REPORT

for

LIMPOPO DEPARTMENT OF AGRICULTURE
RESIS PROGRAMME

by the
INSTITUTE FOR SOIL CLIMATE AND WATER
AGRICULTURAL RESEARCH COUNCIL

RESIS PROJECT: SOIL SURVEY FOR SEHOLOKOANE, UPPER CORK, MKHUHLU WEST and MKHUHLU EAST IRRIGATION SCHEMES

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Irrigation potential classes

Mkhuhlu West					Total
Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	
1.6 ha	-	4.9 ha	15 ha	-	**21.5 ha**
7.44%	-	22.79%	69.77	-	100 %
Mkhuhlu East.					
Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	
2.3 ha	-	50.3 ha	48.3 ha	23.7 ha	**124.6 ha**
1.84%	-	40.37%	38.76%	19.0%	100%
Seholokoane					
Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	
10.5 ha	-	51.8 ha	18 ha	61 ha	**141.3 ha**
7.43%	-	36.66%	12.73%	43.18%	100%
Upper Cork					
Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	
1.5 ha	-	50.8 ha	55.1 ha	9.2 ha	**116.6 ha**
1.28%	-	43.56%	47.26%	7.89%	100%

EXECUTIVE SUMMARY

Theoretically any type of soil is irrigable if enough capital and management skills are available. These ideal conditions are however seldom, if ever, present and the Mkhulu West, Mkhulu East, Seholokoane and Upper Cork irrigation projects are no exception. Successful irrigation schemes are based on, among other things, a sound knowledge of the soil and water quality concerned.

The majority of the soils at Mkhulu West, Mkhulu East, Seholokoane and Upper Cork cannot be regarded as irrigable. The soils of Irrigation Potential Class 1 cover an area of only 15.9 ha (3.9%). These soils have an effective depth in excess of 900 mm and clay content between 15% and 25%. The soils of Irrigation Class 3 cover an area of 157.8 ha (39%). The reason for being allocated to Irrigation Class 3 is the high coarse material content of the soils, very high or very low clay content. The soils of Irrigation Potential Class 4 and 5 are not suitable for irrigation and cover an area of 230.3 ha (57%). These soils are shallow with rock outcrops.

The infiltration rate is 40 mm/h for the soils in Irrigation Potential Class 1 and fluctuates between 10 and 95 mm/h for soils in Irrigation Potential Class 3. The water holding capacity of the soils in Irrigation Potential Class 1 ranges from 100 to 135 mm/m and for Irrigation Potential Class 3 from 40 to 190 mm/m.

Most of the soils are prone to water logging and would need internal and external drainage systems. Reclamation in terms of sodicity and salinity would be required in the future.

The soil reaction is slightly acid to strongly alkaline, with a pH_{water} range between 6.24 and 8.60. The high pH values may result in deficiency and/or toxicity of some elements in certain crops. The soils appear to have low potassium (K) and phosphorus (P) status. Strict adherence to standard reference methods is important for correct interpretation of soil analyses for fertilizer application.

Because the electrical conductivity values of the saturation extract are mostly below the 100 mS/m threshold value, salt-sensitive crops such as beans, carrots, onions, mango and avocados could be grown, subject to other determining factors being met.

The water is suitable for domestic and livestock use. The water is, however, not in chemical equilibrium and it would be corrosive. The water may necessitate premature replacement of pipes, irrigation canals and other irrigation equipment. The resistance of concrete to corrosion as a result of dissolution of lime by low salinity water can be increased by the use of good quality concrete.

1. TERMS OF REFERENCE

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was contracted by Tshwane Consulting Engineers (PTY) Ltd to conduct a detailed soil investigation for irrigation rehabilitation planning of the Mkhuhlu West, Mkhuhlu East, Seholokoane and Upper Cork area in the Limpopo Province. This is part of the RESIS Programme for the Limpopo Department of Agriculture.

The objectives of the study were to determine the soil physical and chemical characteristics in terms of soil type, soil depth, soil texture, soil structure and chemical status in order to evaluate the irrigation potential of the soils, which will form the basis for planning and reconstruction of the schemes.

2. SITE CHARACTERISTICS

2.1 Location

The surveyed areas are about 14 km north east of Hazyview in the Limpopo Province. The location of the surveyed areas can be seen in Figure 1, with the coordinates lying between 24°58'S to 25°00'S and 31°14'E to 31°19'E. A total of 21.5 ha at Mkhulu West, 124.6 ha at Mkhulu East, 141.3 ha at Seholokoane and 116.6 ha at Upper Cork were surveyed.

2.2 Terrain

The surrounding area consists of plains with moderate relief with low to medium drainage density and low to medium stream frequency, lying at an altitude of around 350 metres above sea level (Kruger, 1983). The study areas slope down to the Sabie River and are mainly composed of moderately to strongly sloping midslopes and level to gently sloping river terraces adjacent to the river that, in turn, are dissected by a variety of secondary valley bottoms.

2.3 Climate

The climate of the region is obtained from the Hazyview weather station (AgroMet No. 0556/212LO - ISCW) which is the nearest long term station for the studied areas (Table 1). The long-term average annual rainfall is 887.2 mm, of which 748.2 mm, or 84.3%, falls from October to March. The average evaporation over the same period is 1383.1 mm. Temperatures vary from an average daily maximum and minimum of 30.5ºC and 19.4ºC for January to 24.6ºC and 7.7ºC for July respectively.

TABLE 1: Climate Data

Month	Average Rainfall (mm)	A-Pan Evaporation (mm)	Daily Min. Temp (°C)	Daily Max. Temp (°C)
Jan	151.2	148.9	19.4	30.5
Feb	154.6	120.6	19.3	30.2
Mar	111.2	120.5	18.3	29.5
Apr	54.4	90.8	15.2	28.0
May	20.3	92.2	11.2	26.4
Jun	8.5	91.8	7.9	24.7
Jul	8.7	97.0	7.7	24.6
Aug	13.1	111.9	9.7	26.1
Sep	34.1	129.7	12.9	27.9
Oct	60.3	136.8	15.3	28.3
Nov	116.6	128.4	17.0	28.9
Dec	154.3	114.5	18.5	30.0
Year	**887.3 mm**	**1 383.1 mm**	**21.2°C (Average)**	

2.4 Geology

The geology of the area comprises intrusive rocks of the Timbavati Gabbro and Nelspruit Granite Suite. The lithology of the Timbavati Gabbro includes medium to course-grained gabbro, olivine gabbro and quartz gabbro. The Nelspruit Granite Suite consists of quartz-microcline-plagioclase-biotite migmatite and gneiss with abundant mafic and ultra mafic xenoliths. In the Nelspruit Granite Suite are some intrusions of green, fine to medium grained diabase. (Geological Survey, 1986).

2.5 Vegetation

According to Low & Rebelo, (1996) the dominant vegetation type is that of Mixed Lowveld Bushveld and falls into the Savanna Biome. This vegetation type can be described variously as dense bush on the uplands, open tree savanna in the bottomlands and dense riverine woodland on riverbanks. The vegetation varies from a tree layer to a moderately developed shrub layer, with a poorly to moderately developed grass layer. The Mixed Lowveld Bushveld occurs on flat to undulating landscapes at altitudes from 350 to 500 m and is confined to a frost-free area, with frequent fires and general grazing by cattle and game.

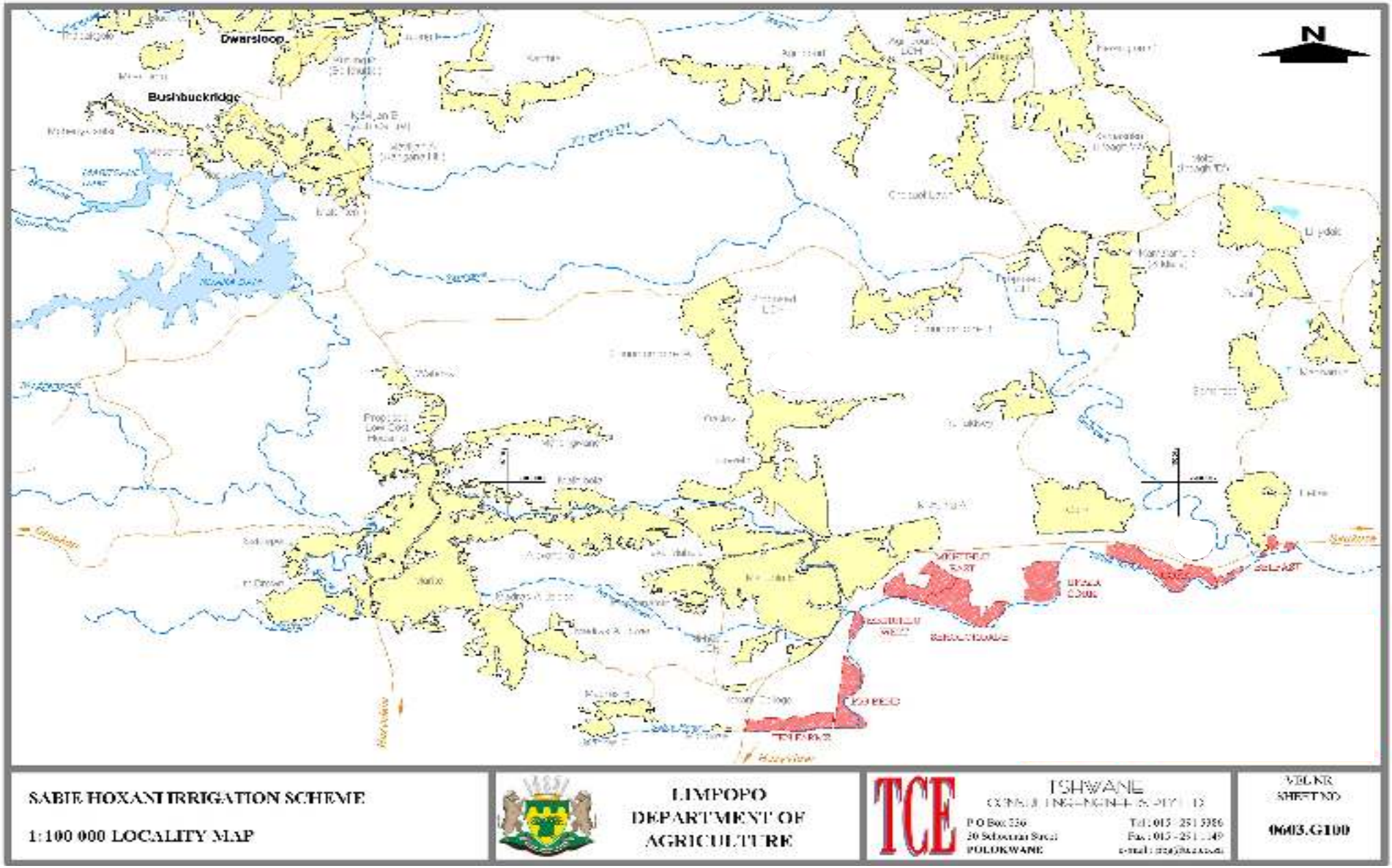

FIGURE 1: Locality Map

3. METHODOLOGY

The survey and observations were done on a fixed grid of 150 x 150 m. The coordinates of these points were loaded onto a Global Positioning System to locate the positions of the points in the field. The survey was conducted using a hand auger to a depth of 1.2 m or shallower, if a restricting layer such as rock was encountered.

Five soil profile pits were dug, described and sampled in the different soil units. About 197 observations were made, described and classified according to the Taxonomic System for South Africa (Soil Classification Working Group, 1991). The following soil characteristics were described for each point; soil form and family, soil depth, depth limiting material, clay % and soil colour of each horizon.

