0.01	0.01 - 0.02	>0.02	
Calcium (Ca)	mg/l Ca	3.34	0 - 32	32	32-80	>80	
Calcium (CaCo3)	mg/l CaCO3		0 - 80	80	80-200	>200	
Chloride (Cl)*	mg/l Cl	4.2	0 - 100	100 - 200	200 - 600	> 600	
Fluoride (F) *	mg/l F	0.01	0 - 1	1 - 1.5	1.5 - 3.5	>3.5	
Iron (Fe) *	mg/l Fe	0.33	0 - 0.1	0.1 - 0.2	0.2 - 2	> 2.0	Class 2 No health effects. Adherse aesthetic effects (taste) gradually increase as do possible problems with plumbing.
Magnesium (Mg)	mg/l Mg	1.82	0 - 30	30 - 70	70 - 100	> 100	
Magnesium (MgCo3) *	mg/l MgCO3		-	-	-	-	
Manganese (Mn) *	mg/l Mn	0.02	0 - 0.05	0.05 - 0.1	0.1 - 1.0	>1	
Nitrate (as NO3) *	mg/l N	0.05	-	-	-	-	
Nitrate (as N) *	mg/l N	2.85	0 - 6	6 - 10	10 - 20	>20	
Potassium (K) *	mg/l K	1	0 - 50	50 - 100	100 - 400	> 400	
Sodium (Na) *	mg/l Na	3.24	0 - 100	100 - 200	200 - 400	> 400	
Sulphate (SO4) *	mg/l SO4	0.16	0 - 200	200 - 400	400 - 600	> 600	
Zinc (Zn) *	mg/l Zn		0 - 3	3 - 5	5 - 10	>10	
Ammonia (NH3)	mg/l NH3		-	-	-	-	
Ammonia (N) **	mg/l NH3	-	-	<2	2-10	>10	

SABS

SUBSTANCE	VALUE	Rec Max	Max	COMMENTS
Faecal coliform	12	0.00	0.00	
TDS	36.22			
EC	5.66			
Total Alkalinity	9.00			
Total Hardness	15.80	300.00	650.00	
Precipitation Potential				
pH	6.47	9.00	9.50	
Turbidity	9.16	1.00	5.00	Unacceptable
Arsenic		0.10	0.30	
Cadmium		0.01	0.02	
Calcium (Ca)	3.34	ns	ns	
Calcium (CaCo3)		300.00	650.00	
Chloride	4.20	250.00	600.00	
Fluoride	0.01	1.00	1.50	
Iron	0.33	0.10	1.00	Maximum Allowable
Magnesium (Mg)	1.82	70.00	100.00	
Magnesium (MgCo3)				
Manganese	0.02	0.05	1.00	
Nitrate (as NO3)	0.05			
Nitrate (as N)	2.85	6.00	10.00	
Potassium	1.00	ns	ns	
Sodium	3.24	100.00	400.00	
Sulphate	0.16	200.00	600.00	
Zinc		1.00	5.00	
Ammonia (NH3)		ns	ns	
Ammonia (N)	-	ns	ns	

Quality of Domestic Water Supplies

SUBSTANCE	VALUE	GOOD	MARGINAL	POOR	UNACCEPTABLE	ACCEPTANCE LEVEL	COMMENTS
Faecal coliform	12.00	0-1	1-10	10-100	>100	Poor	Clinical infections, even for once off users
TDS	36.22						
EC	5.66	70-150	150-370	370-520	>520		
Total Alkalinity	9.00						
Total Hardness	15.80	200-300	300-600	>600			
Precipitation Potential							
pH	6.47	4.5-10	<4 - >10.5	<3 - >11	>11		
Turbidity	9.16	0.1-1	1-20	20-50	>50	Marginal	Possibility of secondary health effects
Arsenic		0.01-0.05	0.05-2	0.2-2	>2		
Cadmium		0.003-0.00	0.005-0.02	0.02-0.05	>0.05		
Calcium (Ca)	3.34	80-150	150 - 300	>300			
Calcium (CaCo3)							
Chloride	4.20	100-200	200-600	600-1200	>1200		
Fluoride	0.01	0.7-1	1-1.5	1.5-3.5	>3.5		
Iron	0.33	0.5-1	2-5	5-10	>10		
Magnesium (Mg)	1.82	70-100	100-200	200-400	>400		
Magnesium (MgCo3)							
Manganese	0.02	0.1-0.4	1.0-4	5-10	>10		
Nitrate (as NO3)	0.05						
Nitrate (as N)	2.85	6-10	10-20	20-40	>40		
Potassium	1.00	25-50	50-100	100-500	>500		
Sodium	3.24	100-200	200-400	400-1000	>1000		
Sulphate	0.16	200-400	400-600	600-1000	>1000		
Zinc		>20					
Ammonia (NH3)							
Ammonia (N)	-						

Conclusion / Recommendation :

Water Class for general use (incl laundry, aesthetic, bathing, etc)	Class 2
Water Class for Drinking (Health Related)	Class 3

According to the above results)

Check:
Ion Balance 22.89 %

Note: If Ion Balance error is higher than 5% or -5% the analysis is faulty and have to be reanalysed.