Soil and water samples were analyzed in the laboratories of the ISCW according to methods described by the Non-Affiliated Soil Analysis Work Committee (1991). Each sample was analyzed for particle size distribution (7 fractions), $pH_{(H_2O)}$, P (Bray 1). Cation exchange capacity (CEC), calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na) were determined according to the ammonium acetate method. A saturation extract was also prepared and the values for electrical conductivity (EC), Na, Ca, Mg, chloride (Cl) and sulphate (SO_4) were determined. Each water sample was analyzed for pH, pH_s, EC, alkalinity, hardness, carbonate, bicarbonate and the basic anions and cations. The methods of Ratliff *et al.* (1983) and Shulze *et al.* (1985) were used to determine water holding capacity. The norms of Bornman *et al.* (1989) were use for phosphate and potassium classification.

Five maps were generated to show the soil classification information and processed soil results. The maps comprise a soil map, a clay content map of the A-horizon, a clay content map of the B-horizon, an effective soil depth map and an irrigation potential map shown in Figures 2.1 -2.5 respectively. Classifying and manually grouping of soils with similar soil properties resulted in a soil map consisting of soil units. The clay content and effective depth maps were generated by spatial data processing of the information gathered at each field observation point.

The maps were spatially referenced using the Longitude of Origin (LO30) coordinate system and 30° parallel based on the WGS 1984 spheroid and Hartebeesthoek 1994 Datum. The spatial distribution of soil data gathered at each observation point was interpolated using the Inverse Distance Weighted method of the Spatial Analyst extension of ArcGIS 9.0 software as follows: A grid of 10 m x 10 m cells was generated throughout the extent of surveyed area. The point data as gathered in the field (e.g. soil depth) was interpolated using the values of the 8 nearest neighbouring points to give each cell a weighted value. The weighted cell values were categorized (e.g. 0 – 300 mm). Each category was then reclassified to give all the cells in a specific category the same value. The categories with the same cell values were then converted to regions, which give each cluster of cells with the same value a unique identity. A mask was generated to identify very small regions (small clusters with less than 9 cells or < 0.1 ha). Each cell in these small clusters was then merged with the dominant surrounding cells of bigger regions. These regions were then converted to a vector format, which consists of polygons.

Procedures for the assessment of land for irrigation development in South Africa have been reviewed by Irrigation Planning Staff (1980), Hensley & Laker (1980), Bester & Liengme (1989), Dohse *et al* (1991) and Nell (1991).

The following irrigation classes were used:

- Class 1 – Highly suitable for irrigation with few or no limitations or preconditions. Topography is flat, soils are well drained, of moderate permeability and are deep, medium textured with good available water holding capacity.
- Class 2 – Suitable for irrigation with slight limitations such as undulating topography, moderately well drained soils, moderately slow or moderately rapid permeability or moderate depth of soil.
- Class 3 – Low suitability with moderately severe limitations such as significantly rolling topography, imperfect or somewhat excessively drained soils, slow or rapid permeability, or shallow soils.
- Class 4 – Not suitable for irrigation under most conditions with severe limitations.
- Class 5 – Soils with severe limitations, not recommended at all, such as soils in natural waterways, soils in the river floodplain, soils presently

eroded or soils showing the presence of any permanent or potential water table.

Soil depth provides the volume of soil material for root development, water storage and nutrient uptake. Effective soil depth can be considered as the depth freely permeable to plant roots and water. The derived irrigation potential classes used in terms of soil depth are:

- Class 1 – 900 to 1500 mm
- Class 2 – 600 to 900 mm
- Class 3 – 300 to 600 mm
- Class 4 – 150 to 300 mm
- Class 5 – 0 to 150 mm

Soil wetness is a reflection of the rate at which water is removed from the soil by both runoff and percolation. Position, slope, infiltration rate, surface runoff, permeability, and redoximorphic features are significant factors influencing the soil wetness class. Profile morphology is used to determine the depth of water saturation and the maximum height of signs of hydromorphy is used as depth limit.

- Class 1: Not wet above 150 cm
- Class 2: Wet in some part between 100 and 150 cm
- Class 3: Wet in some part between 50 and 100 cm
- Class 4: Wet in some part between 25 and 50 cm
- Class 5: Wet in some part above a depth of 25 cm

Soils with more than 10% and less than 35% clay and without significant different textural layers are considered irrigable (Irrigation Class 1). Soils with distinct different textural layers, less than 10% clay and more than 35% clay were classified as irrigation class 3 or more.

Irrigation classes 1 and 2 can be recommended for irrigation. Irrigation class 3 is normally not recommended for large-scale irrigation development under average conditions, but small areas may be considered if they adjoin or are enclosed by areas of irrigation classes 1 and 2.

4. SOILS

4.1 Mkhuhlu West, Mkhuhlu East, Seholokoane and Upper Cork

4.1.1 Irrigation potential

The irrigation potential of the soils at Mkhuhlu West, Mkhuhlu East, Seholokoane and Upper Cork falls into Irrigation Classes 1, 3, 4 and 5 (Figure 2.1). The soils were divided into the Irrigation Classes predominantly on the basis of water logging potential, effective depth, percentage surface stone and coarse material in the subsoil, texture and difference in texture between horizons.

The soils of Irrigation Class 1 cover an area of 1.84% (2.3 ha) at Mkhuhlu East, 7.44% (1.6 ha) at Mkhuhlu West, 7.43% (10.5 ha) at Seholokoane and 1.28% (1.5 ha) at Upper Cork. These soils have an effective depth deeper than 1 200 mm (Figure 2.4) clay content in the A horizon between 15% and 22% (Figure 2.2) and in the B horizon between 18% and 25% (Figure 2.3).

The soils of Irrigation Class 3 cover an area of 40.37% (50.3 ha) at Mkhuhlu East, 22.79% (4.9 ha) at Mkhuhlu West, 7.43% (10.5 ha) at Seholokoane and 36.66% (51.8 ha) at Upper Cork. These soils have an effective depth of mostly shallower than 600 mm (Figure 2.4), clay content in the A horizon between 6% and 55% (Figure 2.2) and in the B/E horizon between 6% and 45% (Figure 2.3). The reason for being allocated to Irrigation Class 3 is the high coarse material content of the soils, very high or very low clay content.

The soils of Irrigation Class 4 and Irrigation Class 5 cover an area of 57.76% (72 ha) at Mkhuhlu East, 22.79% (4.9 ha) at Mkhuhlu West, 69.77% (15 ha) at Seholokoane and 55% (64.3 ha) at Upper Cork and have an effective depth of mostly between 0 to 300 mm. The reasons for being allocated to Irrigation Class 4 and Irrigation Class 5 are the limited effective depth and because some of these soils occur in the natural drainage channel.

4.1.2 Soil physical status

According to Figure 2.4, only 0.7 ha at Mkhuhlu West, 3.2 ha at Upper Cork and 15.7 ha at Mkhuhlu East and Seholokoane, has an effective soil depth between 900 and 1 200 mm and deeper, 18.9 ha at Upper Cork and 71.2 ha at Mkhuhlu East and Seholokoane has an effective soil depth between 600 mm and 900 mm, 9.8 ha

at Mkhuhlu West, 44.0 ha at Upper Cork and 146.4 ha at Mkhuhlu East and Seholokoane, has an effective soil depth between 300 mm and 600 mm and 10.9 ha at Mkhuhlu West, 50.5 ha at Upper Cork and 32.6 ha at Mkhuhlu East and Seholokoane, has an effective soil depth between 200 mm and 300 mm.

At Mkhuhlu West and Upper Cork, the clay content in the A horizon is mostly between 10 and 22% and at Mkhuhlu East and Seholokoane between 20 and 35%. The clay content in the B- horizon is mostly between 20 and 35% (Fig 2.3).

The water holding capacity of the soils in map unit *Oa1* ranges from 100 to 135 mm/m, map unit *Cf* ranges from 40 to 90 mm/m, map unit *Bo* ranges from 160 to 170 mm/m, map unit *Oa2* ranges from 120 to 180 mm/m, map unit *Va* ranges is from 170 to 190 mm/m, map unit *We* ranges from 100 to 160 mm/m and map unit *Gs* ranges from 170 to 190 mm/m.

The expected infiltration rate of the soils in map units *Bo* and *Va* is 10 mm/h, map unit *Oa1* 40 mm/h, map unit *Cf* 95 mm/h, map unit *Oa2* 15 mm/h, map unit *We* 12 mm/h and map unit *Gs* 35 mm/h.

Erosion can be problematic in the natural watercourse, where duplex soils occur and on the shallow soils near granite outcrops.

4.1.3 Soil chemical status

The soil reaction is slightly acid to strongly alkaline, with a pH_{water} range between 6.20 (JPN 61 – Upper Cork) and 8.54 (JPN 31 - Mkhulu East). The high alkalinity may result in deficiency and/or toxicity of some elements in certain crops. High pH soils may have an inadequate availability of iron, manganese, copper, zinc and especially phosphorus. The alkaline soils belong to the Valsrivier, Westleigh, Bonheim and Kroonstad soil forms.

The dominant exchangeable cation in the soil is mostly calcium. The dominant soluble cation is mostly sodium and the dominant soluble anion is mostly chloride.

Some of the subsoils (Profiles JPN 23 and JPN 34) are sodic, with high ESP (exchangeable sodium percentage) and SAR (sodium adsorption ratio) values. The sodic conditions in the subsoil are an indication of poor internal drainage capacity of the soil and the resulting water logging conditions found. The soils are mostly not saline (low electrical conductivity values). Salt sensitive crops such as beans, carrots, onions, mango and avocados can be grown, because the electrical conductivity values are below the 100 mS/m threshold value.

The CEC (cation exchange capacity) of the soils, which ranges from 9.98 cmol (+) kg^{-1} (JPN 34) to 35.19 cmol(+)kg^{-1} (JPN 31), is an indication of the good capacity of the soil to retain and supply water and plant nutrients.

Strict adherence to standard reference methods is important for correct interpretation of soil analyses for fertilization. The critical periods when nutrients are most required are soon after germination, during the period of rapid vegetative growth, and for fruiting crops, at about the time of fruit production. The fertilizer should be applied at the right time and at the right place. The P values range from 0.69 (JPN 43) to 35.33 mg/kg (JPN 31) and attention should be given to the improvement of the fertility status of the soils with low P values. The soils are mostly not well supplied with potassium (K) and the values range from 0.091 (JPN 34) to 0.804 cmol (+) kg^{-1} (JPN 43).

An indication of sufficient levels for P is between 8 and 35 mg/kg for grains and from 15 to 50 mg/kg for vegetables. Sufficient levels for K are between 0.2 and 0.4 cmol (+)kg^{-1} for grains and between 0.3 and 0.4 cmol(+)kg^{-1} for vegetables. Leafy crops and fruit crops can remove over 100 kg ha^{-1} of K when they are harvested, thus depleting the reserve of available K in the soil.

4.1.4. Description of the dominant soil forms

A summary of the main soil characteristics is given in Table 7. The soils of map unit *Oa1* belong to the Oakleaf soil form and comprise of soils with dark reddish brown to dark brown, apedal, sandy loam to sandy clay loam orthic A horizons on sandy loam to sandy clay loam, dark reddish brown to dark brown, weakly structured and non-luvic B horizons. The unit has an effective depth of 900 to deeper than 1200 mm. The soils of map unit *Oa1* belong to Irrigation Potential Class 1.

The soils of map unit *Cf*, belong to the Cartref form with dark greyish brown to very dark greyish brown, apedal, sandy to loamy sand orthic A horizons on brown to dark brown, apedal, sandy to loamy sand, eluvial horizons underlain by a lithocutanic subsoil. The effective depth of this map unit ranges from 450 to 900 mm. This map unit has an Irrigation Potential Class 3, because the majority of the soils have a clay content of below 10%.