Negative effects :
1) See above

Guidelines for Treatment, Classification and Monitoring

Treatment:
TDS / EC / Sodium / Magnesium / Chloride :Desalination by Ion exchange
Calcium : Precipitation with Sodium Carbonate
Iron : Normal coagulation and flocculation, sedimentation and filtration

Class I BH — Water suitable for long term utilization
Class II BH (Fit for interim use) — Borehole must be monitored on two monthly basis for the first year to monitor changes
Class III BH (Must be suitably treated) — Borehole must be monitored on a monthly basis for the first year to monitor changes

Note: Before a borehole is abandoned due to Class II or III analyses, it is recommended that a second sampled is taken to verify

Quote: The hydrogeological consultant will collect water samples for microbiological or bacteriological analysis in instances where this aspect of ground water quality is considered to represent a real concern (DWAF Minimum Standards Document, Part 1 - Section 4)

* **Key parameters for ground water acceptability for potable use (RDP Design Guidelines, October 1997)**
** **Parameters for ground water acceptability for potable use (South African Water Quality Guidelines: Volume 1: Domestic Use)**

QUALITY ANALYSIS

Borehole No.:	Spring 22	**CO-ORDINATES**		
Project No.:	LL1153	**Lat:**	29.57917	**Combination of :** DWAF Minimum Standards document
Village:	KwaNovuka	**Long:**	29.83853	**DWAF Design Criteria** South African Drinking Standards
District;	Impendle			

SUBSTANCE	UNIT OF MEASURE	Value test	Class 0	Class 1	Class 2	Class 3	COMMENTS	
Faecal coliform *	counts/100 ml	1	0	0-1	1 - 10	> 10	Class 2	Slight risk of microbial infection with continuous use: negligible effects with occasional or short term use.
Total Dissolved Solids (TDS) *	(mg/l)	14 523	0 - 450	450-1000	1000 - 2450	> 2450		
Electrical conductivity EC *	mS/m	2.27	0 - 70	70 - 150	150 - 370	>370		
Total Alkalinity	mg/l	9	-		-	-		
Total Hardness **	mg/l	7.4	-	<100	100-300	>300		Soft
Precipitation Potential			-	-	-	-		
pH *	pH units	6.94	6 - 9	5 - 6 or 9 - 9.5	4 - 5 or 9.5 - 10	<4 or >10		
Turbidity	NTU	2.14	-	-	-	-		
Arsenic (As) *	mg/l As		0 - 0.01	0.01 - 0.05	0.05 - 0.2	> 0.2		
Cadmium (Cd) *	mg/l Cd		0 - 0.005	0.005 - 0.01	0.01 - 0.02	>0.02		
Calcium (Ca)	mg/l Ca	1.3	0 - 32	32	32-80	>80		
Calcium (CaCo3)	mg/l CaCO3		0 - 80	80	80-200	>200		
Chloride (Cl)*	mg/l Cl	0.83	0 - 100	100 - 200	200 - 600	> 600		
Fluoride (F) *	mg/l F	0.01	0 - 1	1 - 1.5	1.5 - 3.5	>3.5		
Iron (Fe) *	mg/l Fe	0.03	0 - 0.1	0.1 - 0.2	0.2 - 2	> 2.0		
Magnesium (Mg)	mg/l Mg	1	0 - 30	30 - 70	70 - 100	> 100		
Magnesium (MgCo3) *	mg/l MgCO3		-	-	-	-		
Manganese (Mn) *	mg/l Mn	0.01	0 - 0.05	0.05 - 0.1	0.1 - 1.0	>1		
Nitrate (as NO3) *	mg/l N	0.05	-	-	-	-		
Nitrate (as N) *	mg/l N	0.12	0 - 6	6 - 10	10 - 20	>20		
Potassium (K) *	mg/l K	1	0 - 50	50 - 100	100 - 400	> 400		
Sodium (Na) *	mg/l Na	1.31	0 - 100	100 - 200	200 - 400	> 400		
Sulphate (SO4) *	mg/l SO4	0.16	0 - 200	200 - 400	400 - 600	> 600		
Zinc (Zn) *	mg/l Zn		0 - 3	3 - 5	5 - 10	>10		
Ammonia (NH3)	mg/l NH3		-	-	-	-		
Ammonia (N) **	mg/l NH3		-	<2	2-10	>10		

SABS

VALUE	Rec Max	Max	COMMENTS
1	0.00	0.00	
14.53			
2.27			
9.00			
7.40	300.00	650.00	
6.94	9.00	9.50	
2.14	1.00	5.00	Maximum Allowable
	0.10	0.30	
	0.01	0.02	
1.30	ns	ns	
	300.00	650.00	
0.83	250.00	600.00	
0.01	1.00	1.50	
0.03	0.10	1.00	
1.00	70.00	100.00	
0.01	0.05	1.00	
0.05			
0.12	6.00	10.00	
1.00	ns	ns	
1.31	100.00	400.00	
0.16	200.00	600.00	
	1.00	5.00	
	ns	ns	
-	ns	ns	

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(Drinking)
[DWAF, WRC, Dep Health]

VALUE	GOOD	MARGINA	POOR	UNACCEPTABL	ACCEPTANCE LEVEL	COMMENTS
1.00	0-1	1-10	10-100	>100		
14.53						
2.27	70-150	150-370	370-520	>520		
9.00						
7.40	200-300	300-600	>600			
6.94	4.5-10	<4 - >10.5	<3 - >11	>11		
2.14	0.1-1	1-20	20-50	>50	Marginal	Possibility of secondary health effects
	0.01-0.05	0.05-2	0.2-2	>2		
	0.003-0.00	0.005-0.02	0.02-0.05	>0.05		
1.30	80-150	150 - 300	>300			
0.83	100-200	200-600	600-1200	>1200		
0.01	0.7-1	1-1.5	1.5-3.5	>3.5		
0.03	0.5-1	2-5	5-10	>10		
1.00	70-100	100-200	200-400	>400		
0.01	0.1-0.4	1.0-4	5-10	>10		
0.05						
0.12	6-10	10-20	20-40	>40		
1.00	25-50	50-100	100-500	>500		
1.31	100-200	200-400	400-1000	>1000		
0.16	200-400	400-600	600-1000	>1000		
	>20					
-						

Conclusion / Recommendation :

Water Class for general use (incl laundry, aesthetic, bathing, etc)	Class 2
Water Class for Drinking (Health Related)	Class 0

According to the above results)

Negative effects :
1) Feacal Coliforms

Check:
Ion Balance 4.96 %

Note: If Ion Balance error is higher than 5% or -5% the analysis is faulty and have to be reanalysed.

Guidelines for Treatment, Classification and Monitoring

Treatment:
TDS / EC / Sodium / Magnesium / Chloride :Desalination by ion exchange
Calcium : Precipitation with Sodium Carbonate
Iron : Normal coagulation and flocculation, sedimentation and filtration

Class I BH — Water suitable for long term utilization
Class II BH (Fit for interim use) — Borehole must be monitored on two monthly basis for the first year to monitor changes
Class III BH (Must be suitably treated) — Borehole must be monitored on a monthly basis for the first year to monitor changes

Note: Before a borehole is abandoned due to Class II or III analyses, it is recommended that a second sampled is taken to verify

Quote: The hydrogeological consultant will collect water samples for microbiological or bacteriological analysis in instances where this aspect of ground water quality is considered to represent a real concern (DWAF Minimum Standards Document, Part 1 - Section 4)

* **Key parameters for ground water acceptability for potable use (RDP Design Guidelines, October 1997)**
** **Parameters for ground water acceptability for potable use (South African Water Quality Guidelines: Volume 1: Domestic Use)**

QUALITY ANALYSIS

Borehole No.:	Spring 23	**CO-ORDINATES**		
Project No.:	LL1153	**Lat:**	29.57822	**Combination of :** **DWAF Minimum Standards document**
Village:	KwaNovuka	**Long:**	29.84028	**DWAF Design Criteria** **South African Drinking Standards**
District;	Impendle			

SABS

Quality of Domestic Water Supplies

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(Drinking) [DWAF, WRC, Dep Health]

SUBSTANCE	UNIT OF MEASURE	Value test	Class 0	Class 1	Class 2	Class 3	COMMENTS	VALUE (SABS)	Rec Max	Max	COMMENTS	VALUE	GOOD	MARGINAL	POOR	UNACCEPTABLE	ACCEPTANCE LEVEL	COMMENTS
Faecal coliform *	counts/100 ml	0	0	0-1	1 - 10	> 10		0	0.00	0.00		0.00	0-1	1-10	10-100	>100		
Total Dissolved Solids (TDS) *	(mg/l)	15.486	0 - 450	450-1000	1000 - 2450	> 2450		15.49				15.49						
Electrical conductivity EC *	mS/m	2.42	0 - 70	70 - 150	150 - 370	>370		2.42				2.42	70-150	150-370	370-520	>520		
Total Alkalinity	mg/l	9	-	-	-	-		9.00				9.00						
Total Hardness **	mg/l	7.7	-	<100	100-300	>300	Soft	7.70	300.00	650.00		7.70	200-300	300-600	>600			
Precipitation Potential			-	-	-	-												
pH *	pH units	7.02	6 - 9	5 - 6 or 9 - 9.5	4 - 5 or 9.5 - 10	<4 or >10		7.02	9.00	9.50		7.02	4.5-10	<4 - >10.5	<3 - >11	>11		
Turbidity	NTU	0.452	-	-	-	-		0.45	1.00	5.00		0.45	0.1-1	1-20	20-50	>50		
Arsenic (As) *	mg/l As		0 - 0.01	0.01 - 0.05	0.05 - 0.2	> 0.2			0.10	0.30			0.01-0.05	0.05-2	0.2-2	>2		
Cadmium (Cd) *	mg/l Cd		0 - 0.005	0.005 - 0.01	0.01 - 0.02	>0.02			0.01	0.02			0.003-0.00	0.005-0.02	0.02-0.05	>0.05		
Calcium (Ca)	mg/l Ca	1.43	0 - 32	32	32-80	>80		1.43	ns	ns		1.43	80-150	150 - 300	>300			
Calcium (CaCo3)	mg/l CaCO3		0 - 80	80	80-200	>200			300.00	650.00								
Chloride (Cl) *	mg/l Cl	0.89	0 - 100	100 - 200	200 - 600	> 600		0.89	250.00	600.00		0.89	100-200	200-600	600-1200	>1200		
Fluoride (F) *	mg/l F	0.01	0 - 1	1 - 1.5	1.5 - 3.5	>3.5		0.01	1.00	1.50		0.01	0.7-1	1-1.5	1.5-3.5	>3.5		
Iron (Fe) *	mg/l Fe	0.02	0 - 0.1	0.1 - 0.2	0.2 - 2	> 2.0		0.02	0.10	1.00		0.02	0.5-1	2-5	5-10	>10		
Magnesium (Mg)	mg/l Mg	1	0 - 30	30 - 70	70 - 100	> 100		1.00	70.00	100.00		1.00	70-100	100-200	200-400	>400		
Magnesium (MgCo3) *	mg/l MgCO3		-	-	-	-												
Manganese (Mn) *	mg/l Mn	0.01	0 - 0.05	0.05 - 0.1	0.1 - 1.0	>1		0.01	0.05	1.00		0.01	0.1-0.4	1.0-4	5-10	>10		
Nitrate (as NO3) *	mg/l N	0.05	-	-	-	-		0.05				0.05						
Nitrate (as N) *	mg/l N	0.14	0 - 6	6 - 10	10 - 20	>20		0.14	6.00	10.00		0.14	6-10	10-20	20-40	>40		
Potassium (K) *	mg/l K	1	0 - 50	50 - 100	100 - 400	> 400		1.00	ns	ns		1.00	25-50	50-100	100-500	>500		
Sodium (Na) *	mg/l Na	1.46	0 - 100	100 - 200	200 - 400	> 400		1.46	100.00	400.00		1.46	100-200	200-400	400-1000	>1000		
Sulphate (SO4) *	mg/l SO4	0.16	0 - 200	200 - 400	400 - 600	> 600		0.16	200.00	600.00		0.16	200-400	400-600	600-1000	>1000		
Zinc (Zn) *	mg/l Zn		0 - 3	3 - 5	5 - 10	>10			1.00	5.00			>20					
Ammonia (NH3)	mg/l NH3		-	-	-				ns	ns								
Ammonia (N) **	mg/l NH3	-	-	<2	2-10	>10		-	ns	ns		-						