Soils in map unit *Bo* are of the Bonheim soil form and contain black to very dark brown, strongly structured, clay, melanic topsoils on very dark grey to dark brown, strongly structured, clay, non-calcareous pedocutanic B horizons on saprolite or rock. The effective depth ranges from 450 to 800 mm, depending on the depth of the saprolite or rock underneath. Because of the high clay content of more than 40% these soils fall into the Irrigation Potential Class 3.

The Oakleaf soils of map unit *Oa2* contain dark reddish brown, apedal, sandy clay loam topsoil's abruptly underlain by dark reddish brown, weakly structured, sandy clay, luvic B horizon. The effective depth ranges from 250 to 300 mm because of the strongly duplex character of these soils. Erosion is found on some of the duplex soils on slopes with a perched water table. The Irrigation Potential of this map unit falls into Class 3 because of the relatively permeable topsoil abruptly overlying a very slowly permeable B horizon.

In map unit *Va*, soils of the Valsrivier form were found with dark reddish brown, weakly structured, clay orthic A horizons over dark reddish brown to dark red, non-calcareous, strongly subangular structured, clay pedocutanic B horizons. The soils of this map unit have a low suitability with moderately severe limitations for irrigation because of the high clay content of between 45 to 65% in both the A and B horizons.

Soils of the Westleigh form (map unit *We*) have very dark grey to very dark greyish brown, apedal, sandy loam to sandy clay loam topsoils on brown to dark brown, mottled, weakly structured, sandy clay loam to clay loam, soft plinthic B horizons. The mottlling in the soft plinthic B horizon is an indication of a zone of periodic water saturation, for example under conditions of a fluctuating water table. The effective

depth of these soils is only 250 mm to 400 mm because of the periodic water saturation of the soft plintic B horizon and falls into Irrigation Potential Class 4.

Map unit *Gs,* with the Glenrosa as the dominant soil form, consists of shallow (250-350 mm) soils and which have dark reddish brown to very dark greyish brown, apedal to medium structured, sandy loam to sandy clay loam topsoils and stony/gravelly lithocutanic subsoils grading into weathered rock. Rock outcrops are also found in this map unit. Other soils of this map unit are of the Mispah, Valsrivier and Oakleaf soil forms but are included into this map unit because they are found between rock outcrops and extend over only a small area of about 1 to 1.5 ha. The Irrigation Potential of this map unit falls into Class 5 because of the rock outcrops.

Table 2. Soil analysis results of Mkhuhlu West JPN 23

Sample site:	JPN 23	**Co-ordinates:**	24° 59' 08.1" S
Soil form:	Sterkspruit 2100	**(Lat/Long)**	31° 15' 03.2" E

Horizon	**Depth (mm)**	**Particle size distribution %**							**Texture Class**
		C Sand	**M Sand**	**F Sand**	**VF Sand**	**C Silt**	**F Silt**	**Clay**	
A	0-200	30.38	11.59	11.80	6.68	7.41	7.99	22.60	SaClLm
B	200-700	18.67	10.44	10.02	5.80	7.54	7.01	39.03	SaCl
C	700-900	24.64	9.07	10.82	7.22	6.29	8.35	31.29	SaClLm

Horizon	**Exchangeable cations cmol(+)kg^{-1} (amm. acetate)**						**ESP %**
	Na	**K**	**Ca**	**Mg**	**S-value**	**CEC**	
A	0.855	0.229	4.165	3.449	8.697	17.193	4.97
B	3.252	0.210	7.300	6.690	17.451	25.565	12.72
C	4.577	0.229	8.559	6.802	20.167	20.907	21.89

Horizon	**Saturation extract soluble cations and anions me//**					**SAR**	**Conductivity mS/m**	**P mg/kg**	**pH (H_2O)**
	Ca	**Mg**	**Na**	**Cl**	**SO_4**				
A	0.189	0.123	3.343	2.321	0.479	8.46	40	4.87	6.80
B	0.300	0.092	4.094	3.899	0.220	9.25	49	3.29	8.21
C	0.507	0.324	12.059	14.153	0.352	18.71	141	3.52	9.06

Table 3. Soil analysis results of Mkhuhlu East JPN 31

Sample site:	JPN 31	**Co-ordinates:**	24° 58' 38.8" S
Soil form:	Bonheim 1210	**(Lat/Long)**	31° 15' 45.9" E

Horizon	Depth (mm)	Particle size distribution %							Texture Class
		C Sand	M Sand	F Sand	VF Sand	C Silt	F Silt	Clay	
A	0-450	2.56	5.98	20.62	9.62	5.13	12.34	41.93	Cl
B	450-700	4.63	5.86	20.16	8.95	7.51	9.41	41.56	Cl
C	700-1200	4.96	5.37	18.39	9.09	7.08	9.45	43.03	Cl

Horizon	Exchangeable cations cmol(+)kg^{-1} (amm. acetate)						ESP
	Na	K	Ca	Mg	S-value	CEC	%
A	0.451	0.647	18.021	12.052	31.172	35.188	1.28
B	0.609	0.485	17.169	13.502	31.766	14.142	4.31
C	0.738	0.530	20.830	15.302	37.399	33.419	2.21

Horizon	Saturation extract soluble cations and anions me//					SAR	Conductivity mS/m	P mg/kg	pH (H_2O)
	Ca	Mg	Na	Cl	SO_4				
A	0.497	0.284	0.722	0.448	0.454	1.16	17	35.33	7.16
B	0.342	0.184	0.833	0.228	0.442	1.62	15	4.72	8.15
C	1.077	1.005	1.820	3.133	0.340	1.78	44	3.75	8.54

Table 4. Soil analysis results of Mkhuhlu East JPN 34

Sample site:	JPN 34	**Co-ordinates:**	24° 58' 43.6" S
Soil form:	Westleigh 2000	**(Lat/Long)**	31° 16' 02.0" E

Horizon	Depth (mm)	Particle size distribution %							Texture Class
		C Sand	M Sand	F Sand	VF Sand	C Silt	F Silt	Clay	
A	0-310	7.1	10.8	24.0	14.4	10.6	12.1	19.2	SaLm
B	310-1200	9.3	8.2	15.6	10.3	7.9	9.4	36.5	ClLm

Horizon	Exchangeable cations cmol(+)kg^{-1} (amm. acetate)						ESP %
	Na	K	Ca	Mg	S-value	CEC	
A	0.650	0.091	2.159	2.090	4.989	9.982	6.51
B	3.714	0.127	2.201	4.848	10.891	14.697	25.27

Horizon	Saturation extract soluble cations and anions me//					SAR	Conductivity mS/m	P mg/kg	pH (H_2O)
	Ca	Mg	Na	Cl	SO_4				
A	0.206	0.127	3.505	3.443	1.144	8.59	47	3.72	6.54
B	0.096	0.117	4.525	6.714	0.563	13.89	54	3.06	8.31

Table 5. Soil analysis results of Seholokoane JPN 43

Sample site:	JPN 43	**Co-ordinates:** (Lat/Long)	24° 58' 43.5" S 31° 16' 50.1" E
Soil form:	Valsrivier 1211		

Horizon	Depth (mm)	Particle size distribution %							Texture Class
		C Sand	M Sand	F Sand	VF Sand	C Silt	F Silt	Clay	
A	0-180	3.28	6.97	13.11	6.66	4.71	11.63	52.05	Cl
B	180-800	4.52	3.82	8.03	4.72	4.42	9.79	63.86	Cl
C	800-1200	41.14	17.62	14.81	6.31	4.35	5.46	9.61	LmSa

Horizon	Exchangeable cations cmol(+)kg^{-1} (amm. acetate)						ESP %
	Na	K	Ca	Mg	S-value	CEC	
A	0.124	0.804	14.234	5.544	20.706	16.523	0.75
B	0.236	0.355	19.953	6.887	27.431	25.434	0.93
C	0.173	0.171	13.016	3.478	16.838	13.533	1.28

Horizon	Saturation extract soluble cations and anions me//					SAR	Conductivity mS/m	P mg/kg	pH (H_2O)
	Ca	Mg	Na	Cl	SO_4				
A	0.347	0.230	0.212	0.397	0.315	0.40	13	1.36	6.37
B	0.309	0.169	0.312	0.152	0.367	0.64	11	0.88	7.08
C	0.465	0.241	0.377	0.045	0.228	0.63	10	0.69	7.76

Table 6. Soil analysis results of Upper Cork JPN 61

Sample site:	JPN 61	**Co-ordinates:**	24° 58' 23.8" S
Soil form:	Oakleaf	**(Lat/Long)**	31° 18' 26.3" E

Horizon	Depth (mm)	Particle size distribution %							Texture Class
		C Sand	M Sand	F Sand	VF Sand	C Silt	F Silt	Clay	
A	0-240	20.53	12.56	12.46	6.44	6.84	9.81	28.91	SaClLm
B	240-1300	15.28	6.64	8.22	5.06	5.06	5.90	52.42	Cl

Horizon	Exchangeable cations cmol(+)kg^{-1} (amm. acetate)						ESP %
	Na	K	Ca	Mg	S-value	CEC	
A	0.082	0.550	4.999	2.702	8.332	12.327	0.67
B	0.160	0.127	7.131	3.623	11.040	15.728	1.02

Horizon	Saturation extract soluble cations and anions me//					SAR	Conductivity mS/m	P mg/kg	pH (H_2O)
	Ca	Mg	Na	Cl	SO_4				
A	0.258	0.213	0.205	0.115	0.223	0.42	11	2.57	6.20
B	0.211	0.137	0.295	0.124	0.118	0.71	7	1.17	6.90

Table 7. Soil mapping units and irrigation classes for Mkhuhlu West, Mkhuhlu East, Seholokoane and Upper Cork.

SOIL LEGEND							
MAP UNIT	**DOMINANT SOIL FORM**	**OTHER SOIL FORMS**	**EFFECTIVE DEPTH (mm)**	**TEXTURE: CLAY % PER HORIZON**	**DESCRIPTION OF MAPPING UNIT**	**IRRIGA-TION CLASS**	**AREA (HA)**
Oa1	Oakleaf 1210	Oakleaf 1110 Dundee 2110	900-1200+	A: 15-22 B: 18-25	Dark reddish brown, apedal, sandy loam to sandy clay loam topsoil on a dark reddish brown to dark brown, weakly structured, sandy loam to sandy clay loam subsoil.	1	16
Cf	Cartref 2200	Longlands 2000 Kroonstad 1000	450-900	A: 6-15 E: 6-15	Dark greyish brown to very dark greyish brown, apedal, sand to loamy sand topsoil on a brown to dark brown, apedal, sand to loamy sand subsoil on a lithocutanic B horizon.	3	31
Bo	Bonheim 1210	Mayo 2100 Inhoek 1100	450-800	A: 40-45 B: 40-45	Black to very dark brown, strongly structured, clay topsoil on a very dark grey to dark brown, strongly structured, clay subsoil on saprolite or rock.	3	10
Oa2	Oakleaf 1220	Hutton 3200 Tukulu 1220	250-300	A: 20-30 B: 45-55	Dark reddish brown, apedal, sandy clay loam topsoil on a dark reddish brown, weakly structured, sandy clay, subsoil with a duplex character, on unconsolidated material or saprolite.	3	31
Va	Valsrivier 1211	Oakleaf 1210 Bonheim 2210 Valsrivier 1221	500-1200	A: 45-55 B: 55-65	Dark reddish brown, weakly structured, clay topsoil on a dark reddish brown to dark red, strongly structured, clay subsoil on rock, saprolite or unconsolidated material.	3	69
We	Westleigh 2000	Katspruit 1000 Sterkspruit 2100 Tukulu 2110	250-400	A: 15-30 B: 25-40	Very dark grey to very dark greyish brown, apedal, sandy loam to sandy clay loam topsoil on a on brown to dark brown, weakly structured, sandy clay loam to clay loam, subsoil with more than 10% mottles.	4	136
Gs	Glenrosa 1211	Mispah 1100 Valsrivier 1221 Oakleaf 1210 Rock Outcrops	250-350	A: 15-35	Dark reddish brown to very dark greyish brown, apedal to medium structured, sandy loam to sandy clay loam topsoil on stony/gravelly subsoil, grading into weathered rock. Rock outcrops are also found in this map unit.	5	94

5. WATER QUALITY

If the South African Water Quality Guidelines for Agriculture (DWAF, 1993) are used, the water from the canal at Upper Cork and the Sabie River at Phabene are both Class 1 Irrigation water, because the electrical conductivity is 18 mS/m and 11 mS/m respectively (Appendix 2). The relatively low salt content should ensure that salt-sensitive crops could be grown, without yield reduction.