Conclusion / Recommendation :

Water Class for general use (incl laundry, aesthetic, bathing, etc)	Class 0
Water Class for Drinking (Health Related)	Class 0

According to the above results)

Negative effects :

Check:
Ion Balance 7.30 %

Note: If Ion Balance error is higher than 5% or -5% the analysis is faulty and have to be reanalysed

Guidelines for Treatment, Classification and Monitoring

Treatment:
TDS / EC / Sodium / Magnesium / Chloride :Desalination by Ion exchange
Calcium : Precipitation with Sodium Carbonate
Iron : Normal coagulation and flocculation, sedimentation and filtration

Class I BH — Water suitable for long term utilization
Class II BH (Fit for interim use) — Borehole must be monitored on two monthly basis for the first year to monitor changes
Class III BH (Must be suitably treated) — Borehole must be monitored on a monthly basis for the first year to monitor changes

Note: Before a borehole is abandoned due to Class II or III analyses, it is recommended that a second sampled is taken to verify

Quote: The hydrogeological consultant will collect water samples for microbiological or bacteriological analysis in instances where this aspect of ground water quality is considered to represent a real concern (DWAF Minimum Standards Document, Part 1 - Section 4)

* **Key parameters for ground water acceptability for potable use (RDP Design Guidelines, October 1997)**
** **Parameters for ground water acceptability for potable use (South African Water Quality Guidelines: Volume 1: Domestic Use)**

QUALITY ANALYSIS

Borehole No.:	Spring 25	**CO-ORDINATES**		
Project No.:	LL1153	**Lat:**	29.57233	**Combination of :** **DWAF Minimum Standards document**
Village:	KwaNovuka	**Long:**	29.87025	**DWAF Design Criteria** **South African Drinking Standards**
District;	Impendle			

SUBSTANCE	UNIT OF MEASURE	Value test	Class 0	Class 1	Class 2	Class 3	COMMENTS
Faecal coliform *	counts/100 ml	0	0	0-1	1 - 10	> 10	
Total Dissolved Solids (TDS) *	(mg/l)	18 112	0 - 450	450-1000	1000 - 2450	> 2450	
Electrical conductivity EC *	mS/m	2.83	0 - 70	70 - 150	150 - 370	>370	
Total Alkalinity	mg/l	9		-	-	-	
Total Hardness **	mg/l	8.7		<100	100-300	>300	Soft
Precipitation Potential			-	-	-	-	
pH *	pH units	7.28	6 - 9	5 - 6 or 9 - 9.5	4 - 5 or 9.5 - 10	<4 or >10	
Turbidity	NTU	1.13	-		-		
Arsenic (As) *	mg/l As		0 - 0.01	0.01 - 0.05	0.05 - 0.2	> 0.2	
Cadmium (Cd) *	mg/l Cd		0 - 0.005	0.005 - 0.01	0.01 - 0.02	>0.02	
Calcium (Ca)	mg/l Ca	1.82	0 - 32	32	32-80	>80	
Calcium (CaCo3)	mg/l CaCO3		0 - 80	80	80-200	>200	
Chloride (Cl)*	mg/l Cl	0.93	0 - 100	100 - 200	200 - 600	> 600	
Fluoride (F) *	mg/l F	0.01	0 - 1	1 - 1.5	1.5 - 3.5	>3.5	
Iron (Fe) *	mg/l Fe	0.04	0 - 0.1	0.1 - 0.2	0.2 - 2	> 2.0	
Magnesium (Mg)	mg/l Mg	1	0 - 30	30 - 70	70 - 100	> 100	
Magnesium (MgCo3) *	mg/l MgCO3			-	-	-	
Manganese (Mn) *	mg/l Mn	0.01	0 - 0.05	0.05 - 0.1	0.1 - 1.0	>1	
Nitrate (as NO3) *	mg/l N	0.05	-		-		
Nitrate (as N) *	mg/l N	0.07	0 - 6	6 - 10	10 - 20	>20	
Potassium (K) *	mg/l K	1	0 - 50	50 - 100	100 - 400	> 400	
Sodium (Na) *	mg/l Na	2.18	0 - 100	100 - 200	200 - 400	> 400	
Sulphate (SO4) *	mg/l SO4	0.16	0 - 200	200 - 400	400 - 600	> 600	
Zinc (Zn) *	mg/l Zn		0 - 3	3 - 5	5 - 10	>10	
Ammonia (NH3)	mg/l NH3				-		
Ammonia (N) **	mg/l NH3			<2	2-10	>10	

SABS

SUBSTANCE	VALUE	Rec Max	Max	COMMENTS
Faecal coliform	0	0.00	0.00	
Total Dissolved Solids (TDS)	18.11			
Electrical conductivity EC	2.83			
Total Alkalinity	9.00			
Total Hardness	8.70	300.00	650.00	
Precipitation Potential				
pH	7.28	9.00	9.60	
Turbidity	1.13	1.00	5.00	Maximum Allowable
Arsenic (As)		0.10	0.30	
Cadmium (Cd)		0.01	0.02	
Calcium (Ca)	1.82	ns	ns	
Calcium (CaCo3)		300.00	650.00	
Chloride (Cl)	0.93	250.00	600.00	
Fluoride (F)	0.01	1.00	1.50	
Iron (Fe)	0.04	0.10	1.00	
Magnesium (Mg)	1.00	70.00	100.00	
Magnesium (MgCo3)				
Manganese (Mn)	0.01	0.05	1.00	
Nitrate (as NO3)	0.05			
Nitrate (as N)	0.07	6.00	10.00	
Potassium (K)	1.00	ns	ns	
Sodium (Na)	2.18	100.00	400.00	
Sulphate (SO4)	0.16	200.00	600.00	
Zinc (Zn)		1.00	5.00	
Ammonia (NH3)		ns	ns	
Ammonia (N)	-	ns	ns	

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(Drinking)
[DWAF, WRC, Dep Health]

SUBSTANCE	VALUE	GOOD	MARGINA	POOR	UNACCEPTABL	ACCEPTANCE LEVEL	COMMENTS
Faecal coliform	0.00	0-1	1-10	10-100	>100		
Total Dissolved Solids (TDS)	18.11						
Electrical conductivity EC	2.83	70-150	150-370	370-520	>520		
Total Alkalinity	9.00						
Total Hardness	8.70	200-300	300-600	>600			
Precipitation Potential							
pH	7.28	4.5-10	<4 - >10.5	<3 - >11	>11		
Turbidity	1.13	0.1-1	1-20	20-50	>50	Marginal	Possibility of secondary health effects
Arsenic (As)		0.01-0.05	0.05-2	0.2-2	>2		
Cadmium (Cd)		0.003-0.0	0.005-0.02	0.02-0.05	>0.05		
Calcium (Ca)	1.82	80-150	150 - 300	>300			
Calcium (CaCo3)							
Chloride (Cl)	0.93	100-200	200-600	600-1200	>1200		
Fluoride (F)	0.01	0.7-1	1-1.5	1.5-3.5	>3.5		
Iron (Fe)	0.04	0.5-1	2-5	5-10	>10		
Magnesium (Mg)	1.00	70-100	100-200	200-400	>400		
Magnesium (MgCo3)							
Manganese (Mn)	0.01	0.1-0.4	1.0-4	5-10	>10		
Nitrate (as NO3)	0.05						
Nitrate (as N)	0.07	6-10	10-20	20-40	>40		
Potassium (K)	1.00	25-50	50-100	100-500	>500		
Sodium (Na)	2.18	100-200	200-400	400-1000	>1000		
Sulphate (SO4)	0.16	200-400	400-600	600-1000	>1000		
Zinc (Zn)		>20					
Ammonia (NH3)							
Ammonia (N)	-						

Check:
Ion Balance 16.40 %

Note: If Ion Balance error is higher than 5% or -5% the analysis is faulty and have to be reanalysed.

Conclusion / Recommendation :

Water Class for general use (incl laundry, aesthetic, bathing, etc)	Class 0
Water Class for Drinking (Health Related)	Class 0

According to the above results)

Negative effects :

Guidelines for Treatment, Classification and Monitoring

Treatment:
TDS / EC / Sodium / Magnesium / Chloride :Desalination by Ion exchange
Calcium : Precipitation with Sodium Carbonate
Iron : Normal coagulation and flocculation, sedimentation and filtration

Class I BH — Water suitable for long term utilization
Class II BH (Fit for interim use) — Borehole must be monitored on two monthly basis for the first year to monitor changes
Class III BH (Must be suitably treated) — Borehole must be monitored on a monthly basis for the first year to monitor changes

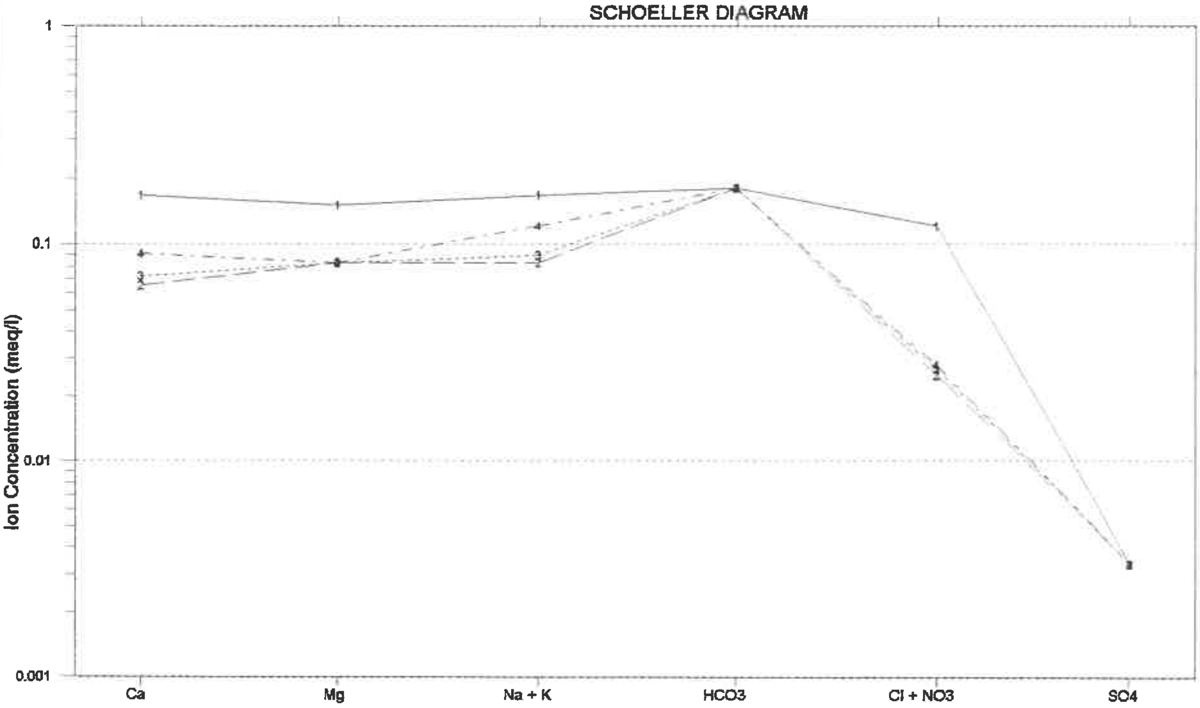
Note: Before a borehole is abandoned due to Class II or III analyses, it is recommended that a second sampled is taken to verify