Sodicity and boron are low and are within the threshold for the best water quality class for irrigation. The chloride value is also low and no problems with the accumulation of chloride to toxic levels in sensitive crops (strawberry, bean, onion, carrot, radish, lettuce and turnip) can be expected when using a low-frequency irrigation system.

The SAR (Sodium Adsorption Ratio) of 0.36 that was found in the Canal Water should ensure an adequate infiltration rate for soils sensitive to the formation of infiltration rate reducing surface seals under conditions of rainfall during the irrigation season.

No indication of pollution was found. The water is suitable for domestic and livestock use. The water is, however, not in chemical equilibrium and it would be corrosive. The water may necessitate premature replacement of pipes, irrigation canals and other irrigation equipment. The resistance of concrete to corrosion as a result of dissolution of lime by low salinity water can be increased by the use of good quality concrete.

According to RHP (2007) the overall ecological state of the Sabie River is good; In-stream habitats and fish are good; riparian habitats and riparian vegetation varies between good and poor. The invertebrate index also reflects a varied picture, with results ranging between natural and poor.

Table 8: Water holding capacity and expected infiltration rate.

Irrigation Class	Map Unit	Effective Depth	Texture (Clay %)	Water holding capacity (mm/m)	Infiltration rate (mm/h)
1	Oa1	900-1200+	A: 15-22 B: 18-25	100-135	40
3	Cf	450-900	A: 6-15 E: 6-15	40-90	95
3	Bo	450-800	A: 40-45 B: 40-45	160-170	10
3	Oa2	250-300	A: 20-30 B: 45-55	120-180	15
3	Va	500-1200	A: 45-55 B: 55-65	170-190	10
4	We	250-400	A: 15-30 B: 25-40	100-160	12
5	Gs	250-350	A: 15-35	90-150	35

Table 9: Irrigation potential classes

Mkhuhlu West					**Total**
Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	
1.6 ha	-	4.9 ha	15 ha	-	**21.5 ha**
7.44%	-	22.79%	69.77	-	100 %
Mkhuhlu East.					
Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	
2.3 ha	-	50.3 ha	48.3 ha	23.7 ha	**124.6 ha**
1.84%	-	40.37%	38.76%	19.0%	100%
Seholokoane					
Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	
10.5 ha	-	51.8 ha	18 ha	61 ha	**141.3 ha**
7.43%	-	36.66%	12.73%	43.18%	100%
Upper Cork					
Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	
1.5 ha	-	50.8 ha	55.1 ha	9.2 ha	**116.6 ha**
1.28%	-	43.56%	47.26%	7.89%	100%

6. SUMMARY

- The majority of the soils at Mkhulu West, Mkhulu East, Seholokoane and Upper Cork cannot be regarded as irrigable. The soils of Irrigation Potential Class 1 cover an area of only 15.9 ha (3.9%).
- Irrigation Class 3 soils are normally not recommended for large-scale irrigation development under average management conditions. The soils of Irrigation Potential Class 3 cover an area of 157.8 ha (39%).
- The soils of Irrigation Potential Class 4 and 5 are not suitable for irrigation and cover an area of 230.3 ha (57%).
- Most of the soils are prone to water logging and would need internal and external drainage systems. Installation of drains is also essential to avoid a salinity and/or sodicity hazard in the future.
- The main limitation of the soils for irrigation is the high clay content of the soils with clay percentages of above 40% in the B horizons of map units *Bo*, *Oa2* and *Va*. The high clay content leads to a reduced infiltration rate and lower hydraulic conductivity, which has a negative effect on irrigation. Another major factor which places a limitation on the irrigability is soils of map unit *We* which are located in wet areas and with signs of wetness in the subsoil. The soils located in the wet areas and with signs of wetness are more suited for and recommended for dry land production. A third factor that places a limitation on irrigability is located in map unit *Gs*, where shallow soils are found between huge rock outcrops. The shallowness and rockiness of soils causes a decrease in the water holding capacity of the soil and the rock outcrops found regularly between small patches of deeper soils make tillage and irrigation problematic.
- The water is not in chemical equilibrium and it would be corrosive. No indication of pollution was found.

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APPENDIX 1

PROFILE DESCRIPTION

SOIL PROFILE DESCRIPTION

NATIONAL SOIL PROFILE NO : 21753

Map/photo : 2431CD Newington

Latitude + Longitude: 24° 59' 8.1" / 31° 15' 3.2"

Land Type No : Fb66

Climate Zone : 1010S

Altitude : 394 m

Terrain Unit: Lower Footslope

Slope: 3 %

Slope Shape : Convex

Aspect : North-east

Microrelief : None

Parent Material Solum : Origin single, unconsolidated material sediments

Underlying Material : Basic intrusive rocks

Geological Group / Formation : Timbavati: Gabbro

Soil form and family Sterkspruit hermon

Surface rockiness : None

Surface stoniness : None

Occurence of flooding : None

Wind erosion : None

Water Erosion : None

Vegetation / Land use : Abandoned field/Disturbed land

Water table : None

Described by : J.P. Nell

Date Described : 11/2006

Weathering of underlying material: Moderate physical, strong chemical

Alteration of underlying material : Normal weathering

Horizon	Depth (mm)	Description	Diagnostic horizon
A1	0 - 210	Moist state; horizon undisturbed; dry colour: light grey to grey 10YR6/1; moist colour: very dark grey 10YR3/1; texture: sandy clay loam; structure: moderate coarse subangular blocky; consistence: very hard, very firm, very sticky, very plastic; common medium & coarse bleached pores, fine cracks; few slickensides; many clay cutans; very few mixed-shape stones 25-75mm; water absorption: 7 second(s); few roots; gradual smooth transition.	Orthic
B2	210 - 700	Moist state; horizon undisturbed; dry colour: greyish brown 10YR5/2; moist colour: dark grey 10YR4/1; texture: sandy clay; few fine distinct yellow, olive and brown reduced iron oxide mottles; structure: strong coarse prismatic; consistence: very hard, very firm, very sticky, very plastic; common medium & coarse bleached pores, fine cracks; few slickensides; many clay cutans; very few fine <2-6mm other fragments; water absorption: 11 second(s); few roots; abrupt smooth transition.	Prismacutanic
C1	700 - 900	Moist state; horizon undisturbed; dry colour: light yellowish brown 10YR6/4; moist colour: yellowish brown 10YR5/4; texture: sandy clay loam; structure: weak fine massive; consistence: slightly hard, loose, slightly sticky, slightly plastic; water absorption: 6 second(s).	Unspecified material, with signs of wetness

SOIL PROFILE DESCRIPTION

NATIONAL SOIL PROFILE NO : 21759

Map/photo : 2431CD Newington

Latitude + Longitude: 24° 58' 38.5" / 31° 15' 44.2"

Land Type No : Fb66

Climate Zone : 1010S

Altitude : 388 m

Terrain Unit: Valley bottom

Slope: 1 %

Slope Shape : Straight

Aspect : South

Microrelief : None

Parent Material Solum : Origin single, alluvium

Underlying Material : Intermediate extrusive rocks

Geological Group / Formation : Timbavati Gabbro

Soil form and family Bonheim onrus

Surface rockiness : None

Surface stoniness : None

Occurence of flooding : Occasional

Wind erosion : None

Water Erosion : None

Vegetation / Land use : Abandoned field/Disturbed land

Water table : None

Described by : J.P. Nell

Date Described : 11/2006

Weathering of underlying material: Weak chemical

Alteration of underlying material : Calcified

Horizon	Depth (mm)	Description	Diagnostic horizon
A1	0 - 450	Wet state; moist colour: black 2.5Y2.5/0; texture: clay; structure: moderate coarse angular blocky; consistence: soft, firm, sticky, plastic; normal pores, common medium & coarse pores, fine cracks; few slickensides; many organic cutans; very few fine <2-6mm sesquioxide concretions; water absorption: 9 second(s); many roots; clear smooth transition.	Melanic
B21	450 - 700	Wet state; moist colour: very dark greyish brown 10YR3/2; texture: clay; few medium faint red and black oxidized iron oxide mottles; structure: moderate medium subangular blocky; consistence: slightly hard, firm, sticky, slightly plastic; normal pores; few slickensides; common clay cutans; water absorption: 8 second(s); few roots; gradual smooth transition.	Pedocutanic
B22	700 - 1200	Wet state; moist colour: very dark greyish brown 10YR3/2; texture: clay; common medium distinct white lime mottles; structure: moderate medium subangular blocky; consistence: hard, slightly firm, sticky, slightly plastic; normal pores; discontinuous slight vesicular cementation of carbonates; non-hardened free lime, moderate effervescence; common clay cutans; very few fine <2-6mm lime concretions; water absorption: 7 second(s).	Soft carbonate

SOIL PROFILE DESCRIPTION

NATIONAL SOIL PROFILE NO : 21758

Map/photo : 2431CD Newington

Latitude + Longitude: 24° 58' 43.5" / 31° 16' 50.1"

Land Type No : Fb66

Climate Zone : 1010S

Altitude : 398 m

Terrain Unit: Upper Midslope

Slope: 4 %

Slope Shape : Concave

Aspect : South-west

Microrelief : None

Parent Material Solum : Origin binary, alluvium, unconsolidated mineral sediments

Underlying Material : Basic extrusive rocks

Geological Group / Formation : Timbavati Gabbro

Soil form and family Valsrivier helvetia

Surface rockiness : <2% exposed surface

Surface stoniness : <2% exposed surface, round, coarse stones

Occurence of flooding : None

Wind erosion : None

Water Erosion : None

Vegetation / Land use : Abandoned field/Disturbed land

Water table : None

Described by : J.P. Nell

Date Described : 11/2006

Weathering of underlying material: Weak physical, strong chemical

Alteration of underlying material : Ferruginised

Horizon	Depth (mm)	Description	Diagnostic horizon
A1	0 - 180	Moist state; horizon disturbed; dry colour: dark reddish brown 5YR3/2; moist colour: reddish black 10R2.5/1; texture: clay; structure: strong medium subangular blocky; consistence: hard, firm, very sticky, very plastic; few fine pores; few slickensides; many clay cutans; water absorption: 8 second(s); few roots; diffuse smooth transition.	Orthic
B21	180 - 800	Moist state; horizon undisturbed; dry colour: dark reddish brown 5YR3/2; moist colour: black 5YR2.5/1; texture: clay; structure: strong coarse subangular blocky; consistence: hard, firm, very sticky, very plastic; few medium & coarse pores; few slickensides; very many clay cutans; water absorption: 9 second(s); few roots; abrupt smooth transition.	Pedocutanic
C	800 - 1450	Dry state; horizon undisturbed; dry colour: yellowish brown 10YR5/8; moist colour: dark yellowish brown 10YR4/4; texture: loamy sand; common fine yellow, brown and red oxidized iron oxide mottles; structure: weak fine massive; consistence: very hard, friable, slightly sticky, slightly plastic; continuous moderate rock structured cementation of iron oxides; very many fine <2-6mm other fragments; water absorption: 3 second(s).	Unconsolidated material, without signs of wetness

SOIL PROFILE DESCRIPTION

NATIONAL SOIL PROFILE NO : 21756

Map/photo : 2431CD Newington

Latitude + Longitude: 24° 58' 23.9" / 31° 18' 26.6"

Land Type No : Fb66

Climate Zone : 1010S

Altitude : 370 m

Terrain Unit: Upper Footslope

Slope: 2 %

Slope Shape : Convex

Aspect : South-east

Microrelief : None

Parent Material Solum : Origin single

Underlying Material : Basic intrusive rocks

Geological Group / Formation : Timbavati Gabbro

Soil form and family Oakleaf dipene

Surface rockiness : None

Surface stoniness : None

Occurence of flooding : Occasional

Wind erosion : None

Water Erosion : None

Vegetation / Land use : Fruit trees

Water table : None

Described by : J.P. Nell

Date Described : 11/2006

Weathering of underlying material: Weak physical, moderate chemical

Horizon	Depth (mm)	Description	Diagnostic horizon
A1	0 - 240	Moist state; horizon disturbed; dry colour: dark reddish brown 5YR3/3; moist colour: dusky red 2.5YR3/2; texture: sandy clay loam; structure: weak medium subangular blocky; consistence: soft, loose, slightly sticky, slightly plastic; water absorption: 6 second(s); common roots; clear smooth transition.	Orthic
B2	240 - 1300	Moist state; horizon undisturbed; dry colour: dark red 2.5YR3/6; moist colour: dark reddish brown 2.5YR3/4; texture: clay; few fine faint red and brown oxidized iron oxide mottles; structure: moderate medium subangular blocky; consistence: soft, friable, sticky, plastic; common sesquioxide cutans; common mixed-shape coarse stones 75-250mm; water absorption: 11 second(s); few roots.	Neocutanic

SOIL PROFILE DESCRIPTION

NATIONAL SOIL PROFILE NO : 21755

Map/photo : 2431CD Newington

Latitude + Longitude: 24° 57' 59.5" / 31° 20' 7.6"

Land Type No : Fb167

Climate Zone : 1013S

Altitude : 369 m

Terrain Unit: Crest

Slope: 2 %

Slope Shape : Convex

Aspect : South

Microrelief : None

Parent Material Solum : Origin single, alluvium

Underlying Material : Basic intrusive rocks

Geological Group / Formation : Timbavati Gabbro

Soil form and family Hutton ventersdorp

Surface rockiness : None

Surface stoniness : None

Occurence of flooding : None

Wind erosion : None

Water Erosion : None

Vegetation / Land use : Agronomic cash crops

Water table : None

Described by : J.P. Nell

Date Described : 11/2006

Weathering of underlying material: Weak physical, strong chemical

Alteration of underlying material : Silicified

Horizon	Depth (mm)	Description	Diagnostic horizon
A1	0 - 280	Moist state; horizon disturbed; dry colour: dark reddish brown 5YR3/2; moist colour: black 5YR2.5/1; texture: sandy clay loam; structure: weak subangular blocky; consistence: slightly hard, slightly firm, sticky, plastic; few fine pores; common clay cutans; water absorption: 8 second(s); few roots; abrupt tonguing transition.	Orthic
B21	280 - 1100	Moist state; horizon undisturbed; dry colour: reddish brown 5YR4/4; moist colour: dark reddish brown 2.5YR3/4; texture: sandy clay; structure: weak subangular blocky; consistence: slightly hard, slightly firm, sticky, plastic; common clay cutans; few medium 6-25mm other fragments; stoneline 70mm, multiple occurrence, lower part of horizon; water absorption: 10 second(s); few roots; abrupt transition.	Red apedal
C1	1100 - 1300	Moist state; horizon undisturbed; dry colour: yellowish red 5YR5/8; moist colour: black 5YR2.5/1; texture: loamy sand; structure: apedal single grain; consistence: soft, friable, non-sticky, slightly plastic; few silica cutans; water absorption: 4 second(s).	Unconsolidated material, without signs of wetness

SOIL PROFILE DESCRIPTION

NATIONAL SOIL PROFILE NO : 21754

Map/photo : 2431CD Newington

Latitude + Longitude: 24° 58' 8.9" / 31° 20' 23.9"

Land Type No : Fb167

Climate Zone : 1013S

Altitude : 360 m

Terrain Unit: Upper Midslope

Slope: 2 %

Slope Shape : Convex

Aspect : North-east

Microrelief :

Parent Material Solum : Origin binary, alluvium

Underlying Material : Basic intrusive rocks

Geological Group / Formation : Cunning Moor Tomalite

Soil form and family Valsrivier helvetia

Surface rockiness : None

Surface stoniness : None

Occurence of flooding : None

Wind erosion : None

Water Erosion : None

Vegetation / Land use : Agronomic cash crops

Water table : None

Described by : J.P. Nell

Date Described : 11/2006

Weathering of underlying material: Weak physical, strong chemical

Alteration of underlying material : Ferruginised

Horizon	Depth (mm)	Description	Diagnostic horizon
A1	0 - 400	Moist state; horizon undisturbed; dry colour: brown to dark brown 7.5YR4/2; moist colour: very dark grey 5YR3/1; texture: sandy clay; few fine many coloured reduced iron oxide mottles; structure: strong coarse subangular blocky; consistence: hard, very firm, very sticky, very plastic; few medium & coarse pores, medium cracks; many clay cutans; water absorption: 129 second(s); few roots; clear smooth transition.	Orthic
B2	400 - 650	Moist state; horizon disturbed; dry colour: strong brown 7.5YR5/8; moist colour: yellowish red 5YR4/6; texture: sandy clay loam; many medium white silica mottles; structure: moderate medium subangular blocky; consistence: hard, firm, sticky, plastic; few medium & coarse pores; continuous slight rock structured cementation of unknown agent; common sesquioxide cutans; few mixed-shape coarse gravel 6-25mm; stoneline 80mm, single occurrence, lower part of horizon.	Pedocutanic

SOIL PROFILE DESCRIPTION

NATIONAL SOIL PROFILE NO : 21757

Map/photo : 2431CD Newington

Latitude + Longitude: 24° 58' 43.2" / 31° 16' 7.7"

Land Type No : Fb66

Climate Zone : 1010S

Altitude : 384 m

Terrain Unit: Valley bottom

Slope: 3 %

Slope Shape : Concave

Aspect : South

Microrelief : None

Parent Material Solum : Origin binary, alluvium, unconsolidated mineral sediments

Underlying Material : Acid intrusive rocks

Geological Group / Formation : Nelspruit Granite Suite

Soil form and family Westleigh mareetsane

Surface rockiness : None

Surface stoniness : None

Occurence of flooding : None

Wind erosion : None

Water Erosion : Rill slight, partially stabilized

Vegetation / Land use : Abandoned field/Disturbed land

Water table : None

Described by : J.P. Nell

Date Described : 11/2006

Weathering of underlying material: Weak physical, moderate chemical

Horizon	Depth (mm)	Description	Diagnostic horizon
A1	0 - 310	Wet state; horizon undisturbed; moist colour: very dark grey 10YR3/1; texture: sandy loam; few fine red and black oxidized iron oxide mottles; structure: moderate medium subangular blocky; consistence: slightly hard, firm, sticky, plastic; few organic cutans; water absorption: 8 second(s); common roots; abrupt smooth transition.	Orthic
B21	310 - 1200	Wet state; horizon undisturbed; moist colour: brownish yellow 10YR6/8; texture: clay loam; common medium yellow, brown and red reduced iron oxide mottles; structure: moderate medium subangular blocky; consistence: hard, slightly firm, slightly sticky, slightly plastic; common sesquioxide cutans; few fine <2-6mm sesquioxide concretions; water absorption: 6 second(s); few roots.	Soft plinthic

SOIL PROFILE DESCRIPTION

NATIONAL SOIL PROFILE NO : 21760

Map/photo : 2431CD Newington

Latitude + Longitude: 24° 57' 39.4" / 31° 22' 27"

Land Type No : Fb167

Climate Zone : 1013S

Altitude : 336 m

Terrain Unit: Upper Midslope

Slope: 8 %

Slope Shape : Convex

Aspect : South

Microrelief : None

Parent Material Solum : Origin single, local colluvium

Underlying Material : Acid intrusive rocks

Geological Group / Formation : Cunning Moor Tomalite

Soil form and family Wasbank louterwater

Surface rockiness : None

Surface stoniness : None

Occurence of flooding : None

Wind erosion : None

Water Erosion : Sheet slight, partially stabilized

Vegetation / Land use : Abandoned field/Disturbed land

Water table : None

Described by : J.P. Nell

Date Described : 11/2006

Weathering of underlying material: Moderate chemical

Alteration of underlying material : Ferruginised

Horizon	Depth (mm)	Description	Diagnostic horizon
A1	0 - 260	Moist state; horizon undisturbed; dry colour: light brownish grey 10YR6/2; moist colour: dark greyish brown 10YR4/2; texture: loamy sand; structure: apedal massive; consistence: hard, slightly firm, non-sticky, slightly plastic; bleached surface crust; water absorption: 2 second(s); common roots; gradual smooth transition.	Orthic
E	260 - 830	Moist state; horizon undisturbed; dry colour: pale brown 10YR6/3; moist colour: greyish brown 10YR5/2; texture: sand; few fine yellow white bleached mottles; structure: apedal massive; consistence: hard, slightly firm, non-sticky, slightly plastic; water absorption: 2 second(s); few roots; gradual smooth transition.	E-horizon
B22	830 - 1200	Moist state; horizon undisturbed; dry colour: light grey 10YR7/2; moist colour: light brownish grey 10YR6/2; texture: loamy sand; common medium black and brown reduced iron oxide mottles; structure: weak single grain; consistence: very hard, firm, non-sticky, slightly plastic; discontinuous strong rock structured cementation of manganese oxides; few sesquioxide cutans; many medium 6-25mm sesquioxide concretions; water absorption: 2 second(s).	Hard plinthic

APPENDIX 2

WATER QUALITY

Mr J.P. Nell

A.R.C.
Pedologie
I.G.K.W. Projek No: 50/025

Tel : 3102600
Fax/Faks

ARC: INSTITUTE FOR SOIL, CLIMATE AND WATER
LNR: INSTITUUT VIR GROND, KLIMAAT EN WATER
Private Bag X79, PRETORIA, 000
Tel: (012) 310 2500
Fax:: (012) 310 2500

Date / Datum: 2007/01/23

REPORT NO:
VERSLAG NR: WATER 200607 5672

Sender ID: CORK **Lab. No:** W 3710

pH	pHS	SAR	Electric Conductivity
6.72	8.67	0.36	18.00 mS/m at 25 ºC

ANIONS	mg/l	mmol(c)/l
Fluoride (1.5)	0.04	0.00
Nitrite (4.0)	0.00	0.00
Nitrate (44.0)	0.33	0.01
Chloride (250)	6.53	0.18
Sulphate (500)	3.32	0.07
Phosphate	0.00	0.00
Carbonate (20.0)	0.00	0.00
Bicarbonate	59.78	0.98
Subtotal	70.00	1.24

CATIONS	mg/l	mmol(c)/l
Sodium (400)	5.77	0.25
Potassium (400)	1.47	0.04
Calcium (200)	10.26	0.51
Magnesium (100)	5.51	0.45
Boron (1.5)	0.01	0.00
Subtotal	23.02	1.26

Sodium Carbonate	0.00	0.00
Sodium Bicarbonate	0.93	0.01
Alkalinity	49.00	0.98
Temp. Hardness	48.45	0.97
Perm. Hardness	0.00	0.00

Total	93.00
Less (*)	29.89
Total disolved Solids	63.11

* Correction for any volatile substances, HCO3/2 or .... HCL + HNO3 + HF + ...
() Figures in brackets are the recommended maximum values for human use in mg/l.