Quote: The hydrogeological consultant will collect water samples for microbiological or bacteriological analysis in instances where this aspect of ground water quality is considered to represent a real concern (DWAF Minimum Standards Document, Part 1 - Section 4)

* **Key parameters for ground water acceptability for potable use (RDP Design Guidelines, October 1997)**
** **Parameters for ground water acceptability for potable use (South African Water Quality Guidelines: Volume 1: Domestic Use)**

DIAGRAMS
PIPER PLOTS
DUROV DIAGRAMS

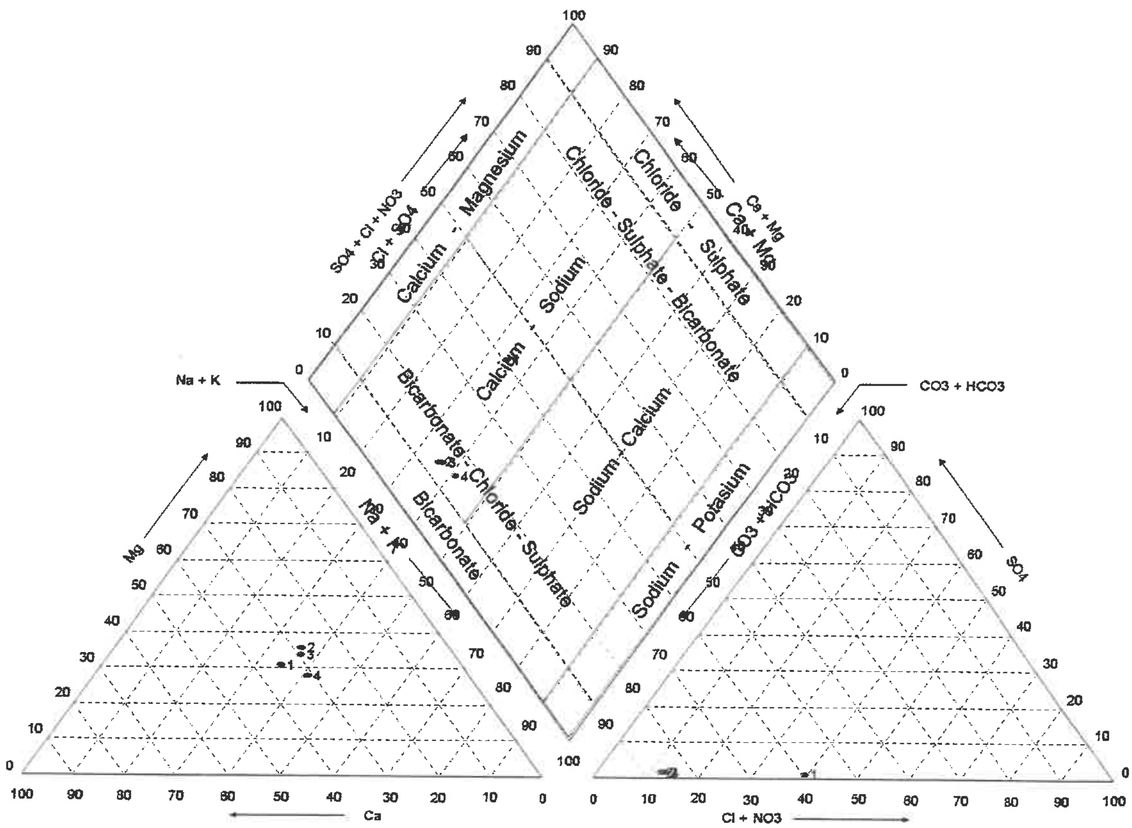
SCHOELLER DIAGRAM



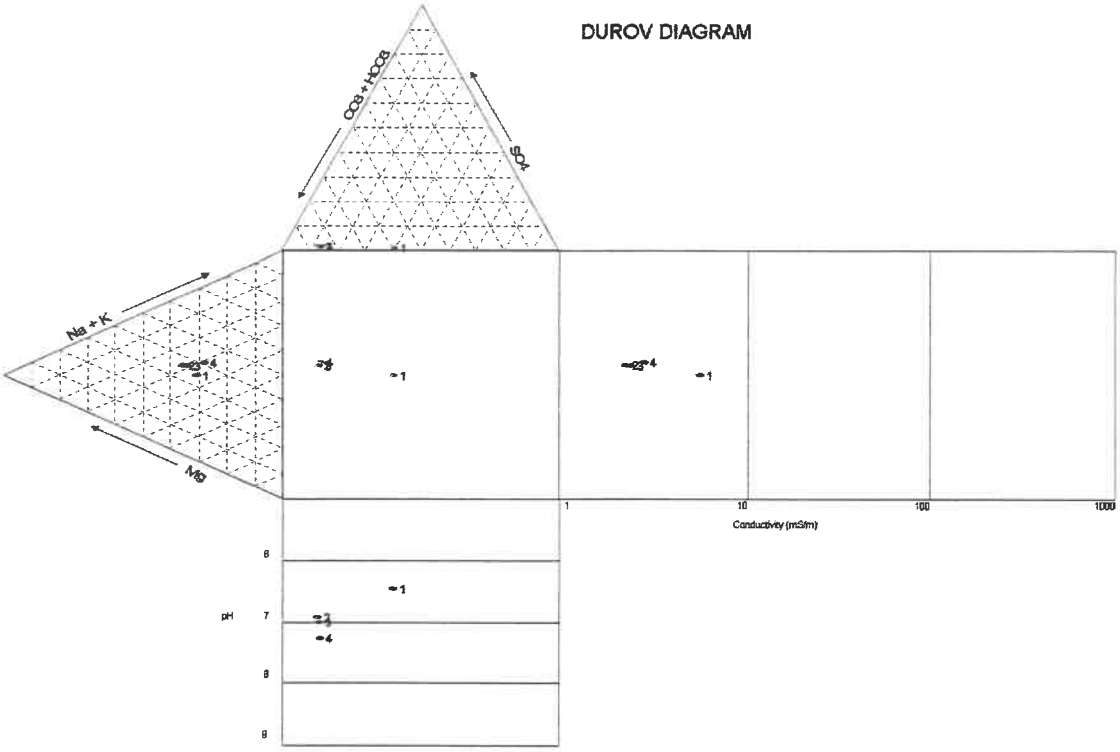
Plot ID	Sample ID
1	Spring 19
2	Spring 22
3	Spring 23
4	Spring 25