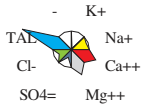
NB: No analysis was done for microbiological pathogenes, organic compounds and insecticides.

X3H012Q01: BARCODE GRAPHS OF WATER QUALITY VARIABLES

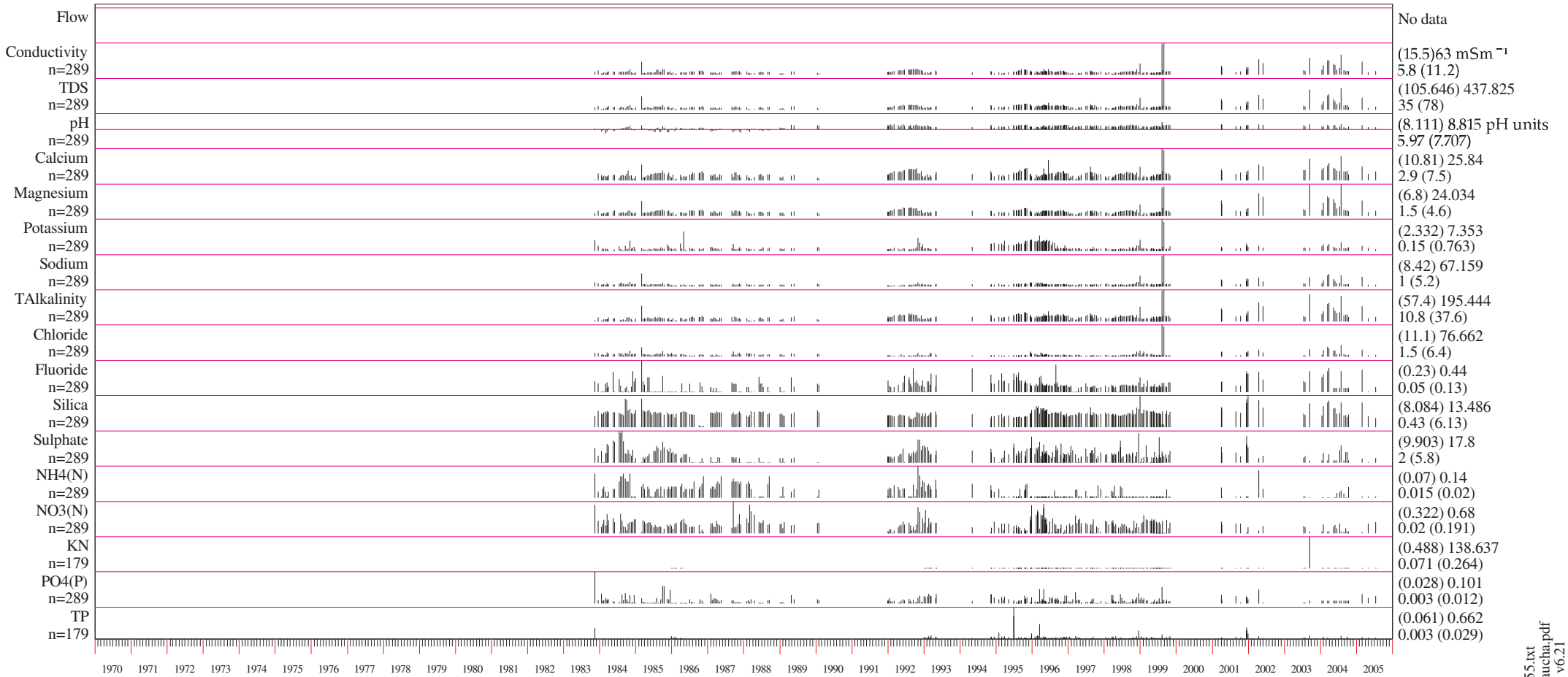
Sabie River at Phabene/Kruger National P

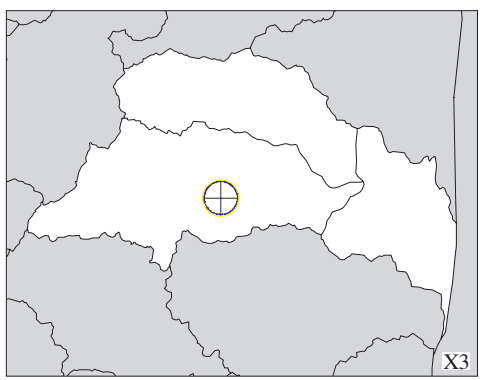
1970-01-01 to 2005-12-31 25°01'05"S 31°15'00"E

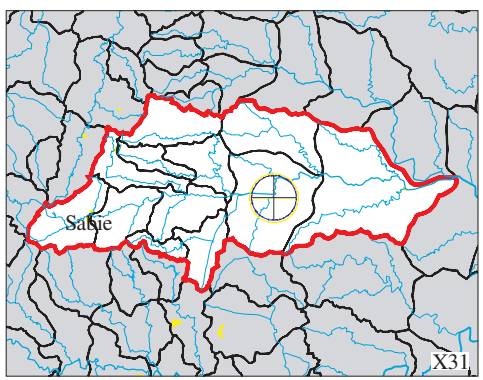
Maucha median ion balance diagram (left) and time series graphs (below) of available flow and water quality data. The y axes show summary statistics.
Source data are from the WMS: INFO /rpd1/hri2/waterm/wmdata/wq/intest.tmp, /hri/db/cover/s-africa/nms_his and Hydsys: /hri/db/iwqs/db/flow/

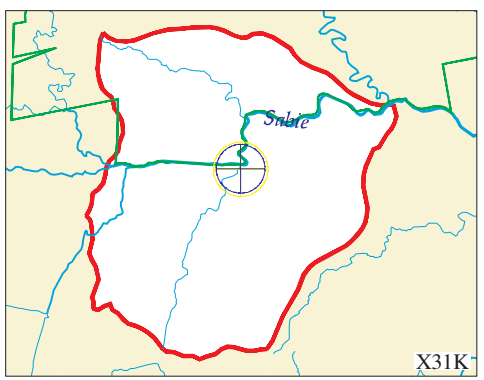


Each y-axis shows:
(90th Pcntl) Maximum
minimum (median) values,
mainly in mg ℓ^{-1}.









X3H012Q01 nr 69 of select > 12 samples
Resource Quality Services directorate
Department of Water Affairs & Forestry
Private Bag X313 PRETORIA.
tel012 808 9605, fax 012 808 2702
E-mail: SilberbauerM@dwaf.gov.za
Run 2005-12-16 - 07:52:48 (by Michael)
'Text in /hri/db/barcode/bcmichael20051216050255.txt
'Maucha: see www.dwaf.gov.za/iwqs/gis_apps/maucha.pdf
/rpd2/spek/prjws8/users/michael/aml/barcode.aml v6.21

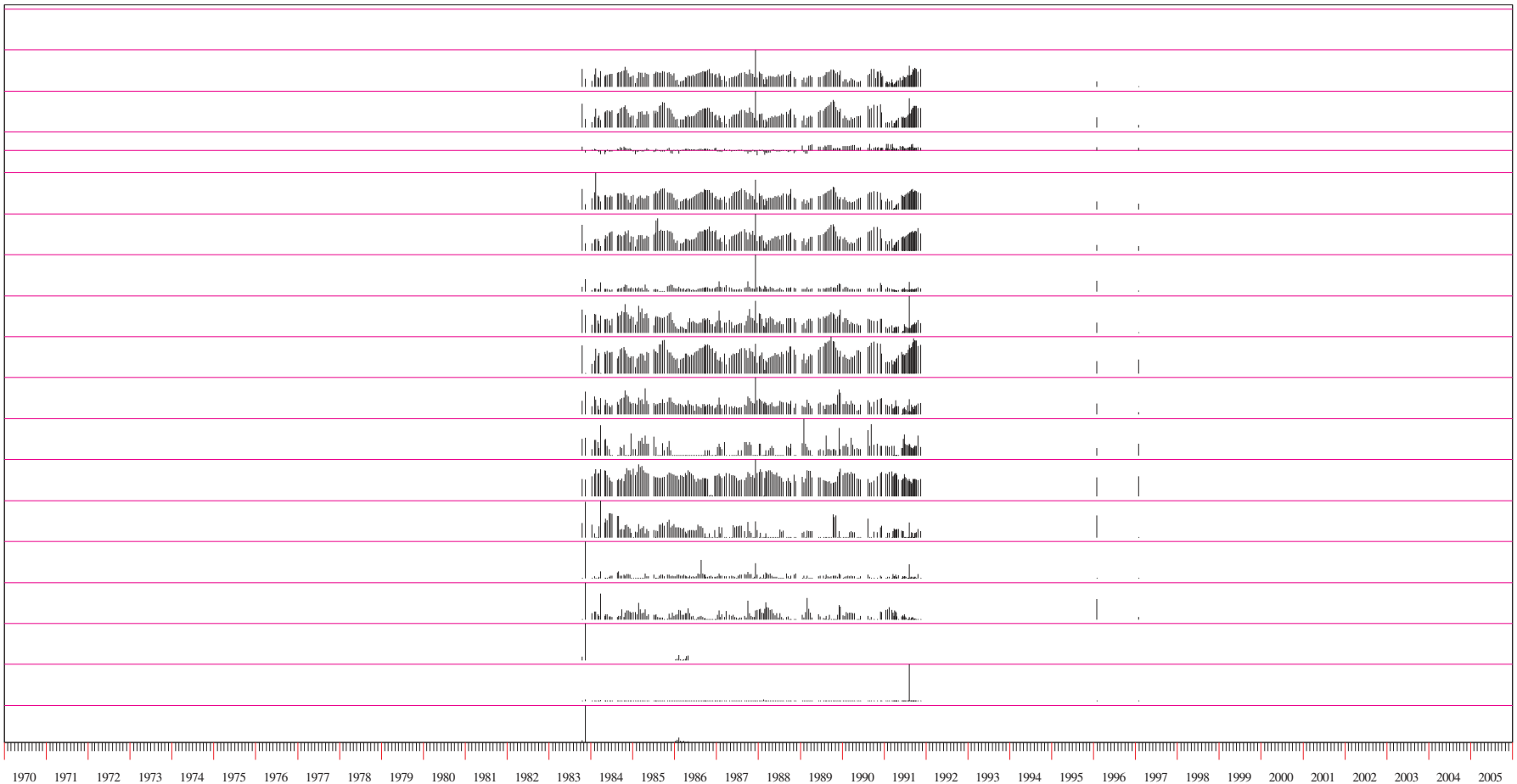
X3H014Q01: BARCODE GRAPHS OF WATER QUALITY VARIABLES

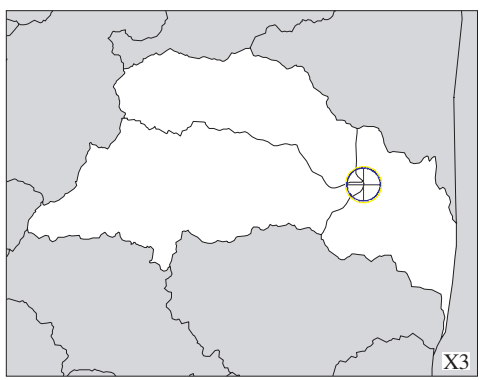
Sabie River at High Water Bridge/Kruger

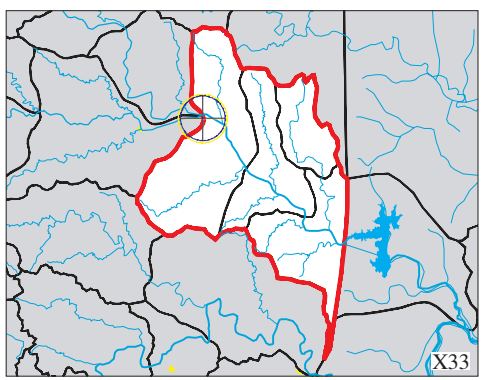
1970-01-01 to 2005-12-31 24°57'18"S 31°43'02"E

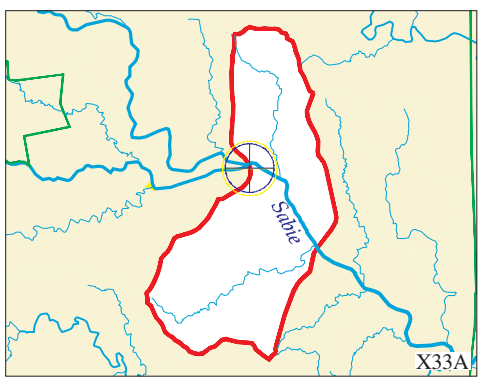
Maucha median ion balance diagram (left) and time series graphs (below) of available flow and water quality data. The y axes show summary statistics.
Source data are from the WMS: INFO /rpd1/hri2/waterm/wmdata/wq/intest.tmp, /hri/db/cover/s-africa/nms_his and Hydsys: /hri/db/iwqs/db/flow/

Each y-axis shows: (90th Pcntl) Maximum minimum (median) values, mainly in mg ℓ^{-1}.









X3H014Q01 nr 72 of select > 12 samples
Resource Quality Services directorate
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Private Bag X313 PRETORIA.
tel012 808 9605, fax 012 808 2702
E-mail: SilberbauerM@dwaf.gov.za

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/rpd2/spek/prjws8/users/michael/aml/barcode.aml v6.21

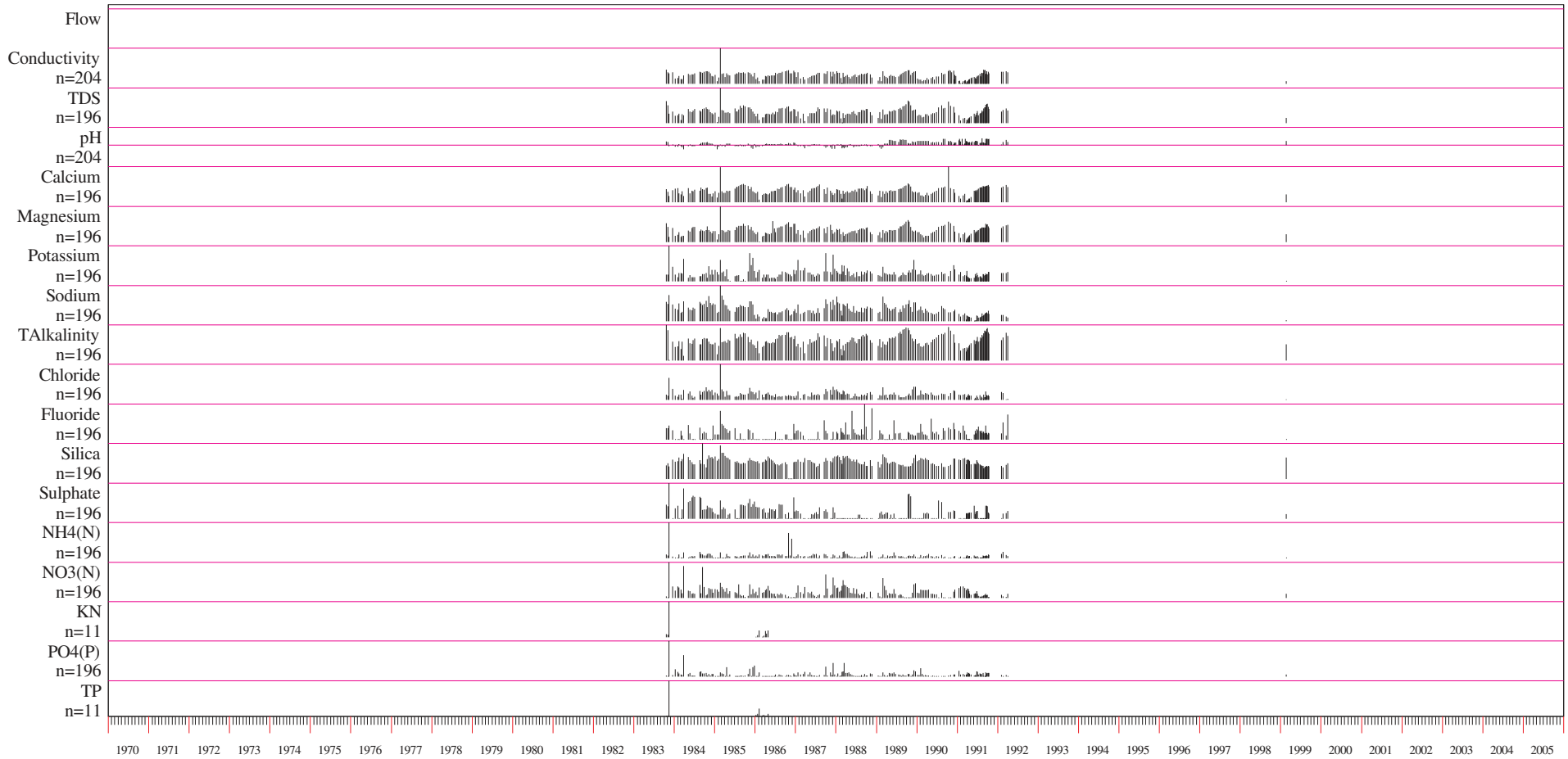
X3H013Q01: BARCODE GRAPHS OF WATER QUALITY VARIABLES

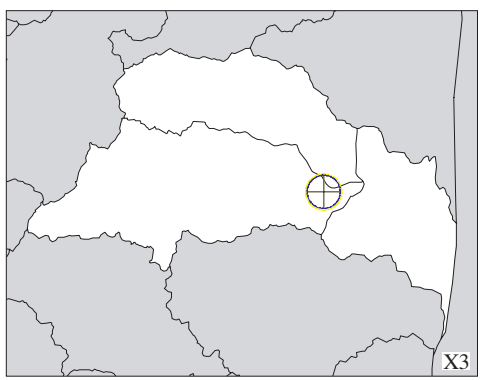
Sabie River at Npd Powerline/Kruger Nati

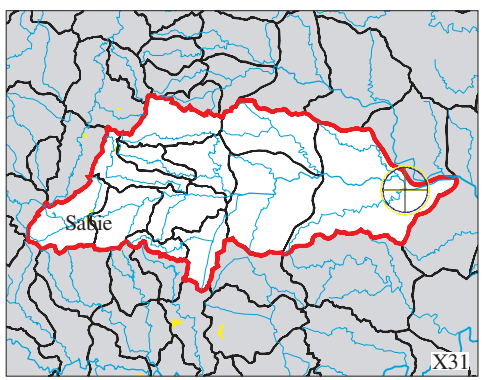
1970-01-01 to 2005-12-31 24°59'00"S 31°35'15"E

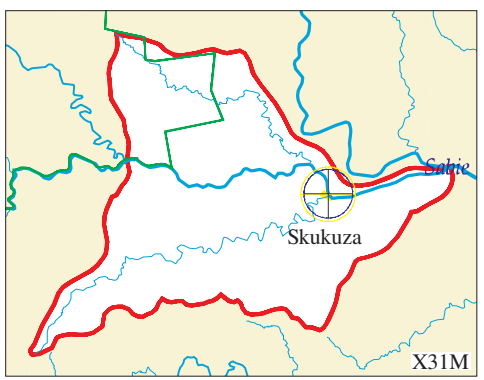
Maucha median ion balance diagram (left) and time series graphs (below) of available flow and water quality data. The y axes show summary statistics.
Source data are from the WMS: INFO /rpd1/hri2/waterm/wmdata/wq/intest.tmp, /hri/db/cover/s-africa/nms_his and Hydsys: /hri/db/iwqs/db/flow/

Each y-axis shows:
(90th Pcntl) Maximum
minimum (median) values,
mainly in mg ℓ^{-1}.









X3H013Q01 nr 70 of select > 12 samples
Resource Quality Services directorate
Department of Water Affairs & Forestry
Private Bag X313 PRETORIA.
tel012 808 9605, fax 012 808 2702
E-mail: SilberbauerM@dwaf.gov.za

Run 2005-12-16 - 07:54:49 (by Michael)
'Text in /hri/db/barcode/bcmichael20051216050255.txt
'Maucha: see www.dwaf.gov.za/iwqs/gis_apps/maucha.pdf
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APPENDIX 3

GLOSSARY OF TERMS

ALLUVIUM: Refers to detrital deposits resulting from the operation of modern streams and rivers.

ALLUVIAL SOIL: A soil developing from recently deposited alluvium and exhibiting essentially no horizon development.

APEDAL: Term is used in general to denote materials that are well aggregated in a microstructure so that well formed peds cannot be detected macroscopically.

ARABLE LAND: Land so located that production of cultivated crops is economical and practical.

ARABLE SOIL: Soil that can produce crops requiring tillage without clearing or other physical improvements

AUGER: A tool for boring the soil and withdrawing a small sample for field or laboratory observation.

BIOME: A biome is a large, easily recognizable community unit formed by the interaction of regional climates with dominant regional biota and substrata.

CALCAREOUS SOIL: A soil with sufficient calcium carbonate or calcium-magnesium carbonate to effervesce visibly when treated with cold dilute hydrochloric acid.

CATENA: A sequence of soils of about the same age and derived from similar parent material. These soils occur under similar macroclimatic conditions, but have different characteristics due only to variation in topography and drainage.

CATION: A positively charged ion, for example Ca^{2+}, Mg^{2}, Na^{+}, K^{+}, Al^{3+}, NH_4^{+} and H_3O^{+}. The term exchangeable metal cations ordinarily refers to calcium, magnesium, potassium and sodium.

CATION EXCHANGE CAPACITY (CEC): The sum total of exchangeable cations that a soil can adsorb.

CLAYEY: A qualitative term for soils with more than approximately 35% clay; soils that are finer textured than loamy.

COLLUVIUM: An unconsolidated deposit of rock fragments and soil material accumulated at the base of slopes primarily as a result of gravitational action and to a lesser extent as a result of front action and local runoff.

COMPACTION: A reduction in soil bulk volume (increase in bulk density and reduction of porosity) resulting from an applied force, such as that due to machinery and animals.