1	Spring 19
2	Spring 22
3	Spring 23
4	Spring 25

PIPER DIAGRAM

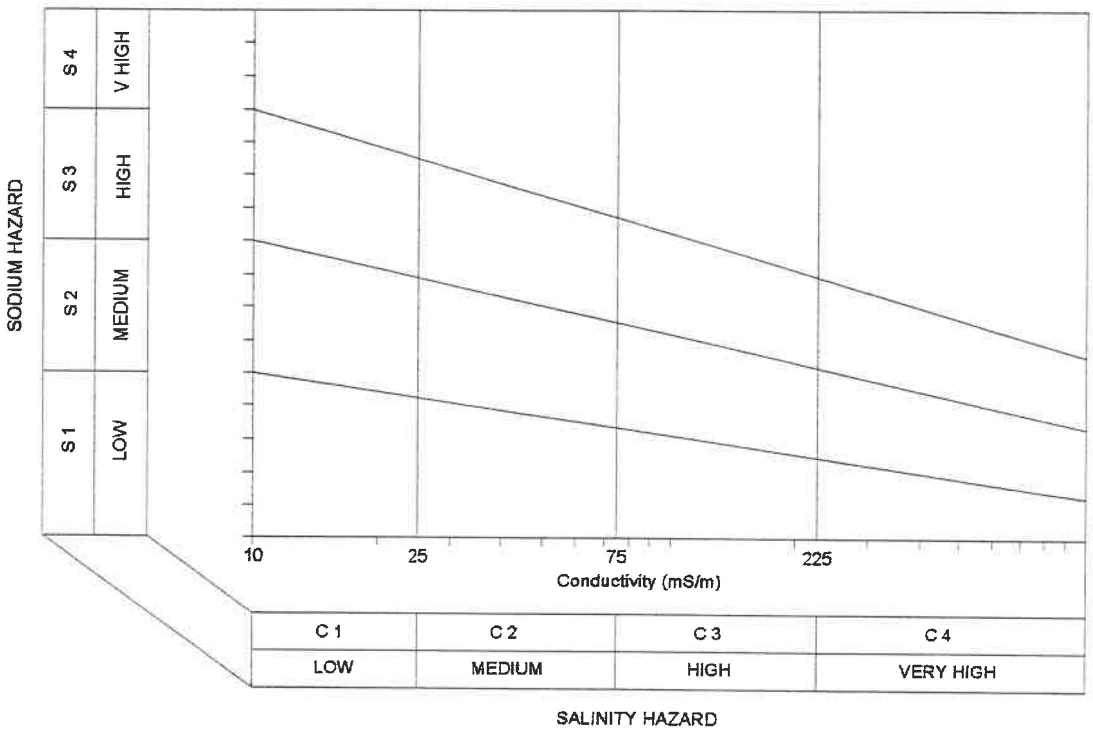


DUROV DIAGRAM



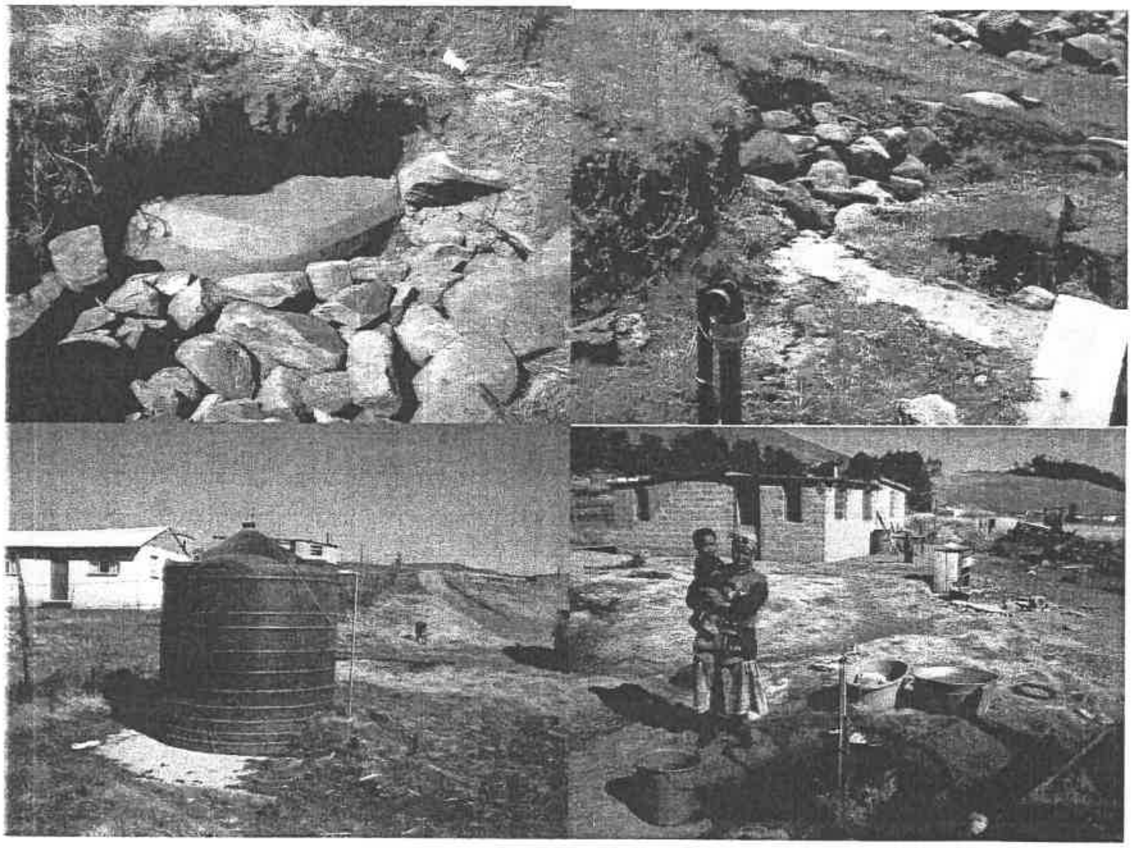
Plot ID	Sample ID
1	Spring 19
2	Spring 22
3	Spring 23
4	Spring 25

SODIUM ADSORPTION RATIO DIAGRAM



EXISTING INFORMATION
KWANOVUKA SPRING PROTECTION
2002 DROUGHT RELIEF PROGRAMME

Project Name: Novuka



Project Area: Novuka   Project Type: Spring Protection
Installation Type: Protection and reservoirs with standpipes.

Source ID	Village	Flow Rate	Latitude	Longitude	Protection Contractor	Date	Geohydrological Consultant	Comments
NOV-1	Novuka	1000 l/hour	29/ 34' 45"	29/ 50' 19"	Pollard Drilling	15/6/2002	Engeocon CC	

Novuka Spring Protection

1. The existing (old) protection was unsuccessful in supplying clear water to the community mainly due to the manner in which it was protected. The total protection area was larger than the current protection, but yielded less water. Excess water was leaking from the existing structure providing cattle and other animals ample opportunity to contaminate the source. The new protection structure (see photo 1) captures all the available water and channels it to the first storage reservoir. In other words, the total volume of water that is yielded by the spring is captured. Some community members believe that by enlarging the protection area i.e. a larger dam will yield more water, but unfortunately this is not true. Community education is required in this regard.

2. The existing 12.5mm diameter pipe was removed and replaced with a 25mm diameter pipe. The reason being that the hydraulic gradient (amount of vertical fall) from the spring source to the reservoir is approximately 2m only (over a distance of almost 800m). Due to the small hydraulic gradient and frictional losses over 800m, it is almost impossible for the water to flow freely from the spring to the reservoir without encountering pressure problems. It was decided that the larger diameter pipe would reduce the frictional and provide a bigger volume of water, even though only 400m was replaced. The community was advised to use the removed 12.5mm pipe and extend the rest of the pipeline with this second pipe. This would result in even a bigger volume of water reaching the reservoir quicker.
3. A second reservoir was also installed on the other side of the community. This was done in order to provide all the excess water to be stored for use by the furthest part of the community. When water is in excess at the first storage reservoir, it is channeled to the second stage reservoir. (see photo 2 on previous page)

Problems noted upon inspection

- Three or four households receive water to their standpipe taps directly from the supply line and not from the storage reservoir. This results in loss of pressure and airlocks, which hamper the supply to the storage reservoir.
- When the valve is closed at the first storage reservoir, the reservoir is filled providing that the taps on the supply line is not opened. Leaks on these lines further result in loss of water to the storage tank. When the valve is opened at the first storage tank, water loss is dramatic and there is no flow to the second storage tank.
- The yield of the spring has been reduced due to the long drought period and this is also a major contributing factor to the water shortage in the community.
- Water is lost through the leaks in the system and there has been an increase in water consumption.

CONCLUSION

No fault could be found with the construction or protection of the water source. See included photos on previous page indicating water from spring source to reservoir (photo 3 taken on 13/12/2002) and water being used in the community (photo 4).
The yield of the spring has been reduced during the dry season and does not yield sufficient water in order to supply the entire community with potable water. Water demand has increased and the community is in desperate need of alternative water sources. (Such as additional springs or boreholes).