CONVERSION FACTORS:
me/100g = cmol(+ or – charge) kg^{-1} or $cmol_c/kg$
me/100g = (mg/kg (ppm))/(equivalent mass x 10)
mg/kg = mg/l x V%/100g
1 me Ca^{2+}/100g = 200.4 ppm = 5 mmol/kg = 401 kg/ha/150 mm (BD= 1333kg/m^3)
1 me Mg^{2+}/100g = 121.5 ppm = 5 mmol/kg = 243 kg/ha/150 mm (BD= 1333kg/m^3)
1 me K^+ 100 g = 391 ppm = 10 mmol/kg = 782 kg/ha/150 mm (BD= 1333kg/m^3)
1 me Na/100g = 230 ppm
1 me Ca^{2+}/l = 0.5 mmol/dm^3
1 me Mg^{2+}/l = 0.5 mmol/dm^3
1 me Na^+/l = 1 mmol/dm^3
1 ppm P = 2.0 kg/ha/150 mm
Electrical conductivity: 1 mS/m = 1 mmho/m = 0.01 mmho/cm =0.01 dS/m=0.01mS/cm= 10µmho/cm

DIAGNOSTIC HORIZON: A surface or subsurface horizon, which is used for the taxonomic classification of soils.

DRAINAGE: A general term applied to the removal of surface or ground water from a given area either by gravity; the removal of excess water from land by means of surface or subsurface drains; internal drainage refers to natural drainage or percolation of water through the soil.

DUPLEX SOIL: A soil with a relatively permeable topsoil abruptly overlying a very slowly permeable diagnostic horizon, which is not a hardpan.

EFFERVESCENCE: The production of gas bubbles, e.g. when hydrochloric acid is added to lime.

ELECTRICAL CONDUCTIVITY: A measure of the ability of a material to conduct current and is a measure of the concentration of salts in solution.

EUTROPHIC: Refers to soil that has suffered little or no leaching, such that the sum of the exchangeable Ca, Mg, K and Na, expressed in $cmol_c/kg$ clay, is more than 15.

GLEY SOIL: A soil developed under conditions of poor drainage resulting in reduction of iron and other elements and in grey colours and mottles. Soil mottling caused by partial oxidation and reduction of its constituent ferric iron compounds, due to conditions of intermittent water saturation.

HARDSETTING SOILS: Unstable when wet and slump after cultivation to a density similar to before cultivation. However on drying, the soil continues to shrink resulting in a massive layer. They have a low hydraulic conductivity because of dense packing and low macro porosity.

HYDRAULIC CONDUCTIVITY: The proportionality factor (K) in Darcey's law as applied to the viscous flow of water in soil, i.e. the volume flux of water per unit gradient of hydraulic head.

HYDROMORPHY: A process of gleying and mottling resulting from the intermittent or permanent presence of excess water. Hydromorphic soils display evidence of this process.

INTERNAL DRAINAGE: The flow of water within and through the solum.

LOAMY: A qualitative term for soils with approximately 10-35% clay; soils that are not sandy or clayey.

LUVIC: A term that refers to a soil in which the essential characteristic to the markedly higher clay content in the B horizon relative to the A or E horizons. The clay increase is mainly due to illuviation.

PARENT MATERIAL: The unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of soils is developed by pedogenic processes.

PED: A unit of coherent soil particles such as an aggregate, crumb, prism, block or granule formed by natural processes (in contrast with a clod, which is formed artificially

PERCHED WATERTABLE: The surface of a local zone of saturation held above the main body of groundwater by an impermeable layer or stratum, usually clay and separated from the main body of groundwater by an unsaturated zone.

PERCOLATION: A qualitative term applicable to the downward movement of water through soil, especially, the downward flow of water in saturated or nearly saturated soil.

SALINIZATION: The process whereby soluble salts accumulate in soil or water.

SANDY: A qualitative term for soils with approximately 10% clay or less; soils that are coarser textured than loamy

SIGNS OF WETNESS: These signs consist of grey, low chroma colours, sometimes with blue or green tints, with present, may be yellowish brown, olive brown, red or black. The signs of wetness must occur within 1 500 mm of the surface and must not be of such a nature or in such a profile position as to qualify as a diagnostic E, G or soft plinthic B horizon.

SODIC SOIL: Soil with a low soluble salt content but sufficient adsorbed sodium to have caused significant deflocculation.

SOIL HORIZON: A layer of soil or soil approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical and biological properties or characteristics such as colour, structure, texture, consistence, etc.

SOIL pH_{water} :

Extremely acid		: <4.5
Very strongly acid	:	4.5-5.0
Strongly acid	:	5.1-5.5
Medium acid	:	5.6-6.0
Slightly acid	:	6.1-6.5
Neutral	:	6.6-7.3
Mildly alkaline	:	7.4-7.8
Moderately alkaline	:	7.9-8.4
Strongly alkaline		:8.5-9.0
Very strongly alkaline	:	>9.0

SOIL PROFILE: A vertical section of the soil through all its horizons and extending to the underlying material.

SOLUM: The upper part of a soil profile, above the parent material, in which the process of soil formation is active. The solum in mature soils includes the A and B horizons. The living roots and other plant and animal characteristics of the soil are largely confined to the solum.

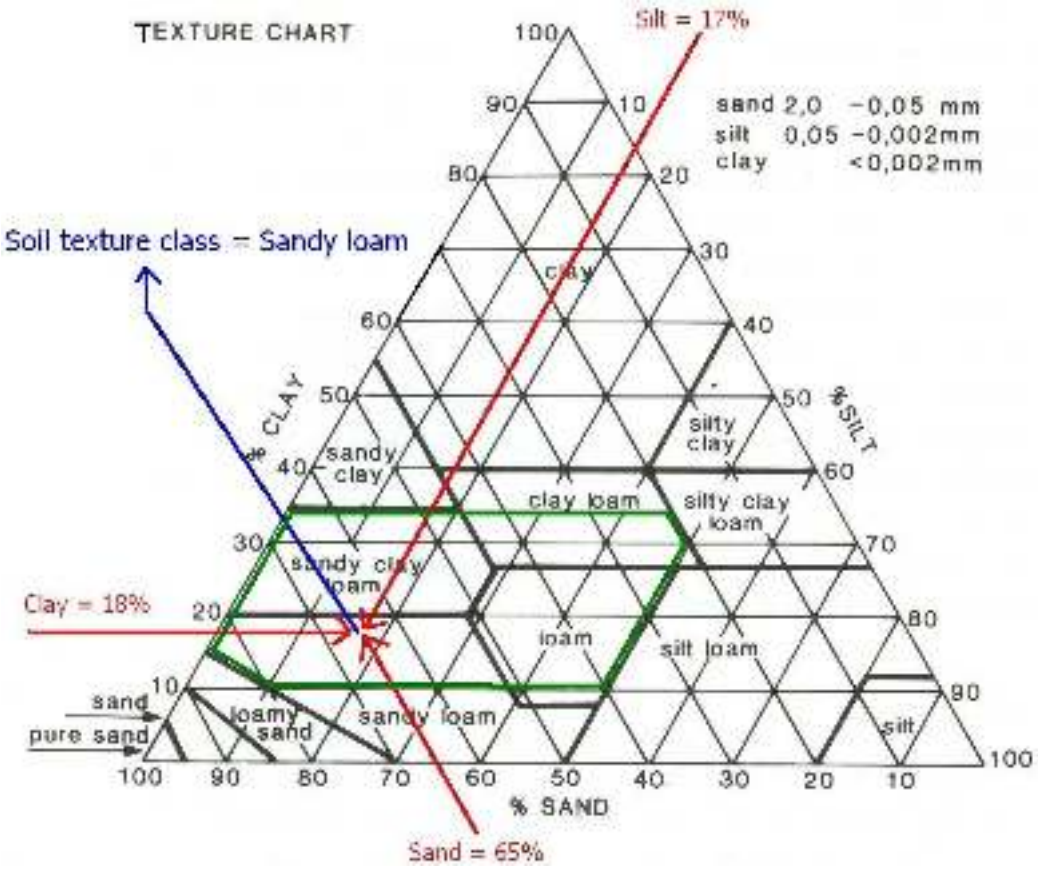
STRATIFICATION: Arranged in or composed of strata or layers

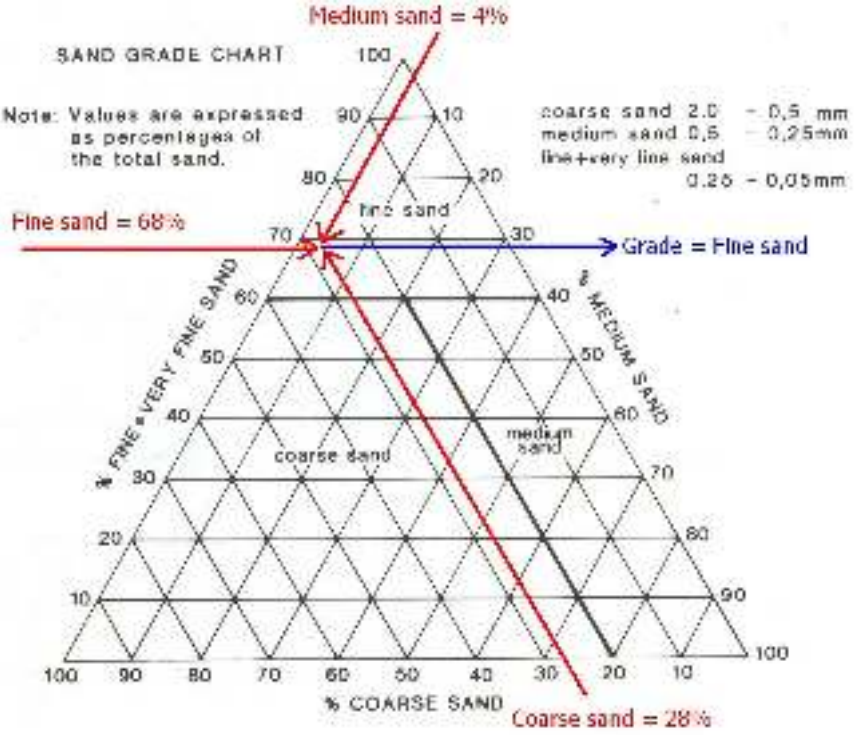
VLEI: A low-lying area subject to periodic or continuous wetness

WATERLOGGED: Soil or land saturated with water. It may result from excessive rain, irrigation or seepage, coupled with inadequate drainage and is detrimental to the growth of most crop plants

WATER QUALITY GUIDELINES FOR IRRIGATION:

Water Quality Constituent	CLASS 1	CLASS 2	CLASS 3	CLASS 4
Salinity (EC) mS/m	0-40	40-90	90-270	270-540
Sodicity (SAR)	0-1.5	1.5-3.0	3.0-5.0	5.0- 10.0
Boron (mg/l)	0-0.2	0.2-0.9	0.9-1.5	1.5-3.0
Chloride (Cl) (mg/l)	0-105	105-140	140-350	>350
Sodium (Na) (mg/l)	0-70	70-115	115-160	160-200
Nitrogen (mg/l as N)	0-5	5-30	>30	
Iron (Fe) (mg/l)	< 0,05	0,05-5	5-10	10-20
Manganese (Mn)(mg/l)	<0,05	0,05-0,2	0,2-5	5-10
pH(Acceptable range)	6.5-8.4			


TEXTURE CHART
Silt = 17%
sand 2,0 – 0,05 mm
silt 0,05 – 0,002mm
clay <0,002mm
Soil texture class = Sandy loam
clay
silty clay
sandy clay
clay loam
silty clay loam
sandy clay loam
loam
silt loam
sandy loam
loamy sand
sand
pure sand
silt
Clay = 18%
Sand = 65%
% CLAY
% SILT
% SAND


Medium sand = 4%
SAND GRADE CHART
Note: Values are expressed as percentages of the total sand.
coarse sand 2.0 – 0,5 mm
medium sand 0,5 – 0,25mm
fine+very fine sand 0.25 – 0,05mm
Fine sand = 68%
fine sand
Grade = Fine sand
coarse sand
medium sand
% FINE + VERY FINE SAND
% MEDIUM SAND
% COARSE SAND
Coarse sand = 28%